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Posted Date: 1 April 2026

doi: 10.20944/preprints202509.0057.v3

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Article

The Time Interval Only Set, Part 2

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Abstract

This paper is Part 2 continuing the investigation from Part 1, in 2024. To recall, in Part 1, with the derivation of two theorems, defined is an axiomatic approach to the time interval only description. The time interval only set approach is an alternative to the usual one moment time description and the traditional tangent approach of change and differentiation. The two fundamental and nearly equivalent set theorems are the multiplication linearity theorem and the multiplication closure theorem. Both these theorems claim for two time intervals the multiplication result is a time interval. The present paper includes the construction of an overall simultaneous emission example surface for any approximation of the limit surface of simultaneous spherical symmetric wave emission, applying a variation to a well known construction for indecomposable continua. To evaluate the example surface and its construction several comments and theorems are derived. These include proof of two new theorems, emission theorem I and II, related to the identity transformation or mapping, which have value in their own right when considered as mathematical theorems. Emission theorem I and II depend on the 'current parameter' concept applying a multiple 'dimensional domain definition' within both the one moment time and time interval only description, concepts defined applying set representation theory. Another part of the approach is the linear functional theorem. Within this approach defined is, within the time interval only description, zero and non-zero equilibrium and simultaneous emission, with 'zero' temperature to be the non-zero lowest bound temperature, resembling Boson type of simultaneous emission within a cosmology of groups of multiple star sources. Since finite time intervals are introduced being asymmetric this approach can be integrated in Curie's principle for asymmetry. The current parameter definition allows for a comment on the fundamental theorem on polynomials. Assuming simultaneous emission internal interaction, including e.m. kinetic energy and gravitation energy, provides with several overall results including introduction of a time interval only description gravitation constant.

Keywords: time interval; (a-)symmetry; current parameter; simultaneous emission; Noether charge; star source collective; non-zero equilibrium; dark matter fraction; gravitation energy; emission temperature; fundamental theorem of polynomials; Kramer's equation; time reversal; set representation theory; identity mapping; reciprocal quantities; gravitation constant

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Paragraph 1. Introduction

1.1. Introduction

The time interval description differs from the Newtonian tangent approach, (Newton, 1686), with definitions from (Hollestelle, 2020). These are, the introduction of new time coordinates and the definition of time intervals, time interval derivatives, and time interval equilibrium. Intervals have been subject of philosophy of science, and of physics, where they are part of e. g. the action principle, (Goldstein, 1950). Time interval equilibrium, termed TE in (Hollestelle, 2024part1, also refered to with Part1) and in this paper Δt-equilibrium, is defined due to averaging, (Hollestelle, 2020). It depends in origin on the 'mean speed theorem' of Medieval science. Within the one moment time description, equilibrium is termed Lagrangian- or t-equilibrium. Where equilibrium is the term for any approach, the pretext t- is sometimes disregarded, to avoid reducing overall meaning. Some phenomena, e. g. frequency, can only be measured, they are to be counted, during a finite measuring event related to

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a finite event time interval. In Part1 is derived the time interval addition property, eq. 1 in par. 2.1 in this paper, only valid for the time interval only set. Two nearly equivalent time interval only set theorems are the multiplication linearity theorem and the multiplication closure theorem, also derived in Part1. Both these theorems claim the multiplication result of two time intervals is a time interval.

Within the time interval description one does not apply the tangent method. Time intervals can be an alternative to the usual introduction to change or the start of change of variables, and assure continuity within phase space, where one moment time parameters reduced to infinitesimal limits can be problematic and where time intervals or their derivatives are not, (Hollestelle, 2020). However, with events where the Hamiltonian is time independent, results for both the time interval description and the one moment time description are the same. The time interval description has been introduced in references by the author, mentioned at the end of this study.

The Noether charge, (Noether, 1918), (De Wit, Smith, 1986), with time interval only set version ΔNC derived to be, for the special case of simultaneous emission due to star sources, equal to the invariant overall simultaneous energy unit, is found to be linear with the time interval only set structure constant Δs. In Part1 multiplication scalars were partly disregarded, this did not affect results. With a1. ΔNC = a2. Δs, for any scalar a1 and a2, time interval only set Noether charge or structure constant requirements are fulfilled by any linear dependent solution a1. ΔNC or a2. Δs. One can choose ΔNC and Δs such that a1 = a2 = 'multiplication unit'||scalar_set, without any change of physics, this is termed gauge transformation invariance. Arguments for this particular choice are discussed in *comment A* and *comment C*. This is subject of a forthcoming paper.

Some earlier results can be written in terms of equivalences, i. e. y1 and y2.

y1. Derived is, simultaneous emission surface energy, can similarly be derived from the geometric surface energy concept with the same result. For the electromagnetic (e.m.) QM emission field energy, (Sakurai, 1967), for the equivalence or similarity with the geometric surface energy, (Hollestelle, 2021, 2024Part1), the geometric surface energy concept originating from (Hollestelle, 2017), and earlier, (Hollestelle, 1990). y2. Within the time interval description it is derived gravitation energy is equivalent, however opposite in result, to simultaneous emission surface energy, (Hollestelle, 2021, 2024part1).

The time interval description and Δt-equilibrium were dependent, from the beginning, on one moment time boundaries for the relevant event time interval Δt, this 'infinite regress' problem to the one moment time description was resolved in Part1 to introduce the time interval only set, instead of the time interval set.

Outline

A question remaining from Part1 is, when emission surfaces are to be exemplary to describe overall physical phenomena, what is to be exemplary for emission surfaces. In *comment B* an example approximation is constructed for an emission surface. This example is a new and extensive version for the proposed example in (Hollestelle, 2021, 2022), there termed 'wrinkled' surface. In par. 1.2 the current parameter concept is introduced and in relation to this the dimensional domain definition and a comment on the fundamental theorem on polynomials. Two decisive theorems, *emission theorem I* and *emission theorem II*, are introduced in paragraph 1.7, their derivation in *comment B*. Also included in par. 1.7 is a summary of other preliminary results.

With an introduction to time development within the time interal only description, par. 2 to par. 7 discuss the example construction applied to simultaneous emission energy from star sources. Simultaneous emission in terms of reciprocal emission density and source density agrees with the emission wave approach. It is argued the star source simultaneous emission description and the emission theorems can be applied to any overall cosmology, due to the specific theorems in par. 3.8.

Within the time interval only set discussed are, in *comment A*: zero or non zero mass wave-particles complementary to simultaneous emission, internal interaction and frequency change, *comment B*: introduction of the example approximation construction (termed construction II) for the

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simultaneous emission surface, *comment C*: emission surface measure preserving specific Lorentz transformations (TS) in addition to the space-time line element measure preserving usual Lorentz transformations (TL).

Definitions of Time Interval Quantity Sets

In this paper investigated are one moment time description quantities and time interval only description quantities, resp. t-quantity and Δt-quantity. These are related through correspondence, applying the zero's and units of these sets, in Part1 termed correspondence C1, with correspondence C2 applying pairs of commutation quantities, giving the same correspondence results. Quantities can be expressed within each of these descriptions, even when they are not proper time parameters or proper time intervals. A t-quantity, e. g. A1, can be considered to be within domain dA1 = [A1_0, a. A1_1], where Δt-quantity, ΔA1, can be regarded to be within domain dΔA1 = [ΔA1_0, M[a, ΔA1_1]], defined with the zero's and units of their resp. sets and some scalar parameter a ≥ 'multiplication unit'||scalar_set. The domain limits or boundaries are indicated with A1_0 = 'multiplication zero'||A1_set and A1_1 = 'multiplication unit'||A1_set, with A1_set or ΔA1_set meaning the complete set for A1 or ΔA1. Δt-quantity set domain boundaries do not have to be always equal to these set zero's and units when less trivial. It is derived in par. 3.8, within theorem 1 and 4, set boundaries of any Δt-quantity set can be reduced to set boundaries of the time interval only set, these sets being linearly dependent.

Time Development and the Time Interval Only Set

Arguments for nonlinearity from discussing time development are included in par. 2.1 and 2.2. Nonlinearity was introduced in the time interval only set from its origin when defining time intervals, e. g. time interval Δt = [tb, ta] according to par. 2.1, eq. 2. Time intervals are found to be asymmetric when the Hamiltonian is time dependent and vice versa, and defined with time interval description Δt-equilibrium instead of one moment time description Lagrange t-equilibrium, (Hollestelle, 2020). The nonlinearity property is recognised from the nonlinear derivative 'set rule' for the time interval derivative of a scalar multiplication of a time interval Δt-quantity, in Part1.

The time interval only description of both time intervals and time development is 1-dim., depending on measured and experienced properties of time development, where within the one moment time description *time moments* are 0-dim. and *time development* is 1-dim. It is not possible considering time development to include to 'turn' or 'reverse', or to 'go to' or 'change to', by time like translation, to another time interval in the time interval only set, (Hollestelle, 2020).

These properties have been introduced and discussed in earlier papers.

Commutation properties for any set including the one moment time set and the time interval only set, on which the derivative 'set rule' depends, are defined in the axiomatic approach from Part1. Time interval Δt related commutation brackets are [A1, A2]||Δt = 1/2. (A1(tb). A2(tb) − A2(ta). A1(ta)) for any t- or Δt- quantities A1, A2 and ΔA1, ΔA2, while Δt-equilibrium is assumed, and one finds time interval derivative D*||Δt[A2] = [A1, A2]||Δt for A1 = 1/t, (Hollestelle, 2021). The time interval derivative 'set rule' is D*||Δt[M[a1, ΔA2]] = A[a1. D*||Δt[ΔA2], Rest(a1)||Δt] with Rest(a1)||Δt = M[D*||Δt[a1], Δt] and similarly D*||t[M[a1, ΔA2]] = A[a1. D*||t[ΔA1], Rest(a1)||t] with Rest(a1)||t = M[D*||t[a1], Δt], D*||t one moment time derivative however following Δt-equilibrium, not Langrangian t-equilibrium. Time interval only set nonlinearity is inferred to relate to its associativity properties and the * operator 'working to the right' and the scalar 'moving to the left' concepts, e. g. from D*||Δt and 'set rule' scalar a1, and commutation relations that define the equation sign, discussed in terms of addition and its inverse, Part1.

Time development, discussed in par. 1.3 and 2.2, when related to 1-dim. one moment time description change of matter properties, when assumed within a continuous series, with Newton's approach and 1-dim. linear tangents, this suggests a path-like interpretation which, however, is not the subject of this paper. The time interval only description does not suggest this, where gravitation

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energy or simultaneous emission energy remain non-local, before possible measurement event interaction and wave-function collapse.

Both one moment time description t-equilibrium and time interval only description Δt-equilibrium relate to infinitesimal linear transformation equations and to Hamilton's derivative equations, assumed to be valid within both descriptions, and valid also when in the latter description the Hamiltonian is time dependent, (Hollestelle, 2020).

Newton's tangent approach can traditionally be discussed in terms of reversability, its invariances with respect to space-time transformations including reflections, (Arnold, 1974). Not all phenomena within the time interval only description, e. g. time development, allow reversal. Time reversal is discussed in par. 2.4. Inferred is a relation exists with specific Lorentz transformations TS, that can describe time interval change, defined in Part1, and thus with the interactions discussed in this paper.

Asymmetry and the Time Interval Only Set

Not considering other arguments, asymmetry for any time interval within the time interval only set relates to asymmetry within time interval description Δt-equilibrium with time development 'relevant event time interval' Δt. The relevant measurement event or the event or situation investigated or described occur within time interval Δt. Within this time interval, the average for one moment time description time-like parameter t is $< t > | | \Delta t = t0$, defined equal to 'multiplication unit'$| | t_set$, and is to correspond with time interval $\Delta t0$ = 'multiplication unit'$| | \Delta t_set$, and similarly for 'addition' units. Correspondences are defined from set units and zero's and relations for Δt, for the one moment time set and the time interval only set, in (Hollestelle, 2024part1). In this way asymmetry of Δt within the time interval only description is part of any result.

Comment 1. Equilibrium can be defined to relate to invariance of some parameters expressing the change of other and different parameters while variable, following e. g. (Arnold, 1974). In this way time interval equilibrium can be included in and become part of *Curie's principle* which refers to the occurrence of asymmetry in cause and effect, (Curie, 1894).

Curie's principle relates asymmetry in one domain, the latter, to asymmetry in another domain, the former. The present research, both Part1 and Part2 (the former and present papers), concerns the time interval only set, specifically with finite, i. e. asymmetric, relevant event time intervals Δt, which implies a time dependent Hamiltonian, in some cases symmetric time intervals Δt however are considered too. Curie's principle in this way refers to non-zero equilibrium, which is defined depending on the asymmetry of time interval Δt.

Emission Energy and Gravitation Energy

Internal interaction, par. 5. and *comment A*, is a possible process for acquiring gravitational mass for wave-particles. Internal interaction as it is meant in this paper, 'internal energy transfer', was introduced in (Hollestelle, 2021), where non-zero mass wave-particles have reduced mass value however increased particle number when outgoing, where due to complementarity only outgoing, i. e. emission, processes are valid within QM, not regarding virtual processes. Zero mass photons, i. e. zero mass particle complementary wave emission, due to time development propagating away from their source, do not acquire mass by internal interaction, not regarding other processes, e. g. the Higgs mechanism. The opposite process, ingoing, i.e., free falling wave-particles, whether with zero or non zero mass, can acquire mass due to internal interaction. This is not an emission rather a wave-particle gravitation process.

In par. 3.1 sets of stars as sets of sources for simultaneous emission are considered and several overall theorems within the time interval only set are summarised in par. 3.8. These theorems, theorem 3b and 3c in particular, claim the addition property is valid for any time interval quantity set. The addition property, the addition of any two or several of the same time intervals remains the same time interval, eq. 1, par. 2.1, is derived by applying a time development definition termed 'overall' or 'cosmological' time, in (Hollestelle, 2024part 1). From this ref. is the following version of

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time development in the sense of simultaneousness. "*Within the one moment time description meant is: there is the same time for the physical universe together and no part is late or early in reference to this 'time'*", (Hollestelle, 2024part1). This version of time development is within the one moment time description, however what is essential is the concept of simultaneousness. Simultaneousness can also apply to time intervals, and this version of time development is applicable within the time interval only description. However, such definitions or descriptions are part of philosophy of science. The addition property applies to any time interval $\Delta t1$, not simply to one specific time interval, and the result of addition is not only a time interval from the time interval only set, it is, unchanged, the time interval one started with, $\Delta t1$. Assuming simultaneousness relevant for the relevant event time interval, this property being valid for not only the time interval only set however also for other sets, e. g. star source sets related to star source emission, is crucial to regarding the time interval addition property universal when applied to any star source set comprising cosmology.

Non-Zero Equilibrium and Acquired Energy

Both within the time interval description and the one moment time description defined is the concept 'non-zero equilibrium', different from the usual 'zero equilibrium', in par. 3. Equilibrium is termed zero equilibrium when following exactly from t-equilibrium Lagrange equations within the one moment time description and similarly from Δt-equilibrium within the time interval description. With acquired energy U, in this paper indicated with 'space-like' energy, meant is energy dependent on one moment time space-like coordinates q, this type of energy being usually termed V (Goldstein, 1950) or U (Arnold, 1974), e. g. gravitation energy. Kinematic energy is indicated with 'time-like' energy, usually termed T or K, including simultaneous emission energy. The terms space-like and time-like for energy do not imply a direct relation with one moment time description space-like and time-like coordinates. When one argues non-zero equilibrium energy difference is not time-like, is not kinematic, this implies it is space-like. Time-like energy can be assumed to relate to space-like invariances, e. g. space transformation conservation of energy, due to the same invariances of space-time universe, if these do apply.

Then, in the one moment time description, acquired energy U applies to any space-like coordinates dependent energy and the energy difference due to non-zero equilibrium equals acquired energy difference dU. The terms zero and non-zero equilibrium apply to both descriptions leaving out the t- or Δt- prescript.

Assuming 'non-zero equilibrium', measured space-like energy U^* can differ from the 'zero equilibrium' space-like energy U, possibly gravitation energy $U = Eg$, derived from zero equilibrium equivalence with kinematic energy, termed T in this paper, where T indicates, traditionally, temperature, following the meaning of the text. With a description change, from zero to non-zero equilibrium, implied is 'acquired' energy change from U to U^*, i. e. space-like energy difference $dU^* = U^* - U$, the indication * meaning the changed situation where the original situation remains without extra *, not meaning the operator * indication. This dU^* can be of unknown 'space-like' acquired energy type, and is not necessarily interpreted with usual space-like gravitation energy, e. g. interpreted with gravitation energy for presently unknown source, e. g. dark matter. Similar definitions for time-like kinetic energy can be drafted, while taking care of the special properties of acquired energy mentioned earlier. An unknown energy type implies an interaction unknown in the present description of the physical universe. This is discussed in par. 3, within both the one moment time and the time interval only description.

1.2. Current Parameters and the Dimensional Domain Definition

Current parameters are new and different from usual parameters, and this paper is a first-time application, i. e. to the time interval only set. Current parameters are introduced to be similar to object rulers to describe a stationary object occurring in space-time. This concept needs some introduction to be defined clearly, it deviates from the usual parameter. The dimensional domain definition implies the current parameter exists of a combination of several, more than one, parameters termed

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dimensional. Their introduction in this case follows from the example emission surface requirements and the set representation approach for current parameters t^^ and w and their domains with respect to infinity. Internal parameters have the same domain as their current parameter. The occurrence of dimensional parameters has its origin in avoiding singularities, *comment B*.

Measuring implies counting current parameter units when accepting these units to be bias or scale for the object. Current parameters describe an object, not with one moment time description t-equilibrium space time coordinates, i. e. one set of unique one moment time parameter t dependent values, instead describe an object with the properties it occurs at all space-like coordinates, i. e. with time interval description domain intervals similar to a place or region in 3-space. A place, a finite local region, is not a position, a position is a single value one moment time description space-like coordinate set in space time, places were introduced e. g. in (Hollestelle, 2018). Current parameters resemble an invariant 'displacement' field in field theory, e. g. (Jauch, Rohrlich, 1955), (De Wit, Smith, 1986).

The concept of center of weight, (Newton, 1686), with object properties reduced to one set of one moment time description space-like coordinates, implies a possibly invariant center of weight parameter set similar to a current parameter set meaning the zero unit 'addition zero'. Invariance is one of the properties to define current parameters.

When a measuring vessel or transparent glasswork laboratory beaker, with volume V in liters being the upper bound for the beaker, e. g. V = 2 liter, where volume is indicated and scaled on the beaker, contains a water volume W ≤ V in liters, e. g. W = 1 liter, the glass beaker can be considered to imply a current parameter termed lab^^ measuring the space-like properties for a certain amount of water, in this case for the water volume W present in the laboratory beaker, while the current parameter domain dlab = ['multiplication zero'||lab^^_set, 'multiplication unit'||lab^^_set], or otherwise termed dlab = [lab^^_0, lab^^_1], remains invariant with changes of W. This means, the current parameter does not measure W, rather is normed by W. This is different for W, the one moment time description space-like water volume quantity, measured to be contained in the laboratory beaker, with domain dW = [V_0, V] = [V_0, V. V_1], with V_0 = 'multiplication zero'||V_set and V_1 = 'multiplication unit'||V_set, a domain which allows to measure any water volume W < V, less than upper-bound volume V. This is defined by the laboratory beaker, and considering water and its property volume W with scalar multiplication of matter volume units, or similarly with addition of matter volume units, e. g. V = 2. 1 liter and V = 1 + 1 liter both valid. The multiplication dimension problem (MDP) of *any volume* W being a volume similar to V_0 or V_1 independent of non-scalar multiplication or addition was resolved in (Hollestelle, 2020). It is discussed again in par. 3.8, when introducing several theorems for the time interval only set while depending on the multiplication closure theorem from Part1.

The definition of 'standard tangent' or 'tract or standard measuring rod' in space-time in GR, (Einstein, 1905), was to define scaling of local measurements to be joined to nonlocal measurements by addition or multiplication of units, not necessarily linear, with a one moment time space like q-quantity domain, however not bounded by the 'multiplication unit'||q_set occurring with the current parameter domain that remains bounded by this unit. Within the traditional one moment time description concepts for local surroundings or local space-like units, to which can be added the space-like 'dot' or 'place' or 'measurement place', introduced in (Hollestelle, 2018, 2021), are somehow similar to a current parameter space-like unit, since they are assumed independent from time interval only set time development and 'multiplication unit'||Δt_set. Specifically, measurement places in space like space-time have some similarity with the current parameter concept.

Comment 2. Current parameters within the one moment time description differ from one moment time space-time coordinates, and are a special type of property indications. One can define properties according to their symmetries. One type of symmetry implies whether or not property values can be negative or positive or both. For objects in space-time the usual properties are the one moment time description coordinates. Usually, one moment time description space-time coordinates are assumed

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to be translation and reversal symmetric, due to the relation of infinite space-time field theory and conserved quantities, (Goldstein, 1950), (De Wit, Smith, 1986).

This is not necessarily valid within the time interval only description, where time intervals are defined depending on counting time. Time intervals, e. g. [tb, ta], apply one moment time parameters tb < 0. t0 and ta > 0. t0, following the definition in par. 2.2, which is from (Hollestelle, 2020, 2024part1). For these time intervals, time reversal symmetry and time translation symmetry do not trivially exist. However, counting and measuring for current parameters is different.

A current parameter, e. g. space-time property current parameter t^^, *comment B*, interpreted to be object ruler, cannot have a symmetric positive negative domain, rather 0. t0^^ = 'multiplication zero'||t^^ is the current parameter domain lower bound. This is due to their definition depending on continuous increasing values from a lower bound towards a certain limit, not so much implying measured values rather counting unit integer values and with off-unit non-integer values not being considered valid counting however to be approximated with 'zero' or 'unit' value, meaning only positive values are possible, *comment B(B3)*.

Definition 1. Any object ruler, e. g. t^^, is defined with a domain being a one-sign only set. Measuring the current parameter domain starts from e. g. 'addition zero'||t^^, when calibrated. One counts by successive addition until the domain off-unit is reached, i. e. the term current parameter. A recent discussion of numbers related to counting is found in (Murawski, Bedürftig, 2010).

In *comment B(B8)* the concept of measuring with the current parameter until a domain limit is reached is made clear to differ from usual measurements, by introducing current parameter t^^ domain [t0^^, tl^^] = [u(0), u(1)] where u(0) = 'addition zero'||t^^_set and u(1) = 'addition unit'||t^^_set and measuring implies counting from u(0) towards the domain limit tlim^^ due to the described object, defining the object dependent calibrated current parameter unit u(1) with tlim^^ = r. u(1). Since, in this case, in *comment B*, the 'measured' object is mathematical in origin and not is meant measuring within physics of the emission surface, the object being the indecomposable continuum surface example and its surface parts, the preferred term is counting rather than measuring within physics and a marge is not necessarily to be decided. In *comment B(B8)*, regarding the equivalence of addition and multiplication within the time interval only set derived in Part1, the units for the current parameter can be in units multiplication or in units addition.

Current parameters are not equilibrium time development dependent one moment time parameters, e. g. the usual Newtonian space time coordinates q and t or generalized coordinates due to Lagrange t-equilibrium within the one moment time description, space like parameters q and conjugate momenta p from Hamilton's equations, together with the usual one moment time complete and partial derivatives d/dt*[p] = -1. ∂/∂q*[U(q)] and d/dt*[q] = ∂/∂q*[U(q)], energy type U termed space-like energy due to one moment time space-like coordinate q dependence, assuming mass m invariance, (Goldstein, 1950), (Arnold, 1974). In this paragraph the * indicates a one moment time operator, 'working to the right' on the quantity in brackets. It was found in Part1, time interval derivatives depend on, non-linear, time interval addition, while one moment time derivatives depend on tangent, linear, one moment time coordinate addition. The derivatives for these sets are related since Δt-equilibrium depends on time interval Δt and on one moment time coordinates within time interval Δt, which causes an infinite regress problem that is resolved when introducing correspondences, (Hollestelle, 2020, 2024part1).

A construction II surface part implies a one moment time place in space and parametrization describes the 2-dim. domain.

The concept of parametrization with object rulers, i. e. current parameters, seems independent of the time development and metric for the overall cosmology, however due to calibration connects to it. For this connection, necessarily, the emission surface related, relevant event time interval Δt should somehow be related to the calibration event time interval Δt_cal, which is unlikely, since these different events are not simultaneous necessarily. With independent current parameters, i. e. current parameters that do not follow equilibrium time development, calibration measurement event properties should possibly be ignored. This provides consistence with the traditional measurement

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description, i. e. differentiated can be two assumed independent measurement events, object ruler calibration measurement event Δt_cal, and object Δt-equilibrium time development measurement event Δt ≠ Δt_cal. Most of *comment B* is within this assumption, except *comment B(B2)*. Another question is whether a cosmology described within physics should be measurement related at all, however this is part of philosophy of science.

Dimensional Domain Definition and the Fundamental Theorem for Polynomials

The definition of current parameters in this paper follows what is termed dimensional domain definition in *comment B(B5)* and *definition 5*, and *comment B12(A3)*. This definition implies the domain for t^^ is a multiplication of m different 1-dim. product spaces, in the case of the emission surface m = 2 and t^^ is equal to multiplication t^^ = tv. tw, while the resulting t^^ domain is divided in domain parts for t^^ finite and t^^ infinite. The m parameters, with m = 2 in this case tv and tw, are termed internal parameters. Due to the singularities encountered when defining transformations of the surface parts ΔPi, i = 1 to N, the dimensional domain definition for the current parameters is necessarily applied. Surface parts ΔPi together by union equal surface ΔPu, which is the example approximation for the emission surface.

Within *comment B* derived is, a comment to the fundamental theorem on polynomial equations in algebra, which is also discussed in par. 2.6 and par. B12(A7). Usually, this theorem is introduced mentioning the number of solutions to these equations to be *at least one* and *less than or equal to n* for a polynomial equation of degree n, (Hocking, Young, 1961), and (Arnold, 1974).

Comment 3. With any nth order polynomial equation P(n)(t^^) = 0 for t^^, apply the M-dimensional t^^ domain definition, introduced more completely in *comment B*, par. *B12(A3)*, with dimension M = 2 and t^^ = tv. tw, with special attention to t^^ with respect to infinities and set cardinal numbers. This can be extrapolated to any dimension $M \geq 2$, e. g. to include $(M-1)$-dimensional tv$(M-1)$ and 1-dimensional tw(1), with t^^ = tv$(M-1)$. tw(1), for any nth order polynomial P(n)(t^^) = 0 similarly implying existence of nth order polynomials P(n)(tv) = 0 and P(n)(tw) = 0 and different solutions can be found by applying the transformations TU and I, *comment B*, related to the surface parts ΔPi and ΔPu, introduced in *comment B* to be an example covering for any emission surface. The construction parameters, related to the construction of the ΔPi and ΔPu, can constrain the dimensional domain definition since the combined transformations TU*I should leave the metric surface measure invariant, i. e. should be specific Lorentz transformations. Where the combination TU*I equals the identity, the single transformations TU and I do not, and to the at most n solutions, mentioned by the ref., they add new solutions for the same polynomial equation.

1.3. Spherical Symmetric Emission Surface

Within the time interval only description events and properties depend on a specific relevant event time interval Δt, with the properties A[Δt1, Δt] = Δt1 and A[Δt, Δt1] = Δt1 for any time interval Δt1, including Δt1 = Δt, with A meaning time interval only set addition and Δt = 'addition zero' | |Δt_set, according to the time interval set addition properties. Similarly M[Δt1, Δt] = M[Δt, Δt1] = Δt1, with the same Δt = 'multiplication unit' | |Δt_set. Relevant time interval Δt relates to the specific description of spherical symmetric wave emission, and to a possibly related measurement event time interval, a description assumed exemplary for any event within the time interval only description. The time interval only description approach is intended to be universal, the discussion starting with spherical symmetric star source emission is considered exemplary for this. Not investigated is linear wave emission, however assumed is there is an emission source and an emission limit surface, termed surface ΔA, dependent on time development with time interval Δt.

Wave emission with some group-velocity $c(\Delta t)$ implies complementary wave-particles of zero or non zero mass. Finite time interval Δt is an indication for measurement events and interaction events. The spherical symmetric emission surface ΔA = ΔA(Δt), within the time interval description, where emission surface energy implies simultaneous emission energy during Δt, was discussed earlier in (Hollestelle, 2021).

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Star-source emission, when interpreted with spherical symmetric emission surfaces, is different from linear wave emission. Time interval description space-like surface measure, not meaning the usual line element dependent metric, remains invariant with change of Δt, or with Δt-equilibrium time development. This is due to overall conservation of energy to which one finds mΔA proportional, this is the first law of thermodynamics for macroscopic events, which is assumed valid trivially for finite time interval events.

From the usual QM concepts within the one moment time description, e. g. discussed in (Sakurai, 1967), (De Wit, Smith, 1986), only the following remain within the time interval only description; zero or non zero mass wave-particle and wave complementarity including momentum p = *h*. k, the linear energy frequency relation E = *h*. ν, with the usual indications, and the operator 'working to the right' concept.

Sphere-like surfaces and their thermodynamic properties were discussed, starting from a set of closed surfaces in a specific volume, in (Hollestelle, 2017). It's surface concept includes surface geometric energy independent of a priori surface or curvature constants. Equivalences y1 and y2, are valid both within the time interval description. Geometric surface energy, defined still within the one moment time description, equals the QM version for e. m. simultaneous emission surface energy and equals gravitation energy, (Hollestelle, 2021, 2024part1).

To assume spherical symmetric emission surfaces does imply wave emission, not complementary wave-particle paths. The discussion of emission from the concept of paths in QM is not the subject of this paper. The current parameter concept, to describe example surface parts Pi from construction II, is completely defined in *comment B*. Hidden parameters are those that are not phase-space variables. It is not investigated whether the parameters from construction II are complete or whether it is possible with these to create a 'path' narrative for QM.

Simultaneous emission energy ΔEs is proportional to surface measure mΔA, where time interval only quantities correspond with one moment time quantities through correspondence from set units and zero's. Specific Lorentz transformations TS can be defined that leave metric 2-dim. surface measures including mΔA invariant, rather than metric 1-dim. measures, metric line elements, invariant with traditional Lorentz transformations TL. TS transformations, TS(Δt) = Δt' where Δt transforms to Δt', due to their definition respect simultaneous emission energy conservation and correlate with time interval only description Δt-equilibrium time development Δt to Δt', which is considered a non interaction time development.

Simultaneous Emission

For one moment time description 2-dim. emission surface A in combination with surface dependent scalar weight Ad for simultaneous emission, indicated wih multiplication 'volume' A3, with measure mA3 = Ad. mA, within the time interval description version ΔA3, with mΔA3 = m(Ad). m(ΔA), with . scalar multiplication. Time interval description estimate < Ad >||A = mΔq, when considering emission surface ΔA(Δt) for time interval Δt, due to average Ad ≈ < Ad >||A. Introduced in (Hollestelle, 2020, 2021) is equation mΔt = a. mΔq, meaning Ad = mΔq relates to the radius of the emission surface ΔA, and due to the 'simply measurable' property for relevant event time interval Δt, defined in the next paragraph, par. 1.4. Relation mΔt = a. mΔq can imply conservation of simultaneous emission energy only for scalar a = 'multiplication unit'||scalar_set and mΔt = mΔq, par. 3.8, originally (Hollestelle, 2020, 2021). Within the time interval only description, this implies measures mΔA3, simultaneous emission energy mΔEs, and time interval Noether charge mΔNC, have equal values.

1.4. 'Simply Measurable' Relevant Event Time Interval ΔT and Specific Lorentz Transformation TS 'Simply Measurable'

Time interval simultaneous emission, while measurement event dependent with event time interval Δt, is defined assuming a finite wave group-velocity, and emitted and 'on the way' during the same relevant event time interval Δt. Within this definition, Δt is termed 'simply measurable',

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meaning the time interval measure mΔt can be measured within specific time interval Δt, a property derived to be always valid for Δt in (Hollestelle, 2021, 2024part1). The property 'simply measurable' could be introduced to define why a relevant event time interval is relevant.

Specific Lorentz Transformation TS and Commutation Quantities

A reciprocal pair of one moment time commutation quantities cn and cn' is defined as follows: t. cn' = cn. t and 1/t. cn = cn'. 1/t, corresponding with time interval only quantities cn(Δt) and cn'(Δt). The specific Lorentz transformation, TS(Δt) = Δt' is consistent with cn'(Δt) = cn(Δt'), and implies invariance for emission surface energy ΔEs, which is as it should be when no interaction occurs, and implies invariance for surface measure mΔA proportional with mΔEs, meaning mΔA'(Δt') = mΔA(Δt), the defining property for the specific Lorentz transformations TS in (Hollestelle, 2021, 2024part1), meaning TS is different from the usual Lorentz transformations TL.

Within the one moment time desription, infinitesimal transformations TS equal linear t-equilibrium transformations and the metric distance measure remains preserved together with the concept of covariance, similar with the usual infinitesimal or complete TL. The non-infinitesimal complete transformations TS are t-equilibrium transformations quadratic in the change of one moment time description 3+1 dim. space-time t-equilibrium coordinates q(t) and t, (Hollestelle, 2021). Within the time interval only discription non-infinitesimal transformations TS remain linear, due to time interval only set properties A[Δt1, Δt1] = Δt1 and M[Δt1, Δt1] = Δt1, and preserve surface measure mΔA.

Commutation Properties of the One Moment Time Set and the Time Interval Only Set

Commutation properties and quantities within the approach of Part1 are defined for both the time interval only set and the one moment time set. Applied can be another approach also, where transformations and operators 'work to the right' indicated with * and due to the derivative 'set rule' with multiplication scalar a1: e. g. mLS*[ΔA] = mΔA, and for any scalar a1, this scalar 'moving to the left' of the derivative operator D*||Δt, meaning D*||Δt[a1. ΔA1] = A[a1. D*||Δt[ΔA1], a1. Δt]. Recall the second associative, distributive, property, termed AP2 in Part1, is not necessarily always valid and the 'set rule' remains non-trivial. This approach is possible due to the definition of time interval operators in (Hollestelle, 2021), and *comment B*, and the derivative 'set rule' and time interval associative properties, derived in Part1. Due to the canonical property for the time interval only set, time interval set generators equal set elements, not regarding scalar multiplication uniqueness, discussed in Part1. Commutation quantities and structure constants in relation to set representations are extensively discussed in the literature.

1.5. Correspondence

Emission surface energy ΔEs = #n. *h.* ν, related to emission surface ΔA(Δt), with variable number #n for a multiple wave function, can depend on one moment time parameter t, when variable during Δt for instance due to external interaction, while wave emission energy ΔEw = *h.* ν remains invariant, a QM relation verified by e. g. photo-electric effect measurements, (Millikan, 1916). The assumption of the wave function number #n implies countable properties, similar to QM properties of wave-groups, whereas emission time development assumes a unity of simultaneous waves with certain frequencies ν, where ν is a countable property.

From a measurement related interaction event, e. g. including wave function collapse, with a change for emission energy from non-localizable to localizable, within the time interval only description, rather than the one moment time description, meaning to this difference can be given, in *comment B(B7)* and (Hollestelle, 2020, 2021), defining multiple wave function collapse, and the simultaneous property for energy. Multiple wave function collapse is a possible physical explanation for emission surface energy ΔEs being non-localizable and emission energy ΔEw localizable, both

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having the same value within the time interval only description, *comment A(A4)* which seems contradictory at first.

Correspondence

Time interval quantities ΔA1(Δt) relate to one moment time quantities A1(t), and correspondence, indicated with ~, is the term for relations A1 ~ ΔA1. In some cases, averaging A1(t), i. e. averaging of A1 during Δt with variable t, can define ΔA1 ~ < A1(t) >|| Δt. mΔt or ΔA1 = M[I*|| Δt [A1(t)], M[Δti, Δt]], however this is not the definition applied for time interval quantity correspondence from (Hollestelle, 2024part1). Time interval integration is indicated with I*|| Δt where time interval quantity ΔA1 = M[∫|| Δt dt [A1(t)], M[Δti, Δt]] with M time interval multiplication.

The original definition of correspondence C1 depends on units and zero's from both time interval and one moment time sets. Starting with average < t >|| Δt = t0, one moment time description 'multiplication unit'|| t_set, where t0 ~ Δt0 = ΔU and M[ΔU, Δt1] = M[Δt1, ΔU] = Δt1. There is 'multiplication zero'|| Δt_set = ΔU0, with M[Δt1, ΔU0] = ΔU0. For finite relevant event time interval Δt, ΔU = Δt and ΔU ≠ ΔU0.

Correspondence from units and zero's and, in different cases, averaging of one moment time quantities, is introduced in (Hollestelle, 2024part1), and depends on time interval only Δt-equilibrium, par. 2.1, together with time interval multiplication M and addition A introduced in (Hollestelle, 2020, 2024part1). Discussion par. 7 gives an overview of set units and zero's and their correspondences.

External Interaction

Assuming external interaction during time interval Δt = [tb, ta], and multiple collapse of most of the multiple wave function within time interval Δt, one derives for the emission surface energy Es(ta) = #n(tb). Es(tb) = (#n)^2. Ew, with the #n = #n(tb) multiple wave function with emission energy Es(tb) = #n. *h.* ν and Ew = *h*. ν, (Hollestelle, 2020).

With external interaction and multiple wave function collapse, energy Es does not remain invariant during Δt. One can write ΔEs = ΔEs(t) as a function of #n, when t changes during Δt and #n = #n(t) variable and decreasing during Δt, ΔEs(t) in this case does not belong to the time interval only set and continued is with one moment time quantity Es(t). For the original discrete #n with #n(tb) = nb >> #n(ta) = na >> 1, an approximation of #n with continuous decreasing function n(t) can be assumed, while Es(t) = (nb)^(t/ t0) increases, with example values ta = 2. t0 and tb = 1. t0, with t0 = 'multiplication unit'|| t_set within the one moment time description. Δti is multiplication inverse for Δt with M[Δti, Δt] = ΔU. It follows:

ΔEs(Δt) = < Es(t) >|| Δt. Δt = I*|| Δt [Es(t)]. M[Δti, Δt] = I*|| Δt [(n)^(t/t0)]. Δt = [1/(t/t0 + 1). (nb)^(t/t0 + 1)] || dn. Δt = (+1/3. (nb)^(3) + 1/2. (nb)^(2)). Δt.

For ta/t0 >> tb/t0 >> 1, and with #n(tb) = nb >> na >> 1, there is Es(tb) is linear with #n^2, and linear in ν and Es(ta) is linear with #n^3 which indeed agrees with Es(ta) = #n(tb). Es(tb). This is as it should be since due to multiple wave function collapse with external interaction the simultaneous emission energy increases during Δt, from Es(tb) to Es(ta) with a factor #n due to one moment time description addition. For this type of wave function collapse energy is to be added. Energy is a multiple #n of Ew, and the description remains within the one moment time approach.

This differs from internal interaction in terms of the time interval only set, with ΔEs(ta) = ΔEs(tb), meaning time interval energy remains invariant and equal to energy ΔEs(Δt) = #n. *h.* ν, linear in ν.

A time interval only version of a QM measurement of wave function properties and collapse is described, while the stationary property is assumed to remain valid, in par. 1.6, and for interaction while assuming 'zero' temperature, par. 4.2. With time interval only description simultaneous energy relation ΔEs = #n. *h.* ν ~ Es, one finds, among other results, one moment time description energy density ϱ = α/β. ν^2. T, with constants α and β, and including frequency ν and temperature T, (Hollestelle, 2021), which is similar to Planck's relation for lower frequencies. Frequency ν and

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number #n are quantities where measurements, dependent on counting, prefer a finite measurement event time interval.

1.6. Theorem on Averages

The relation from par. 1.5, Es(ta) = (#n)^2. Ew, quadratic in #n and linear in ν, seems compatible when considering the assumption of countable properties, one for the emission surface, counting simultaneous space-like occurrences, and for counting simultaneous time-like occurrences within the related relevant event time interval. This is an unexpected approach and result dependent on measurement events, which can be applied to support the theorem on averages, however is not integrated in the mathematical oriented usual approach to the theorem, e. g. (Arnold, 1974). The theorem on averages implies equivalence of integration over space and time within space time phase-space.

Space time considerations, e. g. Lorentz transformations, seem to be related to the overall development of this theorem, that appears similar to t-equilibrium with generalized coordinates. The time interval version of the theorem on averages has value for the discussion of many concepts related to Δt-equilibrium, in this case measurement event time intervals in physics.

Another argument relates the theorem on averages and the time interval only description. Simultaneous space like and time like intervals are related by assuming time interval only description Δt-equilibrium, independent from 'one value' one moment time coordinates and one moment time description t-equilibrium, such that a continuous rather than 'discrete' concept for space time remains possible. The Δt-equilibrium relation is an argument for somehow a theorem on averages within the time interval only description. The relation QM and discontinuity, within the one moment time description, is discussed in e. g. (Beller, 1999). Newton's approach applies the center of weight concept which seems useful for the usual time development within one moment time 3+1 space time to reduce multiple coordinates to one value space time coordinates (Newton, 1686).

Stationary Events

The term 'stationary' implies a 'stationary event property' where a possible interaction variance for the energy, e. g. simultaneous emission energy, is considered to be much less, infinitesimal with respect to the energy measure, (Merzbacher, 1961). This can be applied to a measurement event including wave function reduction, introducing two different time intervals, one to describe on-going emission surface invariance and one to describe interaction and the measurement event. A universal stationary event, without interaction or measurement, implies invariant entropy (Van Kampen, 1988).

The description of a stationary emission event and a wave function collapse measurement event for emission within the time interval description originates from (Hollestelle, 2021). The assumption of the occurrence of stationary emission seems prerogative to the development of a time interval description dependent on a relevant event time interval that is 'simply measurable' and on simultaneity, in par. 1.4. This approach has some similarity with the description of QM and experiments to be divided in two parts, with a preparation procedure and a resultant collecting procedure, which is part of the operational type of interpretation of QM (Beller, 1999), relating to the EPR argument, (Roos, 1978), (Omnès, 1994).

Descriptions of measurement events can include a description of physical phenomena and measurement items both, which is a traditional approach within physics, including for QM, e. g. the 'prepared system' approach for a specific QM measurement event, (Roos, 1978), (Van Kampen, 1988). The interdependence of experiment and phenomenon in physics is however not the subject of this paper.

Stationary Events and Time (in-)Dependence

Time independence is a problematic concept since a measurement not easily can detect time independence within a finite time interval. When a measurement implies counting occurrences, the

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'no occurrence' result can realistically be counted only within a finite measurement event time interval, since infinite time intervals for measurements are not feasible. The change from time independence to time dependence seems contradictory to the stationary event property.

With any event with Δt-equilibrium time development, for Hamiltonian time dependence and asymmetric Δt situation to change due to time development into a situation with H time independence and symmetric Δt, implies an asymptotic stationary event. This is consistent with the interpretation of (Van Kampen, 1988) related to reaching a macroscopic situation from a QM situation including QM measurement.

1.7. Preliminary Results

Emission Surfaces and Example Approximation Surface Construction II

Comment B includes construction of time interval description surface ΔPu, a union of surface parts ΔPi. ΔPu is constructed to be an example approximation and covering of emission surface ΔA. Construction II resembles a construction I of an indecomposable continuum mentioned in (Hocking, Young, 1961). The indication Δ implies the time interval description, for ΔPu and ΔPi and other quantities. The surfaces ΔPi are described with two current parameters w and t^^ with 2-dim. domain dw x dt, which can be transformed with a combination transformation TU*I to the regular unit square domain and successively by transformation TQ to a regular unit sphere domain.

Emission theorem I. Any transformation TU*I is equal to the identity transformation. It's proof is included in the main part of *comment B*.

This theorem implies TU*I provides extra degrees of freedom by iteration of its application.

Time interval surface part ΔPi and overall surface measure mΔPu remain invariant with any transformation TU*I, the 'm' indicating measure. For any ΔPu, and ΔPu' = TU*I*[ΔPu], there is mΔPu' = mΔPu, and covering least requirement RS, necessary for ΔPu to be a covering for emission surface ΔA, remains fulfilled, meaning mΔPu' ≥ mΔA when mΔPu ≥ mΔA. When surface measure is preserved this means any TU*I equals some specific Lorentz transformation TS.

Emission theorem II. Any transformation TU*I, i. e. equal to the identity transformation due to *emission theorem I*, can be related to the time reversal transformation squared and to a specific Lorentz transformation TS. This is discussed in par. 2, and in *comment B12(A4).*

Degrees of Freedom

Due to the independent parameters introduced with construction II of ΔPu, the number D of degrees of freedom is D = 4, par. 2.6 and *comment B*. Apart from these parameters there are three ways to introduce several extra degrees of freedom: when introducing current parameters, due to iteration and the dimensional domain definition. Iteration for TU*I applies to introduce an extra degree of freedom. Reducibility of the domains of the current parameters applies similarly to an extra degree of freedom, *comment B(B3)* and *commentB(B8)*. In this way D can be considered to increase, however not to infinity, which would imply a transition to a Newtonian, macroscopic, description, (De Wit, Smith, 1986), (Van Kampen, 1988). When introducing (a-)symmetry with the number of surface parts ΔPi, parameter N, for the example emission surface ΔPu, and when introducing a lower bound for emission temperature, ΔT_zero, both properties can be applied to provide an experimental estimate for the actual number of degrees of freedom D, these properties being discussed in par. 4.2 and 4.3.

Transition of Emission Energy and Gravitation Energy, Emission Constant and Gravitation Constant

Derived is, within the time interval only description, the gravitation constant is |Δg| = mΔt = mΔNC, while ΔNC is the time interval Noether charge, which is non-divisible, due to the simultaneous distribution property, *comment 5* and *comment 23*. The gravitation constant is expected to be a priori geometric in origin, due to equivalences y1 and y2. Simultaneous QM emission energy

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and gravitation energy are interpreted to be equivalent and represent the same energy with two different interaction constants.

From $|\Delta g| = m\Delta NC$ it follows, par. 1.1, the gravitation constant equals the simultaneous emission energy measure $m\Delta Es$. In *comment A*, eq. A1, introduced is emission surface energy $\Delta Es = M[ci, M[m1, m2]\ ]$, equal to $\Delta Eg = M[\Delta qi, M[\Delta m1, \Delta m2]\ ]$ with $c(\Delta t) = [\Delta q, \Delta ti]$, the latter energy expression allows for the interpretation of $\Delta m2$ to be a emission source, gravitational, mass, however not is meant the star source mass, the former allows to consider a finite group-velocity $c(\Delta t)$ to be of emission surface origin. $\Delta m1$ is the zero or non zero complementarity wave-particle mass.

A transformation from time interval energy interpretation ΔEs to ΔEg, due to time interval quantity definition $c(\Delta t) = M[\Delta q, \Delta ti]$, implies multiplication with a time interval quantity, ΔEM, being equal to Δt, and since $\Delta t = \Delta NC$, equal to the time interval Noether charge. There is $\Delta Eg = M[\Delta EM, \Delta Es]$ and $\Delta Es = M[\Delta EMi, \Delta Eg]$, with ΔEMi time interval multiplication inverse for ΔEM, which means ΔEM is a time interval energy due to the multiplication closure theorem, (Hollestelle, 2024part1).

The time interval description emission constant termed Δv, with zero or non zero mass wave-particle, equals $\Delta v = \Delta t$, and the time interval description gravitation constant termed Δg = 'multiplication unit'$||\Delta t_set = \Delta t$, from the above expressions, and trivially $\Delta g = M[\Delta EM, \Delta v]$. Set units including 'multiplication unit'$||\Delta t_set$ are discussed in overview in par. 7.

From multiplication factor $\Delta EM = \Delta t$ it follows 1-rank tensor quantities $\Delta E2(s)_i = [c(\Delta t), \Delta Es]$ and $\Delta E2(g)^j = [h+, \Delta Eg]$, can form a neutral 2-rank tensor quantity $\Delta E4(s, g)_i{}^j = P[\ [\Delta E2(s)_i], [\Delta E2(g)^j]\ ]$, the i and j = 1, 2, not meaning i indicating multiplication inverse, and P the time interval only set direct product. The indices being upper or lower implies the energy type, $\Delta E(s)$ emission surface energy represented by $\Delta m1$, $\Delta E(g)$ gravitation source energy represented by $\Delta m2$. Internal transformation with conservation of energy within $\Delta E4(s, g)$ can define the two energies $\Delta E(s)$ and $\Delta E(g)$ to be the transform of the other. $\Delta E(s)$ and $\Delta E(g)$ both equal $\Delta E = M[\Delta m1, \Delta m2]$ where $h+$ and $c(\Delta t)$ equal Δt, 'multiplication unit'$||\Delta t$, *comment A*. From the invariant interchange of Es and Eg within average brackets, for both meaning the average over complete energy set ΔE_set, one can derive the former of the following two equations. From this, one derives the latter equation, equal value of time interval emission energy average and time interval gravitation energy average over their relevant variable, the complete time-like or space-like interval set.

$$< Es >||\Delta E_set = < Eg >||\Delta E_set$$

$$< \Delta Es >||\Delta t_set = < \Delta Eg >||\Delta q_set$$

From neutral outer product 2-tensor $\Delta E4(s, g)^m{}_n = [\Delta E2(s)^m] \times [\Delta E2(g)_n]$, due to interaction implied by 4-tensor Q 'working to the right' on $\Delta E4(s, g)$, the resultant is $\Delta E'4(s, g)^u{}_v = Q_m{}^n{}_u{}^v * [\Delta E4(s, g)^m{}_n]$. Within the time interval description one finds, from eq. 1, transition 4-tensor $\Delta Y4(s, g)$, with * indicating 'working to the right', not complex conjugate.

$$\Delta Y4(s, g)_m{}^n{}_u{}_v = M[\Delta E4(s, g)_m{}^n, Q_m{}^n{}_u{}^v * [\Delta E4(s, g)^m{}_n]] =$$

$$= < L >. M[A[\ m\Delta E2(s)_m, m\Delta E2(g)^n\ ], A[\ m\Delta E2(s)^u, m\Delta E2(g)_v\ ]\ ]. \delta_n{}^m\ .\ \delta^v{}_u =$$

$$= < L >. M[\Delta E4(s, g)_n{}^n, \Delta E4(s, g)^v{}_v] = M[M[\Delta L, \Delta g], M[\Delta E4, \Delta E4]]$$

Assumed is the following decomposition for interaction 4-tensor $Q_m{}^n{}_u{}_v = M2(s)_m{}^n \times M2(g)^u{}_v$, where $M2(s)_m{}^n = L0.\ \delta_m{}^n + L1.\ \varepsilon_m{}^k.\ \delta_k{}^l.\ \varepsilon_l{}^n + L2.\ \varepsilon_m{}^k.\ \varepsilon_k{}^n$, which is a 2-tensor and the only invariant complete tensor combination for $M2(s)_m{}^n$ and similar for $M2(g)^u{}_v$. There is $Q_m{}^n{}_u{}_v = < L >.\ \delta_n{}^m.\ \delta^v{}_u$, with usual conventions for the well known invariant constant tensors ε and δ, and where indices i and j, k and l, and m and n, u and v, equal 1, 2 and with one moment time description direct product x.

These transition combinations are well known within the one moment time description of QM phase-space, where 4-tensor $Q_m{}^n{}_u{}_v$ remains group transformation invariant, invariances relative to the relevant symmetry groups, defined for e. g. particle decay with a specific (a-)symmetric transition tensor, (Veltman, 1974).

With $Q_m{}^n{}_u{}_v$ the 4-rank tensor for the $\Delta E(s)$ to $\Delta E(g)$ transition, the invariant trace $Tr[Q_m{}^n{}_u{}_v] = 4.\ < L >$, and there is $\Delta L = < L >||\Delta t.\ \Delta t \sim < L >||\Delta t.\ m\Delta t$.

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The time interval multiplication factor ΔEM, equal to 'multiplication unit'||Δt_set, is equal to Δv = Δt when ΔEM = M[ΔEg, ΔEsi] and M[ΔEg, ΔEsi] = M[Δg, Δvi], the emission constant Δv being for ΔEs what gravitation constant Δg is for ΔEg. The equivalence of ΔEs and ΔEg remains valid for ΔEM = Δt, with M[Δg, Δvi] = Δt, with i indicating multiplication inverse.

The transition tensor ΔY4(s, g) does not have to be necessarily strictly invariant depending on properties before and after the ΔE2(s) to ΔE2(g) internal transition for ΔE4(s, g), e. g. for simultaneous emission mass Δm1 and Δm2 this can imply a change where mΔm1 ≠ mΔm2.

Another way to describe the transformation, follows from multiplication factor ΔEM = Δt and the two energy expressions ΔEs and ΔEg. The q(t < tb) = qb implies ΔE = ΔEs(qb) before the event, the t > ta means ΔE = ΔEg(qa(t > ta)) after the relevant event transition time interval Δt = [tb, ta], both equal to ΔE = 'multiplication unit'||ΔE_set = Δt when ΔE transforms completely from ΔEs to ΔEg. This is a transition, different from claiming equivalence, from ΔEs to ΔEg. One finds time interval equations ΔEg = < ΔEs >||Δt_set and ΔEs = < ΔEg >||Δq_set different from the one moment time equations with Es and Eg. Gravitation energy ΔEg is space like coordinates Δq only dependent. There is ΔEg(t < tb) = ΔEs(t > ta) = 'multiplication zero'||ΔE_set. The average space Δt_set indicates the complete time interval only set, and similar for other sets, discussed earlier.

There is Δq = a2. Δt and D*||Δt*[Δq] = M[a2. D||Δt*[Δt], D||Δt*[a2]] = a2. Δt, from par. 4.2, and from (Hollestelle, 2024part1). Conservation of energy is achieved for scalar a2 = 'multiplication unit'||a_set, par. 4.2, par. 6, or Δq = Δt, and then a2 equals the multiplication factor ΔEMi = ΔEM from ΔEg = M[ΔEM, ΔEs]. Time interval emission energy ΔEs(Δt) depends on quantities *h*+ or *h*-, defined in *comment A*, that is Δp and Δq, and frequency ν, where gravitation energy ΔEg(Δq) depends on M[Δm1, Δm2].

Gravitation Constant Applying the Emission Surface

Due to construction II of example surface ΔPu with N ≥ 1, it follows overall time interval only description equation mΔg = |mΔPu − 1/N| = |mΔt − 1/N|, which includes a relation for mΔt and mΔq, and includes the specific case scalar N = 1. The indication with bars equals indication for measure m.

In this construction ΔPi = M[Δq, Δw], where Δq and Δw are averages to surface parts ΔPi for the current parameters Δt^^ and Δw^^, and due to covering requirement mΔPu ≥ mΔQ for ΔPu, multiplication M[ΔN, Δw] is an invariant, and mΔPi = mM[|Δqi|, ΔNi] and mΔq = mA[mΔNi, mΔPi].

One can apply relation mΔPi = mΔPu, included in *preliminary emission theorem III*, derived in par. 2.7. Within the time interval description, there is multiplication (M) equals addition (A), due to *theorem 6*, par. 3.8. When *preliminary emission theorem III*, par. 2.7, seems contradictory recall the ΔPi are open, disjoint surface parts of closed continuous example surface ΔPu.

Comment 4. The gravitation constant value mΔg equals measure |'multiplication unit'||Δt_set | = mΔt = mΔNC, i. e. mΔg is equal to the measure of the time interval Noether charge which is interesting in its own right. Necessarily mΔq = mΔt to maintain conservation of energy.

Comment 5. Within the time interval only description, mΔg = mΔt is a direct argument for the indivisibility or unity property for gravitation constant mΔg, since distributions, meaning sub-divisions, discussed in *comment 23* and in (Hollestelle, 2024part1), do not exist for Δt.

Wave-particle energy ΔEw = M[D*||Δq [Δt], Δm2] = *h*. ν when Δm1 = 'multiplication unit'||Δm_set, valid for zero mass wave-particles, photons, *comment A*. It follows mΔq = mM[Δm2, Δm2i] = |'multiplication unit'||Δm_set | = mM[Δm2, ΔNCi] = mΔm2 when N >> 1, which is an approximation for the time interval space like measure mΔq = mΔqi, i indicating multiplication inverse.

There is relation M[Δm2i, Δm2] = ΔNC, which can be interpreted to be universal, with ΔNC time interval Noether charge and Δm2 a time interval description gravitational mass, inferred to be similar to a type of re-scaled emission source mass. The overall relation is, from *comment B12(A6)*, where the bars replace the measure indication m.

mΔEw = |*h*. ν| ≤ |*h*+|. |*c*(Δt)i|. mΔq = |*h*+|. |*c*(Δt)|. |mΔA/N − 1/(Z+1)|

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The overall relation implies the specific value |*h*. ν| = |'multiplication zero'||Δt_set| for certain mΔA = |multiplication unit'||Δt_set |, which is a possible solution when |1/N − 1/(Z+1)| = |'multiplication zero'||scalar_set | with N and Z scalar one moment time description parameters.

From this it is derived mΔg = |1/N − 1/(Z+1)|. mΔNC, where N and Z+1 are construction II scalar parameters, *comment B.* A continuous domain for mΔg can occur when N or Z both >> 1 and approximately infinite, however due to construction II requirements, parameter Z has to remain finite. This does not prevent, any value for mΔg can be reached within any sufficiently small margin. The time interval measure mΔg = |'multiplication zero'||Δt_set| is reached when |1/N − 1/(Z + 1)| = |'multiplication zero'||scalar_set |, regardless the value of mΔNC including mΔNC = |'multiplication zero'||Δt_set|. This time interval measure mΔg does not necessarily imply one moment time measures, however due to correspondence from units and zero's one infers measure |g| equals |'multiplication zero'||t_set | = |0. t0|.

Non-Zero and Zero Equilibrium

Introduced in par. 3 to 6 is the concept of non zero equilibrium. Non-zero equilibrium can be transformed to the usual zero equilibrium, termed 'closure' of non-zero equilibrium towards zero equilibrium, by assuming, i. e. introducing, into the one moment time description of the situation, an un-known and yet un-interpreted difference in space-like, acquired, energy U, or ΔU in the time interval only description, depending on star source properties for the simultaneous emission cosmology, inferred to be an overall valid concept for introducing an un-known phenomenon.

Zero and Non-Zero Temperature for Simultaneous Emission

The time interval description, applied to star source simultaneous emission, allows for the definition of zero and non-zero emission temperature, par. 3 and par. 4. Zero temperature, within QM, is usually defined with ground state energy. Applying the definition from averages for time interval quantities, an estimate for a lower bound time interval emission temperature and for a lower bound collective radius, is derived in par. 4.

Paragraph 2. Time Development and Emission

2.1. Time Development and the Functions of Addition and Multiplication

To describe change within the usual one moment time description, derivatives depend on linearity and the method of tangents, (Newton, 1686), and most kinematics textbooks. One moment time t-equilibrium including the principle of least action implies application of one moment time space-like coordinate variations, with invariant transit space-like and time-like end-coordinates however with variations for the space-like path, where a variation means an infinitesimal change, an infinitesimal addition, to the existing coordinate value, (De Wit, Smith, 1986). These variations are not to be confused with the interval concept and time intervals in this paper. There exist several different approaches in the literature concerning coordinate variations.

Continuous and invariant time development, within the one moment time description meaning at any 'time-lapse' a similar 'time-lapse' is added, was discussed within the time interval description, in (Hollestelle, 2020, 2024part1).

The existence of limit difficulties with the one moment time description and the method of tangents, can be resolved within the time interval description, to be an alternative. In a number of papers this alternative is discussed including how it relates to quantum mechanical (QM) field theory and to general relativity (GR). The time development properties applying the time interval only set, independent of the one moment time description, are derived in (Hollestelle, 2020, 2022, 2024part1). Time development can be described with reciprocal commutation quantities depending on commutations within both the one moment time set and the time interval only set. The time interval commutation approach, introduced in Part1, agrees completely with the time interval Δt-equilibrium definition approach from (Hollestelle, 2020).

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To describe time development, it is argued (Hollestelle, 2024part1), time intervals do not exist outside themselves, do not add time from outside to themselves and remain only with themselves. For the time interval only set including only finite measure intervals this means time interval addition A includes the property: any finite time interval 'addition' the same finite time interval, remains the same finite time interval.

1 $A[\Delta t1, \Delta t1] = \Delta t1$, for any time interval $\Delta t1$

$\Delta t1$ can be any time interval within the time interval only set. This confirms the interpretation of time interval only set addition with domain addition where addition of two identical domains results in the same domain. Introduced is the set addition unit 'addition zero' $||\Delta t = \Delta t0$ such that $A[\Delta t0, \Delta t1] = A[\Delta t1, \Delta t0] = \Delta t1$. For sets with finite, i.e., asymmetric, time intervals, implying Hamiltonian H time dependent, there is $\Delta t0 = \Delta t$. It is derived, (Hollestelle, 2024part1), that within the time interval only set, addition A is similar to multiplication M, since the generators of the set are the set elements themselves. This time interval only set property can be re-written within linear representation theory, (Serre, 1967), to imply for traces direct sum equals direct product.

2.2. Time Intervals

Consistency within the time interval only description depends on relation eq. 2, for finite time intervals $\Delta t1 = [tb, ta]$, introduced in (Hollestelle, 2020).

Time intervals are defined depending on counting time. In (Hollestelle, 2020) described is: "*One assumes that a) time is measured with counting, b) there is a present moment now, without knowing what that means yet, c) for the future one counts time further into the future from some moment in the future, however for the past one counts differently: one counts rather from some moment in the past.*"

Some expressions that could be introduced to indicate the one moment time description concept 'now' introduce likewise controversion. One can reduce 'now' to the related measurement event for counting, or not reduce it at all and consider the complete universe related to it, to remain within physics. Not is meant to describe information communication, to connect specific parts of space-time, as it can occur within GR. A resemblance with GR, a space-time dependent metric tensor, is discussed within (Hollestelle, 2021). Within the time interval description the concept 'now' is not defined from the beginning and it is not discussion subject in the present paper.

Time intervals, e. g. [tb, ta], apply one moment time parameters $tb < 0.\ t0$ and $ta > 0.\ t0$, following the definitions from (Hollestelle, 2020, 2024part1). For these time intervals, time reversal symmetry and time translation symmetry do not trivially exist. A time interval $tb = ta = 0.\ t0$, with measure zero, is not a time interval rather a one moment time description moment.

Relation eq. 2 does not define a causality relation for tb and ta. The one moment time interval limit parameters $t = tb$ and $t = ta$ belong to the one moment time description where time development implies $tb << ta$. Coordinate q is one moment time description 3-dim. space-like coordinate q(t), part of the usual 3+1 dim. covariant space time coordinate $q4 = (q, ict)$, similarly in par. 2.4. Due to t-equilibrium space-like parameter q(t) is dependent on time-like parameter t, while invariant scaling quantity n_ is defined such that scalar multiplication (n_. q) remains dimensionless, where the value $|n_|$ can be chosen as a scaling parameter for 3-dim. space-like coordinates q(t).

2 $tb = -1.\ (1 - (n_.\ q(ta))^2)^(-1).\ ta$

For any quantity a the indication a^(-1) indicates the multiplication inverse ai = 1/a and the indication ^ implies an exponent, e. g. ^2 implies a quadratic. When $\Delta t1 = [tb, ta]$ is defined from eq. 2, this implies it relates to space-like interval $\Delta q1 = [q(tb), q(ta)]$. The one moment time parameters tb = tb(ta) and ta are defined starting from certain 'elements', elementary parameters, [n] and [i] that each describe time measurements from counting time, introduced in (Hollestelle, 2020), a definition which agrees exactly with eq. 2, even though of different character. The [n] and [i] count time from certain one moment time parameters in the past and in the future resp. Another way tb and ta can be defined is through specific Lorentz transformations TS, with the following transformation property: instead of metric line measures, 2-dim. surface measures remain invariant, due to which TS agrees

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with eq. 2. From the definition of parameters being related to eq. 2, one cannot conclude tb and ta belong to a discrete set, the one moment time parameter set remains continuous.

Even while eq. 2 can provide a change from one moment time description to time interval description, proceeded is directly from the time interval only set properties derived in (Hollestelle, 2024part1). These include correspondences, indication (~), that relate the one moment time description and time interval only description, from set units and zero's, e. g. time interval only set addition zero, 'addition zero'||$\Delta t = \Delta t$, with $A[\Delta t1, \Delta t] = A[\Delta t, \Delta t1] = \Delta t1$. There is correspondence $\Delta t = \Delta t0 \sim t0$ where $0.t0 + t1 = t1 + 0.t0 = t1$ for Δt symmetric and $t0 + t1 = t1 + t0 = t1$ when Δt asymmetric. Within the time interval only description, Δt-equilibrium assumes Hamiltonian ΔH and Lagrangian ΔL are related by the same Legendre transformation as H and L in the one moment time Lagrange t-equilibrium description, (Hollestelle, 2021).

2.3. Emission and Time Interval Only Description Parameters

Assuming emission group-velocity $c(\Delta t) = M[\Delta q, \Delta ti]$ invariant during Δt, $c(\Delta t)$ is a time interval quantity linear in Δt, with M indicating time interval multiplication. Space-like time interval quantity Δq relates to relevant event time interval Δt, including measurement events for deriving $c(\Delta t)$.

Theorem 1. To resolve the multiplication dimension problem (MDP). Any space-like time interval quantity $\Delta A1$ can be interpreted to be a multiplication of Δt with a quantity of non-zero dimension, which is allowed due to the multiplication closure theorem, discussed in *theorem 1b* and *theorem 4*, par. 3.8, and derived in (Hollestelle, 2024part1).

Comment 6. For instance space-like time interval $\Delta q1 = M[\Delta q1, \Delta t] = a1.\ \Delta t$, since time interval only set 'multiplication unit'||$\Delta t_set = \Delta t0 = \Delta t$, and for $\Delta q1 = \Delta q$ there is $a1 = c(\Delta t)$ considering Δt finite. Assumed is the first associative, series, multiplication property, $M[M[\Delta t1, \Delta t2], \Delta t3]] = M[\Delta t1, M[\Delta t2, \Delta t3]]$. The problem of *theorem 1*, (MDP), can be reduced to the dimension problem t1. $t0 = t0$. $t1 = t1$ for any one moment time description time parameter t1, where t0 = 'multiplication unit'||t_set, and $\Delta t0 \sim t0$, which was solved in (Hollestelle, 2020, 2024part1).

Star source emission is assumed to imply a spherical symmetric limit surface A, meaning the space like limit for waves emitted and 'on the way' simultaneous, from the star source within time interval Δt, depending on Δt and $c(\Delta t)$, discussed in par. 2.4. For star source emission there remains a wave composition for emission symmetric in all directions, where, following par. 1.3., QM energy relation $E = h.\ \nu$ and complementarity relation wave momentum $p = h.\ k$ both remain valid for zero and non-zero mass wave-particles within the time interval description, with h constant of Planck, and k wave 'number'. The relation for wave momentum $h.\ k$ and frequency ν is discussed in (Hollestelle, 2021), and in relation to the theorem on averages, in par. 1.5.

It is argued the non-localizable overall emission surface energy $\Delta Es = \#n.\ h.\ \nu$ equals $\Delta NC = \#n.\ h.\ \nu$, and corresponds with the invariant one moment time Noether charge, where ΔEs equals the relevant event time interval, i. e. Δt = 'multiplication unit'||Δt_set, being non-divisible and defining simultaneous emission, *comment 5*.

Time interval quantity ΔNC refers to simultaneous wave function energy $\#n.\ \Delta Ew = \#n.\ h.\ \nu$, instead of to emission energy ΔEw for one wave-particle. This applies for zero mass photons, and multiple addition of time interval photon mass remains 'addition zero'||Δt_set, due to eq. 1. The time interval simultaneous emission energy approach for wave-particles with zero or non zero mass is discussed in *comment A*.

For the cosmological universe described in par. 3 in terms of the star source simultaneous emission, ΔEs is the relevant phenomenon in physics, a cosmological unit, related to simultaneous emission and simultaneous energy for Δt. Time interval energy $\Delta Ew = h.\ \nu$, which depends on the fundamental QM energy frequency relation, remains un-known similar with un-known frequency ν, unless through a measurement event or wave function collapse event, occurring with e. g. the photo-electric effect event.

2.4. Simultaneous Events, Time Reversal, Kramer's Equation

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The property simultaneous with Δt can be defined for time interval Δt' related measurement events, depending on Δt' being 'timely', which is assured by Δt being 'timely', while Δt' occurs during Δt, (Hollestelle, 2020). Simultaneous emission energy ΔEs for Δt is defined to be the energy of emission emitted and on the way during Δt. The term 'timely' implies: a time interval Δt' is timely when it is 'simply measurable', meaning with a time interval measurement event result |Δt'| from one measurement event within Δt. This resembles Einstein's introduction of simultaneity and 'locality' for space-time discussed within the one moment time description, (Einstein, 1905). Simultaneity within the time interval only description differs from one moment time description space-time simultaneity, due to finite time intervals not being symmetric in one moment time parameters tb and ta, eq. 2, and not time translation or time reversal invariant.

Comment 7. Simultaneous measurement events for any Δt' and Δt'' are possible when Δt' and Δt'' both 'timely' within relevant event time interval Δt. However, Δt always is 'timely', which is assured since Δt is always 'simply measurable', i. e. measurable within one measurement event assuming finite wave group-velocity, properties discussed in (Hollestelle, 2020, 2024part1).

Comment 8. The possibility of free choice for one moment time q0, the space-like 3-dim. coordinate with only zero values, which (usually) is regarded equal to one moment time space-like 'addition zero'||q_set for the existing cosmological universe, is an assumption related to translation invariance within infinite 3-dim. one moment time description space and to similar invariance for measurement results within physics. Translation invariance within the time interval description can be lost due to the necessity to introduce Lorentz transformation variants TS however not when only infinitesimal transformations are considered, (Hollestelle, 2020). Invariance is discussed, from the perspective of philosophy of science, in e. g. (French, Krause, 2006).

Comment 8a. Time reversal within both relativistic and non-relativistic QM being necessarily nonlinear, is discussed in (Jauch, Rohrlich, 1955). They derive e.m. field equations from the Lagrangian and the action principle, to decide on time reversal properties in terms of Lorentz transformations TL. Their approach does not remain within GR.

Within the QM version of the time interval description for Δt-equilibrium and time development, specific Lorentz transformations TS can be applied, different from the usual Lorentz transformations TL, preserving surface measure rather than the metric line element. Within the one moment time description of 4-dim. space time, traditional time reversal is a TL Lorentz transformation.

Time interval only description time reversal can be defined directly from parameter relation eq. 2 or from time elements [n] and [i], par. 2.2, which is problematic, or from specific Lorentz transformations TS.

Comment 8b. One moment time average 'multiplication unit'||t = < t >||Δt = t0 ~ Δt0 = Δt is assumed asymmetric for finite Δt, directly related to the asymmetry of the time interval only set for finite Δt, due to which the result of time reversal of a time interval is not a time interval, and does not belong to the time interval only set, (Hollestelle, 2020, 2024part1).

Comment 8c. Time development, since time is 1-dim. where however space is 3-dim., does not allow time translation symmetry or time reversal symmetry, for any time interval Δt, due to any of the definitions mentioned in par. 2.2. For H time dependent, equivalent to time interval Δt being finite and asymmetric, time development from Δt-equilibrium is 1-dim. and does not allow the addition or multiplication transformations to be canonical, a transformation property that could have related the time interval only set with time reversal symmetry. One moment time description time reversal transformation τ is meant to imply: τ*[t] = t' = -1. t, for time reversal of one moment time parameter t to t', (Jauch, Rohrlich, 1955).

When through some process Hamiltonian H reaches time independence, similarly time interval Δt reaches the infinite and symmetric part of the time interval set. Time development within the time interval only description with Δt-equilibrium implies the infinitesimal time development equations or time transformations, similar to Hamilton's equations, to be linear and canonical, however this is not enough to allow overall time reversal symmetry, (Hollestelle, 2024part1). In (Arnold, 1974) it is

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mentioned the infinitesimal canonical property is not a guaranty for the canonical property. Within general relativity (GR), t-equilibrium time development equations are quadratic, i. e. nonlinear, (Jauch, Rohrlich, 1955). The specific Lorentz transformations TS are indeed quadratic in one moment time coordinates, however linear when infinitesimal.

The time interval description version of the QM e.m. wave equation is derived without the minus sign, which is as it should be, since within the time interval description multiplication inverse $\Delta ti = \Delta t$. The time interval version describes QM e.m. and gravitational interaction to be equivalent, and relies on specific time interval only set properties including property eq. 1, (Hollestelle, 2024part1).

Jauch and Rohrlich, following the usual QM e.m. field theory, find linear time reversal is incompatible with the e.m. field, i. e. has no invariance properties for the field variables. The QM time reversal transformation $TL = \tau$, due to invariance for the traditional e.m. field equations, is nonlinear and follows Kramers equation, $\tau^*[q4]$. $\tau^*[q4] = q4$. q4, for one moment time description 3+1-dim. space time coordinate $q4 = (q, ic.\ t)$. Meant is time reversal transformation τ, which differs from the time reversal operator. The . indicates inner or scalar multiplication. Within the time interval only description, Kramers equation can be written $M[\tau^*[\Delta t1], \tau^*[\Delta t1]] = M[\Delta t1, \Delta t1]$. Solution $\tau^*[\Delta t1] = -1.\ \Delta t1$ for any $\Delta t1$, scalar multiplication with -1, does not belong to the time interval only set, due to eq. 2. All other solutions τ have the same problem, however, well defined is $\tau^*[\Delta t1] = \Delta t1$, implying τ equals the, linear, identity transformation. This time interval description τ does not agree, following correspondence, with the traditional one moment time solution $\tau^*[q4] = \tau^*[(q, ic.\ t)] = q4' = (q, -1.ic.\ t)$. This is not the identity transformation, however when squared is a solution that equals identity, $\tau^*\tau^*[q4] = q4$ and $\tau^*[q4]$. $\tau^*[q4] = q4$. q4, (Jauch, Rohrlich, 1955).

There is $D^*||t^*D^*||t^*[NC] = -1$. NC, with one moment time derivative $D^*||t$, the wave equation for the one moment time Noether charge NC. Indication * implies for both transformation or operator 'working to the right', not is meant complex conjugate. With e.m. field theory with field variables A and A', one finds $\tau^*\tau^*[A] = A$ and $\tau^*\tau^*[A'] = -1$. A', within the one moment time description. Due to these properties a 'super selection' rule, (Jauch, Rohrlich, 1955), decomposes A, A' overall phase space and is complete and definitive.

Within the time interval description, the wave equation is $D^*||\Delta t^*D^*||\Delta t^*[\Delta NC] = \Delta NC$, (Hollestelle, 2024part1). Within this description the difference for the two equivalent energies ΔEs and ΔEg depends on the group-velocity $c(\Delta t) = M[\Delta q, \Delta ti]$, where $\Delta ti = \Delta t$, while one moment time description $(dt)i = -1$. dt. The wave equation can be written including $I^*||\Delta t$ and $D^*||\Delta t$ instead of two $D^*||\Delta t$, within the time interval only description only, due to which τ equals identity.

Comment 9. Time reversal τ depends on the multiplication inverse. When field theory allows negative energy values, within the usual one moment time description, this is not immediately clear for gravitation and Eg, where negative energy is problematic. This can be argued to depend on the difference $c(\Delta t)$ and Δq within the equations for ΔEs and ΔEg, *comment A,* meaning $c(\Delta t) = M[\Delta q, \Delta t]$ invariance differs from Δq, $c(\Delta t)$ being dependent on Δt development. The Dirac equation is linear in $D^*||\Delta t$ instead of quadratic and the identity argument is not valid in this case.

The 'super selection' rule, that does apply within the one moment time description, does not apply within the time interval description, where τ equals the identity at all phase space. This means in phase space variables are allowed to become non-selective, and this saves 4-dim. space time covariance. Inferred is from the wave equation, time reversal operator τ equals derivative $D^*||t$ or $D^*||\Delta t$ resp. within the one moment time or time interval only description.

2.5. Simultaneous Emission Surfaces

An example emission surface, an example approximation to the realistic emission limit surface, simultaneous star source emission dependent, is discussed in *comment B*. Assumed is time development of simultaneous emission and the emission surface depends on relevant event time interval Δt and wave group-velocity $c(\Delta t)$.

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The time interval version for simultaneous emission, with emission energy for emission surfaces ΔA(Δt), requires, measures on surface ΔA do not apply the linear metric line element, even when the metric surface measure of a regular sphere usually relates to the metric radius measure squared. To describe emission energy with the time interval description version of QM, introduced is necessarily the requirement 2-dim. space-like surface measure mΔA(Δt) to remain invariant for variable Δt, to maintain energy conservation within time development, (Hollestelle, 2021, 2024part1).

2.6. Example Approximation for Spherical Symmetric Emission Surfaces Parametrization with Current Parameters

For emission surface ΔA, assumed is approximation surface ΔPu, a union of a variable number N of surface parts ΔPi, i = 1 to N. The ΔPi = ΔPi(N, w, tl^^) are open, disjoint and dense parts of ΔPu, union ΔPu is an indecomposable medium and covering for ΔA, and ΔPi and ΔPu are 2-dim. time interval description space like surfaces in 3-dim. space. The ΔPi are described with two parameters w^^ and t^^. Surfaces ΔPi tend to be 'linear'-like, due to a decreasing width-parameter domain measure mdw that indicates the measure of ΔPi in one dimension, d1, however this does not imply the metric line-element for ΔPi. More specific, to describe the 2-dim. surface parts ΔPi there are: parameter w^^ with domain dw = [w0, w=w^^(t^^)] with w assumed finite, and parameter t^^ with domain dt = [t0^^, tlim^^] with tlim^^ assumed infinite, where w = w^^(t^^) and t^^ parametrisation for ΔPi, which could be the other way around. The parameters w and t^^ are current parameters, introduced in par. 1.2 and in the next paragraph when discussing time development.

Time Development

For the one moment time description surface part Pi, parameters w and t^^ are assumed not to depend on one moment time parameter t, not to depend on t-equilibrium time development, they are similar to object rulers. A 'synchronous' change of dw and dt implies w = w(t^^), and implies the existence of surface measure mPi preserving, specific Lorentz type of transformations TS for parameters TS*[w] and TS*[t^^], and TS*[dw] and TS*[dt], to continue to describe TS*[Pi] while mPi = mTS*[Pi] remains invariant.

Any measurement for a one moment time space like coordinate qi = (w, t^^) existing on Pi can be described with one moment time coordinate t when assuming t^^ = t^^(t), dependent on one moment time t-equilibrium time development for surface part Pi(t) with parameter domain dw(t) and dt^^(t). This is similar to the usual one moment time development for 3+1 dim. space time coordinates q(t) and t for the center of weight or any space like coordinate of an object, in this case qi and Pi, with Newtonian coordinates q(t) and t in space time. The qi = qi(t) follows one moment time development together with complete object Pi(t). Recall not always there will be t^^ = t^^(t), since t^^ is a current parameter, when Pi including qi remains time independent, with invariant space coordinates.

Example Construction II

A variable number N allows for a new construction II for approximation surface Pu, introduced in *Comment B*. It is an example approximation for the emission surface, starting from the 2-dim surface parts Pi and union Pu and a transformation applied to Pu unto the regular sphere Q while mPu ≥ mA is the covering least requirement RS for Pu to be a covering for A. This is valid both within the one moment time description and the time interval only description. The regular sphere is the most simple spherical symmetric emission surface due to star source emission, i. e. symmetric in all directions, even though since the introduction within QM of the wave function and photon concept, c.q. wave and wave-particle complementarity, photo-electric effect events related to emission detection remain being explained with photons, (Beller, 1999).

Construction II resembles construction I, when N = N0 remains invariant, which is well-known and applies a theorem from topology for indecomposable media, (Hocking, Young, 1961), to argue

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the resultant is a covering for the emission surface. It is argued for construction II the overall number of degrees of freedom is one larger than for construction I. With construction II one can find an example approximation for spherical symmetric emission surface A, depending on the identity transformation in two space-like dim. The addition to the fundamental theorem on polynomial equations relates to this identity transformation, is mentioned in par. 1.2, and in *comment B*, par. *B12(A7)*, *theorem B8*.

Interpretation: Symmetry Transformation and Zero Temperature

With Δt and ΔA(Δt) unchanged, parameter N ≥ 1, when variable, is undecided when interdependent with domain dw and dt, meaning parameter N supports an extra degree of freedom. Covering least requirement (RS) for union surface ΔPu to be a covering for regular sphere ΔQ(Δt) and emission surface ΔA(Δt) is, surface measure mΔPu ≥ mΔA. All quantities are within the time interval description. Time interval Δt is left out of indications, for simplicity, in the following. Two interpretations are argumented in (Hollestelle, 2024part1).

Interpretation A: when energy does not change with N, a change of N implies a *symmetry transformation*. For any number N ≥ 1, interdependent with dw, the union ΔPu remains a covering for emission surface ΔA. Time interval Δt can not be divided into a simultaneous distribution, like is possible for space-like interval Δq, *comment 23*. This symmetry possibly is not a complete symmetry, which could imply the introduction of some un-specified energy is necessary, this is discussed in par. 3, starting from the concept of closure to zero of non zero t-equilibrium introducing acquired energy difference dU = U* − U.

Interpretation B: construction II implies *zero temperature* for simultaneous emission. Star source simultaneous emission within the time interval description including zero overall temperature is discussed in par. 3, and par. 4.

2.7. Results: Symmetry Transformations

Symmetry Transformations

Several relations can be derived for time interval emission surface ΔA and example surface ΔPu and parts ΔPi within construction II, *comment B*. These can be summarised, starting from interpretation (A).

Where union surface ΔPu is the addition or sum of all ΔPi, i equals 1 to N, the ΔPi can be united in pairs. It follows the union of all pairs ends with only the last pair or the last ΔPi = ΔPN. Due to time interval property eq. 1, all unions end with the last ΔPN, or equivalently end with the first ΔP1 'moving through the union collection', cancelling the other ΔPi. Union or addition is indicated with Σ for one moment time quantities, with A for addition for time interval quantities. The current parameters are for each ΔPi: w(t^^)i and t^^i defined with their domain completely in *comment B*, and their time interval versions defined with averaging. For this to be valid within the one moment time description the following equations need to be valid:

Σi < wi >||Δt^^ = N

Pu = Σ[P(i=1), P(i=2)] ~ ΔPu = A[< P(i=1) >||Δt^^, < P(i=2) >||Δt^^] = A[ΔP(i=1), ΔP(i=2)]

Correspondence with one moment time quantities P(i=1) and P(i=2) follows from the expression for one moment time quantity Pi averages for time interval quantities, ΔPi = < Pi >||Δt^^. Δt^^ = I*||Δt^^. dt^^[Pi]. M[Δt^^i, Δt^^], with Δt^^i multiplication inverse for Δt^^, from par. 1.5. One derives the former equation from this latter one, when to maintain invariance of measure mdΔPi = m(dΔw(Δt^^) x dΔt^^) = mdw. mdt to define all possible domain variations dΔw(Δt^^) and dΔt^^, for ΔPi. The x indicates domain phase-space outer multiplication. Similarly N is variable with w and tlim^^ when invariance of measure mΔPu is cared for, such that mΔPu = N. mΔw. mdt remains invariant.

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Moving through the union collection. From these equations one finds time interval description ΔPu = ΔPN for any N, e. g. ΔPu = ΔP2 for N =2, where ΔP1 is added to all succesive ΔPi, untill ΔPu = A[ΔPN, A[ΔPN-1, ΔP1]] = A[ΔPN, ΔP1] = ΔP1 due to A[ΔPi, ΔP1] = ΔP1 for all i ≤ N.

One finds mΔPi = mdw. mdt, where time interval current parameter Δt^^ = η(i). Δq(i, dt) with Δq(i, dt) related to surface part ΔPi, and the same is valid for mdw = m(< w >| |Δt^^. Δt^^), i. e. the measure for domain dw. One finds time interval derivative D*| |Δt[Δt^^] = η(i). D*| |Δt[Δq(dt)] = η(i), with Δq(dt) = Δt for any surface part ΔPi for ΔA(Δt), for all N, and due to this result, there is time interval measure mΔPu = N. mΔPi ≈ N. mdw. mdt = N. mw. mΔt^^. mΔt^^ = mΔPu. (< η(i) >)^2, which means < η(i) > = 1 with mΔt^^ = mΔt = 1 is a valid assumption, and mΔPu = N. w. (mΔt^^)^2 and mΔPi = w. (mΔt^^)^2 is of the order mA, and independent of N. These are arguments for *preliminary emission theorem III*.

Preliminary emission theorem III. The surface ΔPu and the surfaces ΔP(i) for any i ≤ N fulfill the covering least requirement RS for surface ΔA. Surface measure mΔP(i) = mΔPu ≥ mΔA, where required is invariance of surface measure mΔP(i=1) during addition of successive ΔP(i), which is due to eq. 1. The result is valid within the time interval only description, not in the one moment time description. The derivation is as follows:

Starting from the 2-dim. surfaces ΔPi = Δq x Δw there is,

mΔPi = M[mΔqi(Δt^^), m(< w(t^^) >| |Δt^^. Δt^^)] = A[< qi(t^^) >| |Δt^^. mdt, mdw. mdt], the addition A occurs due to theorem 6, where N. mΔw. mdt is invariant, and mM[Δt^^, Δt^^] = mΔt^^ = mdt.

For N = 1, there is trivially time interval description relation mΔPu = mΔPi, and it follows mΔq = mΔt = mM[Δm2, Δm2i], and mΔq = mΔPu − 1 = m('addition zero'| |Δt). For all N the result is M[Δm2, Δm2i] = 1/N. (mΔPu − 1), where theorem 1b and 1c, par. 3.8, is applied.

The Δt^^ average for q(Pi)(t^^) dependent on current parameter t^^ can be transformed into a Δt average for q(Pi)(t), dependent on one moment time parameter t, due to calibration of t^^ to one moment time parameter t, which does not have to be simultaneous with time interval Δt, however calibration should occur during some time interval Δt' for current parameters to be real object ruler. This requires to interpret t^^ and w(t^^) to be one moment time t-equilibrium dependent parameters during Δt' even though not during Δt, which is discussed in par 1.2, and par. B12(A4).

2.8. Parameters for Construction II

Example Construction II

Construction II includes transformation from infinite 2-parameter space to the regular square and successively to the regular sphere. The former transformation includes a singularity and requires the definition of parameter r = tlim^^/tl^^.

The two space-like one moment time current parameters for Pi, are d1 dimension parameter w with domain dw = [w0, w(t^^)], and d2 dimension parameter t^^ with domain dt = [t0^^, tlim^^] = [t0^^, r. tl^^]. Both limit tl^^ and tlim^^ are infinite. By changing limit tl^^ to tlim^^ for domain dt the singularity at tl^^ can be resolved, therefore parameter r is introduced, however r is not undecided or free. In *comment B* included are the covering least requirement for r and the other free parameters.

There is, ΔNC is 'multiplication unit'| |Δt_set and equal to 'addition zero'| |Δt_set due to time interval theorem 1c, par. 3.8. Interchanging the ΔPi can be the result of specific Lorentz transformations TS, that leave surface measures invariant. Interchanging the N surface parts, with N invariant, does not change the emission surface energy ΔEs, however a change of N implies possibly change for parameter Δw and other parameters and energy ΔEs.

The symmetry during change of N not necessarily implies invariance for all parameters, and can mean a change of #n due to external interaction including wave function collapse. It is not meant with construction II the number N of surface parts ΔPi should depend on number #n of wave-particles or equals the number n of star sources within the star source set.

Current Parameters for Surface Parts of Example Construction II

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For any surface parts Pi, current parameter w = w(t^^) is a t^^-quantity. One applies correspondence with averages to define time interval description quantity Δt^^ ~ < t^^ >||Pi(dt). mPi(dt), and Δw ~ < w >||Pi(dt). mPi(dt), following par. 1.5, meaning averaging for the place in 3-space where the surface parts Pi occur. However it is not meant averaging one moment time current parameter w during time interval Δt, since surface part Pi is assumed to remain time independent and to remain at the same place disregarding one moment time parameter t.

One can write averaging for ||Pi(dt). mPi(dt) = ||dt. mdt = ||Δt^^. mΔt^^. Instead of averaging during Δt one can introduce averaging for domain dw = [w0, w(t^^)], i. e. averaging for t^^ which depends on averaging for Pi with t^^ domain D1 = [t0^^, tl^^]: the two domains dw and dt are 'synchroneous'. Assumed is t^^ remains independent of one moment time parameter t and one writes time interval description Δt^^ ~ t^^, and similarly Δw ~ w. Including these comments, one derives, applying the integral I*||Δt definition for time interval multiplication M from (Hollestelle, 2024part1):

Σi Δwi = Σi < wi >||Δt^^. Δt^^ = Σi I*||Δt^^[wi]. M[Δt^^i, Δt^^] = Σi 'multiplication unit'||Δt^^_set = ΔN ~ Σi ((mdt. mdwi). (1/mdt. mdt)) = Σi (mdt. mdwi) = N

The average of wi for Pi, wi0 = < wi >||Pi or wi0 = 'multiplication unit'||wi_set, can be expressed in terms of parameter r, assuming mD1 = m('multiplication unit'||t^^). When during Pi the parameter wi remains asymmetric while wi0. wi can differ from wi0, and wi0. wi = wi. wi0 = wi ≠ wi0 can be defined non trivially valid, one finds wi0 = 'multiplication unit'||Δt^^, due to the definitions for units and zero's in (Hollestelle, 2024part1). The applied domain for t^^ is dt = [t0^^, tlim^^] = [t0^^, r. tl^^] with r < 1 or r > 1, where dt ≠ D1, in *Comment B*, to assure singularity tl^^ of the transformation of current parameter domain dw x dt to the regular sphere domain dQ is resolved.

Paragraph 3. Discussion A. Acquired Energy and Star Source Simultaneous Emission

3.1. Star Source Simultaneous Emission

Temperature dependent t-equilibrium for a set of spherical symmetric surfaces can be interpreted as a concept for the star source simultaneous emission surface, within resp. the one moment time and time interval approach this was discussed in (Hollestelle, 2017, 2021).

With simultaneous emission from a star-source collective meant is a combination of n star-sources, at one moment time space-like places qi, i = 1 to n, that are grouped with a certain one moment time space-like average, group center Q(n) = < qi >||n. To one moment time description 3 + 1 dim. space time coordinate q4 = (q, i*c*. t), due to one moment time t-equilibrium time development, define with i.*c*. t the fourth coordinate, *c* the velocity of light, t the one moment time parameter, and i the imaginary scalar unit. One can define a space-like measure m(Q(n) − q0) = mQ(n), towards the overall emission surface A, when chosen is q0 remains at A(Δt). By definition q0 = 'addition zero'||q_set for the one moment time space-like parameter q set. The prescript m indicates measure. The spherical and non-spherical spacial configurations for star- or galaxy clusters have been subject of extensive research within astrophysics, within the usual one moment time description, (De Theije, e. a., 1995), (Lee and Koh, 1995), and (Hollestelle, 2017b).

Star sources are emission sources, together they are assumed to be one collective of sources for several emission units including one collective simultaneous emission surface A(Δt). At surface A for any Δt measurement place qm is chosen with m(qm − Q(n)) = mQ(n), and with m(qm − q0) infinitesimally small, i. e. place qm is infinitesimal 'close' to place q0 and both qm and q0 continue to remain at surface A(Δt) during time development say from Δt = Δt' to Δt = Δt'' (Hollestelle, 2021). This is a realistic choice since star source emission surface A changes from A(Δt') to A(Δt''), and by definition reaches the measurement apparatus at qm at A(Δt) with exactly the relevant measurement event time interval Δt changing from Δt' to Δt''.

3.2. Inter-Dependent Quantities Q(n) and Q2(n) and Zero Equilibrium

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For star i defined is one moment time space-like measure mqi = m(qi − q0), i.e., place qi relative to q0, and space-like coordinate Qi = qi − Q(n), i.e., qi relative to average Q(n) = < qi >||n. The one moment time average < Qi >||n = < qi − Q(n) >||n = Q(n) − < Q(n) >||n = Q(n) − A[qn, A(n-1)]. 1/n, since by definition the average Q(n) = < qi >||n equals the one moment time quantity Q2(n) = A(n). 1/n, with A(i) = q(i) + A(i-1) ~ ΔA(i) with A(i = 1) = q(i = 1). Correspondence eqs. 3 and 4 are the result, arguing < Q(n) >||n = Q(n) since Q(n) remains independent from parameter i:

3 $< Qi >||n = Q(n) - < Q(n) >||n = q0 \sim \Delta Q0 =$ 'addition zero'||Δq

For the time interval quantities Δqi: the time interval average is equal to the time interval addition, applying the iterative addition ΔQ2(n) = ΔA(n), in terms of time intervals, without factor 1/n due to eq. 1, and it follows eq. 4:

4 $< Qi >||n = Q(n) - Q2(n) = 0.\ t0 \sim A[\Delta Q(n), \Delta A(n)iv] = \Delta U0$

The one moment time, left side, difference in eq. 4 corresponds with time interval 'addition zero'||Δq. Within par. 3.8, theorem 1, and theorem 1b and 1c, it is derived units and zero's for the Δq interval set equal those for the Δt time interval set, due to which 'addition zero'||Δq = 'addition zero||Δt = ΔU0 corresponding with 'addition zero'||q = 0. t0.

3.3. Equivalence Y2 of Gravitation Energy and Simultaneous Emission Energy

The time intergral of the time interval Noether charge density is an overall 3-dim space-like quantity, and one expects ΔNC to relate to the invariant and overall emission surface energy ΔEs, due to conservation of energy during time development of simultaneous emission.

The time interval description relates integration to addition such that Noether charge ΔNC equals the Noether charge density in value, which implies time interval overall cosmological 'volume' ΔR3 ~ R3 which then should equal a unit, 'multiplication unit'||Δq_set. This depends on time interval addition eq. 1. Thus, mΔR3 equals mΔq = mΔt, with Δt = 'multiplication unit'||Δt_set.

Comment 10. Within the one moment time description one can write the emission surface energy with the following equations, *comment A*, where support for the theorem on averages is implied by the time interval derivative expressions.

There is one moment time description Es = A [1/|c(Δt)|, M[m1, m2]] and Eg = M[1/|Δq|, M[m1, m2]], derived in Part1. Within the time interval only description one finds ΔEg = D*||Δq*[M[Δm1, Δm2]], and ΔEs = D*||Δt*[M[Δm1, Δm2]].

The first derivative expression refers to time interval gravitation interpretation energy ΔEg, the second one to time interval emission interpretation energy ΔEs = #n. ΔEw = #n. *h*. ν. Relations for time interval energy ΔEs and ΔEw, dependent on Lorentz transformations and commutations are discussed in *comment C*. Two expressions are 'apparent emission source density' Δm2, and 'apparent emission surface density' Δm1, both in terms of density, while equal energy measures mΔEg = mΔEs, equivalence C2 from par. 1.1, imply equal energy values for two different physical situations, where free fall seems to equal and opposite to free wave emission pressure similar to Newton's equivalence relation for mass measurements, *comment 12* and discussion. Due to the unit value of overall cosmological volume measure mΔR3 = mΔt the time interval density measures mΔEs and mΔEg equal time interval mass measures mΔm1 and mΔm2, *comment A*.

Comment 11. The existence of time interval 'addition zero'||Δq_set can be assumed, independent of the existence of one moment time set 'addition zero||q_set, due to *theorem 1*. Eq. 4 interpreted with: specific one moment time average for Qi, equal to addition of two quantities Q and Q2, corresponds with time interval wave energy ΔEw = *h*. ν, a result that can be derived directly from time interval description t-equilibrium and time interval addition properties.

Theorem 2. Canonical property for correspondence. The time interval quantity corresponding with an addition of one moment time quantities is the addition of the time interval quantities corresponding with these one moment time quantities. The theorem is valid due to regarding eq. 4 to be a zero equilibrium equation rather than a equation with zero value result. Regarded is (equilibrium) theorem c, which originates from (Hollestelle, 2017).

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Comment 12. When e.m. emission occurs with 'zero' mass complementary wave-particle this implies Δm1 = Δm0 = 'addition zero'||Δm_set = 'multiplication unit'||Δm_set. In this case simultaneous emission energy ΔEs = A[c(Δt)i, Δm2] equals ΔEg = A[Δqi, Δm2] = Δm2, which can be interpreted to be the *apparent emission source density* $\Delta m2 = \#n.\ h.\ \nu$. Wave group-velocity c(Δt) = M[Δqi, Δm1] = Δm1, where Δm1 = 'multiplication unit'||Δm_set, and |c(Δt)| = mΔq, and Δm1 can be interpreted to be *apparent emission surface density*, Δm1 = $h.\ \nu$, discussed in *comment A*.

Within this emission related setting without measurements, ΔEw = $h.\ \nu$ is of unknown measure and remains unknown until a QM measurement including wave function collapse occurs, par. 2.3, however discussed in *comment A* in terms of the time interval only description and Δm1 and Δm2.

The time interval mass quantities Δm0 = 'addition zero'||Δm_set and Δm0 = 'multiplication unit'||Δm_set being equal, is rather similar, however not necessarily, to Newton's equivalence relation for 'gravitation' mass measured from heaving, and forwarded mass measured from accelerating, (Newton, 1686), sometimes termed heavy and inert mass. This is subject also of *comment A* and *comment C*.

Including a 'non-zero' mass Δm1 one finds Δt = M[Δm1, Δm2] and time interval energy ΔEw typically is linear in Δqi, a linear energy interaction, not the usual quadratic field interaction, and is consistent with the surface energy proposed in (Hollestelle, 2017). This surface energy concept has its own merits within the one moment time description. A linear energy resembles an energy change during free fall, implying gravitation and kinetic energy exchange.

Within field theory, energy requires some type of change to be meaningfull, the field wave (Goldstein, 1950), (De Wit, Smith, 1986). Wave energy, i. e. from the wave interpretation of QM, for free waves without interaction, depends on the frequency momentum relation described by momentum density functions for dispersion free, stationary events, within the time interval description this was discussed in (Hollestelle, 2021), and remaining within one moment time description, in (Merzbacher, 1961). This situation can be interpreted to imply 'zero' temperature, par. 4. Some of these relations, e. g. internal interaction, are discussed in par. 5 and *comment A,* and originate from (Hollestelle, 2021).

3.4. Kinematic Energy and Acquired Energy

From Newton's second law retained is d/dt*[p] = -1. ∂/∂q*[U], with p and q generalised coordinates within the one moment time description and with partial derivative of space-like energy U, due to Hamilton's equations. Energy U occurs due to space-like coordinate q dependence, termed acquired since the relevant object occurs within one moment time description 3-space which decides upon U = U(q). Change of one moment time space-like coordinates implies a change of acquired and non-mechanical energy U. This is valid for the usual one moment time description conservative system with Hamiltonian H = T + U, including kinematic time-like energy T quadratic in generalised coordinate p, (Goldstein, 1950). The term acquired is new in this respect.

Newton's law in this form relates to the conservation of energy. However it applies the center of mass concept, which allows the description of a mass and volume combination in 3-dim. space, which is partly independent of the mass distribution, i. e. how mass is related to multiple one moment time space-time coordinates.

Comment 13. Where simultaneous emission energy equals ΔEs, wave-particle energy ΔEw = $h.\ \nu$ remains unknown untill measurement events including wave function collapse occur. This is especially clear from the equivalence of gravitation energy and e.m. field energy, which relate to the *same* measure of energy mΔEs = mΔEg. This depends on the non distribution property for Δt, par. 5, *comment 23*.

Usually one moment time description kinetic energy T is considered quadratic in p, however time interval description ΔT is linear in Δx, and due to conservation of energy and due to eq. 1, implies conservation of time interval 'velocity' Δx ~ x, where the corresponding one moment time quantity is x = d/dt*[q] from Newton's second law, not to be confused with conservation of momentum Δp =

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M[Δm1, Δx], including wave-particle mass Δm1, with Δm1 possibly a variable. This is not meant to imply pre-Newtonian kinematics.

It seems a change of mass Δm1 does not change time interval kinetic energy ΔT linear in Δx. Velocity Δx to be a constant of the motion, does not imply Δx invariance during covariant transformations of coordinate systems, however means invariance during space time coordinate transformations due to time interval Δt-equilibrium time development. How Lorentz transformations including covariance relate to Δt-equilibrium time development, depends on the commutator relations of the time interval only set, defined and discussed in (Hollestelle, 2024part1), and in this paper in *comment C*.

One moment time acquired energy U, acquired due to external parameters, e. g. one moment time space-like coordinate parameters q, relates to a certain event time interval Δt which allows variation of these parameters. Not is meant one moment time wave-particle coordinates within the quantum domain, the description remains within the wave rather than the wave-particle concept, while localizable properties are expected to occur after measurement, i. e. after wave function collapse. A time interval description of wave function collapse and measurement events was introduced in (Hollestelle, 2020). Kinetic energy ΔT = ΔEs equals the simultaneous emission surface energy unit 'addition unit'||ΔE_set, while ΔEs is non localizable. Theorem 4b, par. 3.8, can be applied such that units and zero's for the ΔE_set equal units and zero's for the Δt_set. Within the time interval only description, gravitation energy ΔEg is an acquired energy ΔU, depending on time interval space-like quantity Δq. Within the one moment time description the invariant total energy H0 = T + U ~ ΔH0 = A[ΔT, ΔU], while ΔH0 = 'addition zero'||ΔE_set equals 'addition zero'||Δt_set.

3.5. Non-Zero to Zero Equilibrium Introducing Energy dU Within the One Moment Time Description*

Within a yet to consider situation, indication (with-*) and introducing an unknown, and not before included, acquired energy dU* implies Lagrangian L changes to L* = L – dU* and Hamiltonian H changes to H* = H + dU*. The original situation (no-*) does not include energy dU*, i. e. dU*(no-*) = 'addition zero'||E_set in the (no-*) situation, while dU* not necessarily equals 'addition zero'||E*_set in the (with-*) situation. This is the one moment time description.

Introducing energy dU* with adiabatic change, *comment 22*, can be related to a situation change within time development, however it is a thermodynamic, macroscopic, change of event (Roos, 1978), (Van Kampen, 1988). Rather meant is, fundamentally, energy dU* is regarded occuring only, emerging only, in the (with-*) situation. This allows to interprete (with-*) to describe a new energy.

*Definition 2. Closing(*) equilibrium by energy dU**

Within one moment time description *closure means change of non-zero (no-*) to zero equilibrium (with- *) terms with new energy dU**. The opposite change due to zero to non-zero equilibrium terms can be introduced similarly. The proposed interpretation is, the original (no-*) situation describes energy with non-zero, open, equilibrium and acquired energy dU* = 'addition zero'||E_set can be assumed to occur when zero, closed, equilibrium occurs in the (with-*) situation, where not necessarily dU* = 'addition zero'||E_set.

Comment 14. When including a possible difference for ΔEs and ΔEg, due to considering them independent, can contribute to acquired energy. In par. 3.3. following (Hollestelle, 2021, 2024part1), derived was equivalence of the two ΔEs and ΔEg interpretations of the same energy, similar to equivalence within GR of gravitation and kinematic energy. Simultaneous emission surface energy ΔEs and gravitation energy ΔEg, with mΔEg = mΔEs, are both time interval expressions derived from the emission surface description, par. 3.3. When some 'non zero' acquired energy ΔdU* is necessary for zero equilibrium, this can be interpreted to imply the mentioned equivalence is not complete.

Interpretation A for ΔdU* Within the Time Interval Only Description

It is a possible inference to assume gravitation energy is different from ΔEg and similarly zero or non zero mass wave-particle simultaneous emission surface energy different from ΔEs, in this way introducing a non zero equilibrium original (no-*) situation. Non zero equilibrium in this case would

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mean the assumption is open to arguments, to assert emission surface energy is in principle and rigorously equivalent with gravitation energy and to introduce a third and new energy dU*, or to assert the energy difference ΔEg and ΔEs implies the existence of a third energy dU*. These two different arguments are to achieve zero equilibrium for the (with-*) situation.

A third option is to accept non zero equilibrium as a possibility in reality, described by time interval asymmetry, where the asymmetry of Δt implies < t > | | Δt = t0 ~ Δt0 = 'multiplication unit' | | Δt is different from 'multiplication zero' | | Δt = 0. t0, meaning one moment time description equation t0 = 0.t0 is not valid, and similarly D* | | Δt[ΔA1] = 'multiplication zero' | | Δt = 'addition zero' | | Δt not necessarily is valid for an invariant time interval quantity ΔA1.

Closure from Non-Zero to Zero Equilibrium Within the Time Interval Only Description

Change of eq. 4 (no-*) and eq. 5 (no-*) and resultant ΔU0 and ΔEs*, i. e. change to closure (with-*) with resultant 'addition zero' | | ΔE*_set = ΔU0*, means including ΔdU* within situation (with-*). For situation (no-*), Lagrangian L = T − U does not close eq. 4 or eq. 5 to resultant 'addition zero' | | ΔE_set = ΔU0 or 'addition zero' | | ΔE_set = ΔU0 = ΔU0*. In this case (no-*) implies ΔdU* = 'addition zero' | | ΔE_set = ΔU0 and (with-*) implies ΔdU* differs from 'addition zero | | ΔE*_set = ΔU0.

The Lagrangian L is applied to define zero or non zero equilibrium since it appears in the action principle, where for t-equilibrium, L is related to Q(n) − Q2(n) = 'addition zero' | | E_set. The application of invariance of L to derive t-equilibrium equations is an accepted guiding principle within the 4-dim. covariant Lorentz approach, (Sakurai, 1967).

3.6. Non-Zero to Zero Equilibrium Due to Inter-Dependent Resultant Quantities Q and Q2**

To reach zero equilibrium eq. 5a one can choose Q* and Q2* to be inter-dependent energy quantities while a 'non zero' energy dU* is introduced. It follows from par. 3.5 the originally space-like quantities Q and Q2 can be interpreted to be energy quantities. There is quantity Q0* = 'addition zero' | | E*_set = 'addition zero' | | t* = U0*. This is a well known solution for non-zero-resultant equations like eq. 5a without dU*, for instance when introducing e.m. gauge transformations, (De Wit, Smith, 1986), a transformation meaning to include 'addition' with (+/-)1. dU*.

5a Q*(n) − Q2*(n) + dU* = Q0* ~ A[ΔU0, ΔdU*] = A[ΔEs*, ΔdU*] = ΔU0* = 'addition zero' | | ΔE*_set

From time interval eq. 1, there is ΔU0 = ΔEs and ΔEs = #n. ΔEw = ΔEw. Within the one moment time description situation (with-*) including closure of eq. 5, there is L* = L − dU* = 'addition zero' | | E*_set, and due to L = T − U = T = Es, follow eq. 6 and eq. 7. With correspondence eq. 7, the time interval description resultant is: ΔL* = A[ΔT, A[ΔU, ΔdU*]iv] = 'addition zero' | | ΔE*_set. Addition inverse is indicated with iv, different from multiplication inverse indicated with i and independent of these, star source parameter i = 1 to n.

6 Q(n)* − Q2(n)* = 'addition zero' | | E*_set = L* = L − dU*

7 Q(n)* − Q2(n)* ~ 'addition zero' | | ΔE*_set = ΔL* = A[ΔT, A[ΔU, ΔdU*]iv]

Comment 15. From eq. 4 to eq. 7 one can define t- or Δt-equilibrium in the style of the action principle depending on variations. The variables are the Qi with i = 1 to n. Proposed is the action principle, variation of space-like integration, to mean the resultant for eq. 6 and eq. 7 remains exactly the same resultant L* = L and ΔL*= ΔL due to 'zero' closure remaining valid with variation. The one moment time description t-equilibrium resultant change should cancel, for variations to this zero equation t-equilibrium principle, since dU = 'addition zero' | | E_set and L* = L.

Applied, within eq. 7, is the associative property (series property), par. 2.3. Time interval description eq. 7 depends on application of *theorem 1*, while time interval Δt-equilibrium depends on < t > | | Δt, being non zero for H time dependent and for Δt asymmetric and finite.

The usual one moment time description applies Lagrange t-equilibrium, the time interval only description Δt-equilibrium, while for both descriptions H and L are the Legendre transform of one another, (Hollestelle, 2020). This suggests dU is not kinetic energy, rather acquired energy. Results can differ with description when H time dependent and Δt asymmetric and finite, where results for

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the one moment time and the time interval description are the same for H time independent and Δt symmetric and infinite, (Hollestelle, 2020).

3.7. Non-Zero to Zero Equilibrium Due to Independent Resultant Quantities ΔQ′ and ΔQ2 ′

Within the time interval description, integration and derivatives can be related to time interval multiplication and addition. The time interval Noether charge ΔNC depends on time interval derivatives, D*||Δt, this was discussed extensively in (Hollestelle, 2024part1). In par. 3.5 the quantities Q and Q2 were defined being inter-dependent.

Assuming time interval Δt-equilibrium and introducing independent one moment time quantities Q′, Q2′, and Q1′ indicated with an accent, the difference Q′ − Q2′ = Q1′ corresponds with ΔEs = ΔNC to be equal to 'multiplication unit'||Δt = Δt, due to theorem 4 and 4b, where closure, zero equilibrium, occurs for the (accent) situation, open, non zero, equilibrium for the (no accent) situation, recall the 3rd option in par. 3.5.

For eq. 4 and eq. 5a closure occurs, with inter-dependent quantities Q, Q2 and Q − Q2 = Q1 ~ 'addition zero'||Δt, where for eq. 5b closure occurs with independent quantities Q′ − Q2′ = Q1′ ~ 'multiplication unit'||Δt' = ΔdU' = ΔNC' and from introducing ΔdU'. Since 'addition zero'||Δt = Δt and 'multiplication unit'||Δt' = Δt' = Δt, this ensures the correspondence Q1 ~ 'multiplication unit'||Δt, within eq. 5b applied with all accents.

Definition 3. Closing(') equilibrium by energy dU'

Introduce energy dU' with a change of energy Es to Es' = Es + dU' ~ ΔEs' = A[ΔEs, ΔdU'], to reach zero equilibrium with Q1 changing to Q1' = 'multiplication unit'||Δt. This was assumed for eq. 4 with energy Es, the zero difference Q1 is lost in eq. 5b with independence of the Q' and Q2', and is regained with the extra dU', and relates to Noether charge ΔNC to ΔNC'. For this interpretation, time interval description quantities are necessary.

5b Q′(n) − Q2′ (n) = Q0′ ~ ΔU0′ = A[ΔU0, ΔdU'] = A[ΔEs, ΔdU']

In eq. 4, zero equilibrium with Q(n) − Q2(n) = Q0, corresponds with time interval 'addition zero'||Δt = ΔU0, and is, in eq. 5b, interpreted with zero equilibrium for energy ΔEs' = M[ΔEs, ΔdU'] = ΔU0′ .

Interpretation A for ΔdU'

Differences in physics can be described for the (with-*) and (with-') situations, when acquired energy ΔdU* and ΔdU' is of un-recognised origin. With situation change not meant is a physical change, rather a change of concept of description, from open, non-zero, equilibrium to closed, zero, equilibrium in both cases.

This paragraph includes several concepts, while depending on the time interval only description. Introduced is an equilibrium type starting from a simultaneous emission star source cosmology, defined from the space-like coordinates of individual stars, an approach which can be assumed overall valid. Then, introduced is simultaneous emission dependent energy in terms of Noether charges. Asymmetry can be introduced also within equilibrium, from the start dependent on relevant event time interval Δt, where asymmetry derives from the units and zero's of resp. the one moment time set and the time interval only set.

Comment 16. An asymmetry within equilibrium means, following Curie's principle, there is an asymmetry in the cause, i. e. in the energies involved, (Curie, 1894). This gives the freedom, due to the time interval only description concept of interval and asymmetry, to derive properties for an energy different from the usual energies T and U. Curie's principle is defined originally within the one moment time description just like energies T and U, where the new unknown energy and its properties are derived within the time interval only description.

It is well known asymmetry, interpreted to be a variation of a symmetry transformation, can imply differences for a property like mass. Curie's principle regarding asymmetry can be adjusted to include asymmetric time intervals, i. e. non-zero symmetry, this is discussed earlier in (Hollestelle, 2020) and in *Comment A*.

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Asymmetry is applied to describe emission energy and acquired energies from star source collectives, par. 3, and to describe zero temperature, par. 4. Independence for the new Δt-quantities ΔQ′ and ΔQ2′ can be applied to the set of star-source time interval quantities Δqi, with the average < Δqi >||n unaltered, with ΔQ equal to ΔQ′, while there is possibly a change ΔQ2 towards ΔQ2′ = ΔA′.

Similar to interpreting the occurence of (with-*) situation energy ΔdU*, one can argue the difference ΔQ′ and ΔQ2′ to become zero equilibrium to mean gravitation energy and emission surface energy should be interpreted to be independent within the (accent-′) situation, i. e. time interval energy ΔdU′ is an un-recognised energy to complete the equivalence for ΔEg and ΔEs.

3.8. Theorems for the Time Interval Only Set

The time interval space-like Δqi, the variation of individual star-sources, is integral with simultaneous emission time interval Δt and wave group velocity $c(\Delta t)$, responsible for the property simultaneous. It is assumed 'addition zero'||Δq_set = Δq0 exists and is well defined. Several theorems for the time interval set and for star-source simultaneous emission can be derived, while partly dependent on theorems from (Hollestelle, 2024part1), e. g. *theorem 1* and *theorem 4*. To render the theorems in this paragraph universal, depended is on the star source simultaneous emission unit properties being a valuable reduction of a cosmological universe and its properties.

Theorems 1 and *2* are included in par. 2.3, and par. 3.3, *theorem 9* continues in par. 4.2 for time interval Noether charge ΔNC, *theorem 4b, 10* and *11* are continued with par. 4.3 for 'zero' temperature, and *theorem 12* in par. 5 for gravitation and entropy. Several of *theorem 1* to *theorem 8* originate from earlier research, to which is referred.

Theorem 1. To resolve the multiplication dimension problem (MDP), (Hollestelle, 2020). Any space-like interval Δq can be interpreted to be a multiplication of Δt with a quantity a1 of non-zero dimension, which is allowed due to the multiplication closure theorem, in this paper *theorem 4*, which is derived in Part1. This is discussed also in *comment 6*.

Theorem 1b. All simultaneous emission properties can be described in terms of time interval only set properties and vice versa, meaning these two sets are linearly dependent. This is due to the multiplication closure theorem which is referred to in *theorem 4*. *Theorem 1b* is a special case of *theorem 4b*.

Within the time interval only description, to introduce a derivative to a quantity Δy starting from a derivative to time interval Δt, *theorem 1b* can be applied.

There is for a Δt-quantity Δy_set, Δy0 = 'addition zero'||Δy_set = 'addition zero'||Δt_set = Δt, which can be derived due to *theorem 4*: A[Δy1, Δy0] = Δy1 = a1. Δt1 = a1. A[Δt1, Δt] = a1. A[a1i. Δy1, Δt] = A[Δy1, Δt], and this implies a solution is Δy0 = Δt, up to some uniqueness in linearity issue, *theorem 1c* and *theorem 4b*. Applying *theorem 1b* and with addition related to derivative Δy(Δt) = D*||Δt[Δz] with Δt-quantity Δz, for any other Δt-quantity Δy1 a similar solution is valid.

Theorem 1c. Due to *theorem 1b*, there is ΔQ1 = a1. Δt for any quantity ΔQ1, from the set of ΔQ quantities, and it follows 'addition zero'||ΔQ_set units equal time interval set 'addition zero' ||Δt_set units. This is the same theorem as *theorem 4b*.

Theorem 2. Canonical property for correspondence. The time interval quantity corresponding with an addition of one moment time quantities is the addition of the time interval quantities corresponding with these one moment time quantities. *Theorem 2* is discussed earlier in par. 3.2. It is valid due to regarding eq. 4 to define zero equilibrium, and applying (equilibrium) theorem c, which originates from (Hollestelle, 2017). It is closely related to one moment time description parameters q and t being separable within the time dependent part of the Hamiltonian, (Hollestelle, 2020). *Theorem 2* is considered an independent proof for the convex isometry theorem for connected (Peano) spaces, images of the unit interval, a theorem mentioned in (Hocking, Young, 1961).

Theorem 3. According to (Arnold, 1974), equilibrium can be proposed to relate to invariance of some parameters expressing other and different parameters being variable, and in this way

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equilibrium can be included in and become part of Curie's principle for (a-)symmetries (Curie, 1894), this was discussed in (Hollestelle, 2020).

Theorem 3b. Within the time interval description, from eq. 1, including space-like interval quantity Δq, any star sources center 'addition' any other star sources center, remains invariant and equal to 'addition zero'||Δq_set.

When this seems contradictory, it can be re-assured by considering the following. It seems to imply a star source collective 'addition' any one star-source, remains with the same, thus invariant, star source collective center. Recall Q(n) = < qi >||n and qi are within the one moment time description. For time interval quantities ΔQ(n) = < Δqi >||n and Δqi, indeed there can be some quantity 'addition' the same quantity with resultant the original quantity, e. g. ΔQ(n) and Δqi, in agreement with eq. 1. This means two similar. i. e. their centers with equal one moment time coordinates, star-source collective center Q1 and Q2, can be 'added' to each other to result in the un-changed center Q1 = Q2, according to this argument. The following theorem goes beyond this.

Theorem 3c. Within the time interval only description a union ΔPu of several ΔPi corresponds with excluded overlap. A union ΔPu of the ΔPi does not construct overlap for the ΔPi. The Pi are always disjoint.

For time interval quantities addition implies the overlap parts are reduced to one part, with the non-overlap parts unchanged, to result in one multiple star-source emission collective where double star entries are avoided. This means for time interval quantities, e. g. star-source and simultaneous emission properties, theorem 3 is valid, even while the relativation by theorem 3b, the quantities to be added, the center in theorem 3b, have to be similar, does not apply.

Theorem 4. The multiplication closure theorem, (Hollestelle, 2024part1): for any multiplication M[ΔA2, ΔA3] = A1, where ΔAi, i = 2, 3, are time intervals, a1 scalar, there is necessarily the resultant A1 = a1. Δt = ΔA1 is time interval, implying multiplication closure within the time interval only set. The multiplication linearity theorem, only slightly different to it, is introduced also in Part1.

The multiplication closure theorem, is derived within the time interval only description for multiplication, however similarly valid for time interval addition due to *theorem 6.*

Theorem 4b. Due to *theorem 4*, there is ΔQ1 = a1. Δt and for any quantity ΔQ1, from the set of ΔQ quantities, it follows 'addition zero'||ΔQ units equal time interval set 'addition zero' ||Δt units. *Theorem 4b* resembles *theorem 1c*.

Theorem 5. There is an argument for the usual one moment time description definition of the thermodynamical limit (TDL), describing cosmological phenomena and events at large scale, due to *theorem 1*. Within the time interval description, indicating with i time interval multiplication inverse, only when < f. gi > = < f >. < gi > the individual quantities remain individual, following the definition of correspondence applying averages, par. 1.4, and a theorem found e. g. in (Hocking, Young, 1961).

Definition of TDL: The thermodynamical limit (TDL) includes enlarging the complete 'system' with its overall volume V including the number N of objects occurring, however not changing the average value N/V, e. g. individual mass values (Fetter, Walecka, 1971).

Theorem 6. Time interval only set theorem, (Hollestelle, 2024part1). Within the time interval only description, addition equals multiplication in value: A[Δt1, Δt2] = M[Δt1, Δt2] for any Δt1 and Δt2, time intervals or time interval quantities. This theorem is confirmed within the time interval only description by equality of time interval derivative D*||Δt and time interval integral I*||Δt working on any Δt-quantity.

Theorem 7. Time interval complementarity relation (Hollestelle, 2024part1). Within the time interval only description structure constant Δs and Noether charge are the same, Δs = ΔNC, where Δs follows from the time interval wave equation, and disregarding a multiplication scalar. The multiplication scalar is found to be equal to a1 = 'multiplication unit'||scalar_set due to conservation of energy. The theorem on averages implies D*||Δt[ΔA1] = D*||Δq[ΔA1], and the time interval wave equation D*||Δt*[D*||Δt*[ΔA2]] = ΔA2 implies ΔA2 = a1. ΔA1, where there is D*||Δt[ΔA1] = ΔA1, and this means a1. ΔA1 = ΔNC and ΔNC = #n. *h*. ν, which seems acceptable being a way to write the time interval version of the complementarity relation, for the overall cosmology of the simultaneous

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emission and star source collective, and it suggests the usual complementarity relation, ΔEs = #n. *h*. ν and Ew = *h*. ν, follows similar considerations. This is also discussed in *comment A*.

Theorem 8. There exist arguments for the ergodic hypothesis and arguments to derive the theorem on averages, starting from *theorem 3*, implying a new version for it. Within both GR and QM, relations occur similar to the theorem on averages. *Theorem 3* seems to be equivalent to the following theorem from thermodynamics. Thermodynamic functions and ensembles: time average at one state equals the state average over many states at equal time, (Van Kampen, 1988).

Correspondence of time interval derivative and one moment time derivative, D*||Δt[a1] ~ D*||t[a1], for a1 one moment time invariant scalar, reduces to D*||Δt[a1] = D*||t[a1]. Δt.

Due to *theorem 2*, difference Q(n) − Q2(n) equals one moment time Noether charge NC ~ ΔNC, i. e. corresponds with time interval Noether charge ΔNC, linear in Δt. There is ΔNC = ΔEs = #n. *h*. ν, the kinetic emission energy, proportional to emission surface measure mA, which equals, due to eq. 1, wave group-velocity measure m*c(Δt)*. Specific Lorentz transformations TS, preserving surface measures including mA, differ from usual Lorentz transformations TL that preserve the metric line element, where due to this, ΔEs and ΔNC both remain TS invariant, (Hollestelle, 2024part1).

Paragraph 4. Discussion B. Zero Temperature and Simultaneous Emission

4.1. Zero and No-Zero Equilibrium

For a change from (no-*) situation to (with-*) dU* situation with Hamiltonian H changing to H* = H + dU*, the new energy introduced within the description is acquired energy dU*, without change of physics. Indication * implies the (with- *) situation, not the operator * or transformation * indication.

Legendre transformation TD remains valid, within one moment time description and time interval description: ΔH = TD*[ΔL] = A[M[Δp, Δx], ΔLiv] and similarly ΔL = TD*[ΔH], which applies the symmetric associative property (for series), and *theorem 6*, (Hollestelle, 2024part1). Within the one moment time description for quantities H and L, and p and x(p) = d(q)/dt one finds eq. 8.

Defined is H = H0 + dH, (Hollestelle, 2020) while avoiding confusion with time interval description indication Δ: in earlier papers H = H0 + ΔH, where in the present paper, differently, correspondence H ~ ΔH applies the indication Δ. Hamiltonian part H0 is time independent and rescaled to be equal to one moment time description energy 'addition zero'||t_set ~ 'addition zero'||Δt_set due to *theorem 4,* and dH is the time dependent and variable part of the Hamiltonian. To derive eq. 9, theorem 6 is applied again. One finds multiplication M[Δp*, Δx*] = 'addition zero||Δt_set* effectively for any situation. This implies eq. 8 reaches equilibrium closure, i.e., zero equilibrium, in the (with-*) situation through addition with dU*: H* = H + dU*. Both eq. 8 and eq. 9 are in the (with-*) situation.

8 H* = H + dU* = H0* + dH* = dH* = 'addition zero'||t_set* ~ M[Δp*, Δx*] = A[ΔL*, ΔH*] = A[ΔL, ΔH]

9 ΔH* = A[ΔH, ΔdU*] = ΔdH* = 'addition zero'||Δt_set* = A[ΔdH, ΔdU*] = ΔdU*

There is M[Δp, Δx] = M[Δp*, Δx*] = M[Δp, Δx]iv, and M[Δp, Δx] remains invariant when changing from (no-*) to (with-*). Traditionally the invariant energy H0 = T + U can be chosen equal to 'addition zero'||t, due to re-scaling.

There is H0* = 'addition zero'||t*. Within both situations (no-*) and (with-*) the one moment time units 'zero' are equal, 'addition zero'||t_set = 'addition zero'||t_set*.

Due to correspondence there is H0 = 'addition zero'||t_set ~ ΔH0 = 'addition zero'||Δt_set = ΔU0. From eq. 8 and with A[ΔH, ΔH*] = ΔH* there is A[A[ΔL, ΔH], ΔdH*] = A[ΔL, A[ΔH, ΔdU*]] = A[ΔL, ΔdU*] = ΔdU* and:

10 A[ΔL, ΔH] = M[Δp, Δx] = ΔL = ΔH = 'addition zero'||Δt_set* = 'addition zero'||Δt_set

11 ΔH = 'addition zero'||Δt_set = A[A[ΔL, ΔH], ΔH] = A[ΔL, 'addition zero'||Δt_set] = ΔL

Theorem 4b. Due to *theorem 4,* from the set of ΔQ quantities there is unit ΔQ1 = a1. Δt and for any quantity ΔQ1, it follows 'addition zero'||ΔQ_set units equal time interval set 'addition zero' ||Δt_set

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units. This theorem is also included in par. 3.8. The scalar a1 equals the 'multiplication unit'||scalar_set, this is derived in Part1.

With eq. 8, and A[ΔL, ΔH] = 'addition zero'||Δt_set*, and *theorem 4b,* it follows eq. 11. For space-like interval Δq and space-time interval Δp, eqs. 12 are valid, i.e., the *canonical time interval Δt-equilibrium equations* (Hollestelle, 2020). The derivative of time interval momentum Δp*, second line eq. 12, equals the time interval version of Newton's second law, par. 3.4, for the complete acquired energies U and U* = U + dU*.

12 D||Δt* [Δq*] = M[Δt*i, Δq*] = Δq*

D||Δt* [Δp*] = -1. D||Δq* [ΔH*] = M[Δq*i, ΔH*] = M[c*(Δt*)i, ΔEs*]

It is not assumed the group-velocity necessarily remains un-altered in the (with-*) situation always. The group-velocity c(Δt) and wave energy ΔEs* are specific for the time interval version of emission spherical symmetric surfaces. Some of these properties are applied to derive overall time interval set properties and definitions, e. g. time interval derivative D||Δt* [Δt1] for any time interval Δt1, where the * indicates 'working to the right' similarly to an operator, (Hollestelle, 2021).

4.2. Zero Temperature

Definition of Zero or Lowest Bound Temperature

The definition of zero temperature can be chosen to imply: a situation without interaction, when interaction and time dependence imply change, related to non zero temperature. A situation without interaction can imply 'free' or 'plane' waves, where a stationary state with uncertainty relation |Δ*E|. |Δ*t| ≈ |h|, not necessarily implies zero temperature, the Δ* indicating variances. Within this definition zero interaction includes the zero, lowest bound, temperature property, where however interaction is assumed necessarily to imply action and increased energy.

Dispersion free star source simultaneous emission is described, instead of with plane waves, with sphere-like emission surfaces. This makes sense for a multiple star source emision applying the simultaneous emission concept, where no interaction is meant to imply continuous and invariant simultaneous emission from the star sources and invariant simultaneous emission energy for equilibrium time development, described in par. 3.1, and (Hollestelle, 2020).

Within QM, defined can be a ground state, however possibly including interaction, (Fetter, Walecka, 1971). When field wave energy and Lagrange density depend on wave type of variation, i.e., change, of field variables (Sakurai, 1967), (De Wit, Smith, 1986), the concept of zero temperature is un-interpreted, since a field plane wave assumes change, if only due to wave group-velocity and the wave frequency-momentum relation, which defines ground state energy and energy exchange which is one of the reasons for the QM field to be defined. The following depends on the time interval description version of the QM complementarity relation, introduced in (Hollestelle, 2021).

The usual introduction of ensemble temperature from the partition function and the traditional β-function inversely proportional to temperature, (Fetter, Walecka, 1971), does not apply for all zero temperature cases. Temperature refers to simultaneous emission, not is meant temperature of the star sources in this paper. Within the time interval description one can define absence of interaction to mean absence of interaction within relevant event time interval Δt, the finite measurement event time interval. In (Hollestelle, 2021) an attempt is made to describe a measurement event including wave function reduction. A combination of time dependent and time independent properties was assumed for two subsequent time intervals which together describe the measurement event.

Simultaneous Emission Energy and the Constant of Planck H

The simultaneous emission energy ΔEs is a multitude of wave function energy ΔE = h. ν, for wave emission with average wave momentum p = h. k_, for k_ = 1/ν, and this ΔE relation becomes invalid, due to a singularity, for zero energy and zero frequency ν. The QM emission spectrum often assumes emission spectral lines, however instead one can similarly assume a spectrum weight function. For a continuous weight function, introduce average < k > = k_, momentum variance |Δ*k|,

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where variance can be assumed equal to weight function width, i. e. |Δ*k| = 2u, (Merzbacher, 1961). Introduced is indication * for variances, different from the * , that indicate transformations and operators, e. g. TS*[Δt], transformation TS 'working to the right' on Δt, and the addition indication (with-*) from par. 3. This follows indications in (Hollestelle, 2020).

It is derived |Δ*k_|. |Δ*q| = *h*+/*h* from which it follows < |Δ*p|^2 > = *h*+^2, with *h* the constant of Planck and *h*+ = +1/2 (Δ*p. Δ*q + Δ*q. Δ*p), defined in *comment A*, with variances Δ* equal to interval measures, *h*+. This is valid only within the time interval description where time interval quantity Δq equals time interval Δt = ΔU = 'multiplication unit'||Δt. The following is from (Hollestelle, 2020).

Assume zero temperature to imply no interaction change occuring, with time independence and zero energy. In this situation, with E = 'addition zero'||t, the usual requirement for time independence is the stationary situation with mΔ*E << mE which however does not apply, and mΔ*E = mE is allowed to be assumed valid. One finds Δ*k. Δ*q = c_ = *h*+/*h* where < c_ > = 1 implies time independence including *h*+ = *h*. This result relates to the limit for QM to be applicable, while < c_ > = 0 implies time dependence. The < c_ > values are written with scalar numbers.

For E = 'addition zero'||t this would mean < c_ > = 0 where c_ = mE/mΔ*E. *h*+, and thus not necessarily a time independent situation with < c_ > = 1, which can still be valid however due to the presence of two zero value quantities, mE and mΔ*E. This special case can be interpreted with both averages < |E| > and < |c_| > to differ from zero infinitesimaly such that *h*+ can be assumed approximately equal to *h*. This depends on the weight function for the frequency density, and is different from what one expects from one value ν frequency emission.

It follows eqs. 13, within the time interval description, energy ΔEs = ΔT is a kinetic energy and Δm1 wave-particle mass related to kinetic energy ΔT, where zero temperature does not imply zero energy, due to application of averages. The third part of eq. 13 includes a singularity for Δm1 = 'multiplication zero'||m_set, e. g. for Δm1 meaning zero-mass wave-particle, which can be resolved with the time interval asymmetry average < Es >||Δt = ΔEs different from 'multiplication zero'||E_set for finite Δt and time dependent H, *comment 13*.

Comment 17. At temperature T_zero, the photon mass m1 can be different from m0 = 'multiplication zero'||m_set, or otherwise written, temperature T_zero implies wave particles for ΔEw = *h*. ν or photons different from zero mass m1 = m0.

13 < |Δ*p|^2 > = *h*+^2 ≈ *h*^2

< |Δ*k_|^2 > = *h*+^2/*h*^2 = *c*_^2 ≈ 1(scalar)

mΔ*Es = *h*+^2. 1/|Δm1| ≈ *h*^2. 1/|Δm1|

ΔT-Equilibrium Time Development and Interaction

Comment 18. From this discussion one can interpret more symmetrical time intervals imply lower temperature. Any time interval measure mΔt is no garantee for interaction to occur or not. One can infer from relevant event time interval measures mΔt' < mΔt'' to imply Δt'' is 'more' stationary and measurement of interaction to be 'more' diffuse, with reference to Δt'. This can be related to a measure for stationary event property change.

From eq. 5b and eq. 11, and the discussion from par. 3.8, one finds eq. 14, the accent originating from par. 3.7 for interaction, for any possible emission star-source collective with independent Q'(n) and Q2' (n), with interaction implying change different from Δt-equilibrium time development with invariant energie ΔEs.

14 ΔEs = A[< ΔQ'i >||n, ΔNC'iv] = Δt

It follows for zero temperature both < Δp >||Δt_set and < Δq >||Δt_set equal time interval 'addition zero'||Δp = 'addition zero'||Δq equal to 'addition zero'||Δt = Δt, due to theorem 1c, and comment 10.

Eq. 15 is a simplified version of eq. 12, and the time interval version of the Δt-equilibrium time development equations. The eq. 15 right side resultant equals ΔU when Δt finite, ΔU0 when Δt infinite. The time interval addition inverse for Δt is Δtiv = Δt, due to which the minus sign is absent.

15 D*||Δt [Δq] = 'multiplication unit'||Δt

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D*||Δt [Δp] = 'multiplication unit'||Δt

Within eq. 12 it is possible ΔH = ΔdU remains invariant, while however derivative D*||Δq [ΔdU] not necessarily equal to 'addition zero'||Δt and in this case does not reduce to the Newtonian result.

Due to the time interval multiplication closure theorem, within theorem 4, there is ΔdU = a1. Δt and Δq = a2. Δt with scalars a1 and a2, while it can be derived Δq = Δt equal to the time interval only set Noether charge ΔNC or structure constant Δs (Hollestelle, 2024). In the same ref. derived is the time interval 'derivative set rule' for any scalar multiplication a. Δt1, D*||Δt[a. Δt1] = A[a. D*||Δt[Δt1], M[D*||Δt[a], Δt]], the first part of eq. 16, and it follows:

16 D*||Δt [Δq] = A[a2. D*||Δt [Δt], D*||Δt [a2]] = A[Δq, Δt] = Δq

One result is, Δq is an invariant for derivative D*||Δt and D*||Δt [D*||Δt [Δq]] = Δq, which is the time interval description wave equation in this case with solution Δq, where the minus sign disappears naturally, similar to eq. 15, (Hollestelle, 2024part1).

Theorem 9. Time interval quantity Δq is equal to the time interval only set Noether charge. It follows ΔdU = a1. Δt = a1. Δq equals the same structure constant, except upon linear multiplication, and one finds D*||Δt [D*||Δt [ΔdU]] = ΔdU from which follows ΔdU = ΔNC.

4.3. Simultaneous Emission Properties from the Lowest Bound Emission Temperature

A cosmology described with star source collective and simultaneous emission, where defined is emission surface A 'nearby' all star sources, was introduced in (Hollestelle, 2021). One defines the places qi for the star-sources, with Q(n) + qi_iv = ∂i and m∂i << mQ(n), Q(n) = < qi >||n the one moment time description 3-dim. space like coordinate for the center of the star collective equally at the center of the simultaneous emission, iv indicates addition inverse, mQ(n) = | < Q(n) + ∂i_iv >||n | with i = 1 to n for n the number of star sources. Meant is stars i occur around emission center Q(n). The term collective indicates a singular or multiple collective of emission sources, from one or multiple star groups, together the star collective. Within this paragraph T_ indicates temperature for simultaneous emission, or for emission measurement event, T_ = T_emission or T = T_e, not emission kinetic energy T = Es.

There exists a transition temperature Tc, (Hollestelle, 2017), such that for T_ >> Tc there is |Q(n) + q0_iv| << mQ(n) infinitesimal, and for T_ << Tc there is |Q(n) + q0_iv| >> Q(n), with q0 one moment time space-like coordinate zero place, which is defined to be on surface A in par. 3.1.

Reference 2017 is written within the one moment time description, and Tc is proportional with |Q(n)|^4. Proceeding within the time interval description, one finds mΔTc is proportional with mΔt^4, and mΔt^4 = mΔNC, applying mΔA = mΔt and mΔq = mΔt and Δt = ΔU.

This can be combined with par. 4.2: Noether charge |NC| = mA^2 ~ ΔNC = M[ΔA, ΔA] = ΔA. One finds: T_e / T_star-source ~ < |#n(i)| >||i_set. (#nc). ((Σi #n(i))^(-1)), assuming emission energy depends on one frequency for the overall star-source group collective, (Hollestelle, 2021). The #n(i) refers to star source number for group(i), equal to star-source group(i) emission wave function number. The (i) is to facilitate multiple groups in the star-source collective, with i = 1 to #nc, the number of groups, however reduced is to #nc = 1 and #n(i) = n, meaning one star-source simultaneous emission group including n star-sources. One moment time description overall emission group zero temperature, with T_zero = T_e = < |n| >||(i = 1). 1/n = 'multiplication unit'||t_set = t0, is not consistent T_zero = 'lower bound' = 0. t0 for domain dT, this implies asymmetry. One can introduce time interval quantities with averages, ΔT_zero = ΔT_e = < < |n| >||t_set . 1/n >||Δt . Δt = < t0 >||Δt. Δt = ΔU, following theorem 4b, which can be 'non zero', different from ΔU0, for Δt finite, and can be 'zero', i. e. equal to ΔU0, for Δt infinite. The overall simultaneous emission zero temperature ΔT_zero result is, from theorem 9:

17 Δq_group(ΔT_zero) = M[Δq, Δq]_group = ΔNC_group = Δt_group(ΔT_zero)

This result is valid only within the time interval description. It can be extrapolated to a more complex star source emission surface from a multiple group collective, following theorem 3b and 3c, par. 3.8.

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Simultaneous Emission Temperature ΔT, and Estimate ΔT_zero for the Lower Bound of Temperature

In par. 4.2 it was derived ΔEs = Δt, and ΔEs can be estimated due to the virial theorem, ΔEs = ½. D. *k*. ΔT, with D the number of degrees of freedom for the wave emission surface, with the radius interval Δq_group = Δt_group, and *k* the constant of Boltzmann. One finds eq. 18 with time interval zero temperature ΔT_zero for overall simultaneous emission with D = 4, due to the discussion in par. 3 and *comment B*.

The number of degrees of freedom can vary due to transition, to include resultant parameters different from original parameters. In par. 1.6 transition is different from usual, meant is a change from wave emission energy description to gravitation energy description, rather than a change of objects.

Transition of objects can mean transition of properties, however ΔT_zero remains equal to ΔU and ΔEs_zero equal to Δt_zero. When properties change this can occur with temperature ΔT to change to a temperature ΔT ≠ ΔT_zero, e. g. related to < n > | | Δt, ni = n and |n| = n >> 0. Applied is M[*c*(Δt), Δt] = *c*(Δt) = Δt and M[*c*(Δt), ΔT] = ΔT.

18 ΔEs = ½. D. *k*. ΔT = #n. *h*. ν

ΔEs = ½. D. *k*. M[*c*(Δt), ΔT]

19 ΔT_zero = < n > | | Δt. Δt = 'addition zero' | | Δt

Theorem 10. For simultaneous emission, with one overall emission surface, ΔEs = Δt, eq. 14, is proportional with Δq, at temperature T_zero. This is a re-statement and confirmation of the constant average wave group-velocity assumption for invariant temperature, i. e. without dispersion, *c*(Δt) = M[Δq, Δti] from par. 2.3 and *comment A*.

Comment 19. Estimates for temperature ΔT_zero. One can estimate a simultaneous emission temperature from eq. 18 and eq. 19 with D = 1; wave emission surface energy ½. *k*. ΔT is ca. 0.43. 10^(-4) eV, (electronvolt), and for emission temperature ΔT, linear with Δqi and Δt, this means ΔT_zero = ca. 0.50 K, (Kelvin). Any degree of freedom adds ca. 0.5 K or ca. 0.4 10^(-4) eV, value of energy to T_zero. Marges are left out of the results. Applied are constant values from (Cohen, Giacomo, 1987).

For D = 4, *comment B*, par. *B3*, one finds ΔT_zero equals 2 K. With approximation n = 2 for the average number of star sources within one collective this could imply a collective of two stars, with one moment time space like coordinate q1 ≠ q2. At ΔT_zero all star sources being far enough 'remote' from each other and from emission surface ΔA, *theorem 3b*, to be independent sources both with number n = mΔT_zero = mΔU = 1, and with 'near' zero mass emission wave-particles. This means star sources can be independently added to the collective, similar to the resultant of theorem 3b, and 3c, par. 3.8. The term collective indicates singular or multiple star groups or a multiple emission surface collective, par. 3.1.

One estimates value mΔq for D =1 at ΔT_zero, with m(Δq_zero)i = 1/2. k. < |n| > | | Δt. |c(Δt)|, and mΔq = 1/|ΔEs|. 1/|c(Δt)| = ca. 0.78 (10^12) m, (meter), = ca. 52 AE, (astron. Units), at emission temperature T_zero, linear with 1/D. From the discussion in *comment A* one finds Δq = M[*h*+, Δm1] for any zero or non zero mass Δm1 wave particle and Δq = *h*+ for Δm1 = 'addition zero' | | Δm = Δm0 for zero mass wave particles, photons, with photon mass Δmp. For infinite 'remote', Δq = *h*, since in this case *h*+ approximates *h*, and infinite 'remote' means lowest bound mΔq = 13 AE for D = 4. Similarly the zero mass Δm1 = 'multiplication unit' | | Δt infinite 'remote' wave particle, and D = 1, mΔt = 1/|*h*+|. 1/|c|. |Δm1|. 1/D = 0.5 10^25 sec = 1.6 10^17 year, which is a highest bound with D = 1 and zero mass Δm1.

Theorem 11. Simultaneous emission temperature equal to Noether charge. At temperature T_zero, relation ΔNC_zero = Δq_zero means there is a preferred T_zero time interval Δt_zero = ΔNC_zero = 2. *k*. ΔT_zero, due to eq. 18 and eq. 19, where both measure mΔt_zero and mΔT_zero, due to asymmetry, differ from measure value zero and are both finite, i.e., related to ΔU and different from ΔU0. It is inferred for any temperature, simultaneous emission temperature ΔT_e equals time interval unit Noether charge ΔNC. Recall simultaneous emission does resemble boson objects, due to *preliminary emission theorem III*, par. 2.7, and the related mathematically inclined *theorems* 3, 3b and 3c,

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par. 3.8, and where the ground state lowest energy is the 'zero' energy unit and is available for any wave function number #n.

Paragraph 5. Discussion. Time Interval Zero Temperature

Time Interval Only Description Zero Temperature ΔT_zero

From Clausius definition, the quantity temperature T is a proportionality, included in dQ = T. dS, for warmth Q and entropy measure S, where d indicates in this case divergence change. At zero temperature T_zero, infered is the following proportionality, dEs = T_zero. dt and D*||Δt[ΔEs] = ΔT_zero, with T_zero equal to unit 'multiplication zero'||T_set, within the temperature set. ΔQ = ΔEs is the kinetic energy with star collective emission surface A.

Time interval only description temperature follows from correspondence ΔT ~ T.

Emission temperature T is similar to a current parameter, par. 1.2, and can be assumed independent of t-equilibrium time development, it should be integrated within, e. g. the gas law, to find its relations to other quantities. Defined is, with the averaging definition for current parameters, time interval description quantity ΔT = < T >||Δt_set. Δt, and ΔT = α. Δt, following theorem 4 with unknown linearity scalar α, which however leaves both T_zero and ΔT_zero = 'multiplication zero'||ΔT_set invariant.

The argument for T_zero, dΔS = dΔt, and D*||Δt[ΔS] = Δt, is consistent with D*||ΔS[ΔQ] = ΔT_zero, the first law of thermodynamics, energy conservation.

When similarly ΔS = γ. Δt, linear with Δt, due to theorem 4, the linearity scalar γ implies re-scaling T which leaves T_zero and ΔT_zero invariant. For ΔH = ΔEs one finds at zero temperature T_zero, D||Δt*[ΔH] = 'multiplication zero'||ΔT_set = ΔT_zero, i. e. minimal dispersion and maximum energy conservation, for the overall universe at temperature ΔT_zero at any time interval Δt. When ΔH = ΔEs = ΔNC, from par 3.5, one finds ΔT_zero = ΔNC_zero, the time interval Noether charge at T_zero, which is equal to the lowest ground state energy, including ΔNC_zero = #n. *h*. ν, as it should, for the overall universe. The time interval wave energy *h*. ν applies to both zero or non zero mass wave-particle.

The 'Remote' Property and Simultaneous Emission Internal Interaction

Internal interaction was discussed in (Hollestelle, 2021). Some results are collected in this paragraph.

Comment 20. Infinite 'remote', with respect to the source, can be approximated with 'remote' or infinitely 'remote'. Then, both latter types of 'remote' correspond with the limit mass 'addition zero'||m_set, with incomplete correspondence, the former infinite 'remote' with complete correspondence. For infinite 'remote' the average < t >||Δt = t0 = 0. t0, i. e. t0 equals 'zero', assuming the infinite time interval, and symmetries are complete and with similar 'zero' transition elements.

Comment 21. The infinite 'remote' relates to H time independent and infinite Δt, where 'remote' and infinitely 'remote' both still relate to H time dependent and finite Δt. From eqs. 7 and 8, dispersion and H time dependence is not consistent with infinite and symmetric Δt, where relation 'addition zero'||Δt_set = Δt0 = ΔU0 differs from the H time dependent event, which is rather consistent with finite asymmetric Δt relation 'addition zero'||Δt_set = Δt0 = ΔU.

This difference should be observable within some finite measurement event time interval Δt. The average < t >||t = t0 ~ Δt0 = 'multiplication unit'||Δt_set = 'addition zero'||Δt_set = ΔU0 only for infinite, i. e. symmetric, Δt with average t0 = 0. t0 where 0 = multiplication zero'||scalar_set. However, 'multiplication unit'||t_set = < t >||t = t0 ~ Δt0 = ΔU, for all finite, i. e. asymmetric, Δt with average t0 ≠ 0. t0.

Comment 22. Due to internal interaction, any type of non-zero mass wave particle emission would appear to be zero mass particles, photons, at the emission limit, i. e. emission surface ΔA, when infinite 'remote'. The apparent non-zero mass particle is only measurable at 'remote' with finite asymmetric Δt and H time dependent, however not at infinite 'remote' at infinite symmetric Δt where

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H remains time independent. Adiabatic energy transfer is an interaction where H remains time independent, at least stationary, with $|\Delta^* dH|. 1/|\Delta^* H| << 1$.

Internal Energy Transfer

The one moment time description measure for the Noether charge is: mNC_zero = mA^2, with mA invariant due to emission surface energy invariance. Time interval Noether charge ΔNC equals wave group-velocity $c(\Delta t)$, which can be assumed constant at T_zero due to zero dispersion, where plane- or free waves remain plane- or free waves. This is, for T_zero, an independent confirmation of invariance of mA with t-equilibrium time development, an invariance derived in (Hollestelle, 2021).

From par 4.3, $\Delta T_zero = < |n| > | |\Delta t = n$, for a one group collective with #nc = 1, which means for H time independent and Δt symmetric, T_zero equals ΔU0, however, differently, for H time dependent and Δt asymmetric, T_zero equals ΔU = Δt. The situation with #nc = 1 can easily be extrapolated to more complex star source emission from a multiple group collective with #nc > 1, following theorems in par. 3.8.

Thermodynamical Limit TDL and Reversibility

In par. 3, emission surface energy does not change due to time development, where however with change due to thermodynamical limit TDL, surface energy ΔEs does not increase since the emission surface ΔA'' = ΔA', remains the same, and measurement place qm'' = qm' remains the same. The thermodynamical limit TDL includes enlarging the complete 'system' with its overall volume, which would mean, the property 'remote' limits towards infinite 'remote'.

The reverse change from infinite 'remote' towards 'remote' is one of increasing mass value, *comment 16*. This means the gravitation energy interpretation ΔEg for acquired surface energy is valid instead of the outgoing wave emission energy interpretation ΔEs.

The simultaneous wave emission surface energy ΔEs remains invariant with any change for Δt and remains equal to m2, which implies mass m2 does not depend on the number #n of photons, when zero mass photons are the wave-particles, this is discussed in *comment A*. When mass m2 is subject to internal interaction and energy transfer, and possibly depends on other parameters, e. g. parameters #n and ν, these parameters can only be separable and measurable at invariant infinite 'remote'.

One can attempt to describe a transition from Hamiltonian time dependence to time independence, or, meaning the same physics, from time interval Δt finite to infinite, this transition is however not easily reversed. This was discussed in (Hollestelle, 2020) introducing internal interaction where the complete surface energy remains invariant. Infinite time intervals are not well defined, for these time intervals $< t > | |\Delta t = t0 = 0. t0$.

Theorem 12. Acquired energy, e. g. gravitation energy ΔEg, does not contribute to entropy.

At infinite 'remote', interpretation of surface energy with ΔEg = M[Δqi, M[m1, m2]] and with gravitation energy fails since the infinite Δq and Δt, due to H time independent, do not allow external, only internal, interaction. Gravitation energy is inverse linear with Δq, *comment 9,* and internal interaction implies an invariant surface energy, while energy ΔEs can transfer to energy ΔEg, with entropy transfer similarly to ΔEg. However, acquired energy, e. g. gravitation energy ΔEg, does not contribute to entropy, considering the discussion in (Van Kampen, 1988) claiming the entropy of the complete system remains zero, thus also including a system with free fall change of ΔEg without heat exchange. For *theorem 12*, consistency with the Higgs's mechanism can be evaluated, when Δm can be variable. This is possible also for acquired energy to be interpreted with an un-specified phenomenon, e. g. the dark matter energy fraction.

Comment 23. Simultaneous distribution property

Definition 4: a distribution is defined to be a series of subsets, of a quantity, regarded as a set. Any distribution is assumed to be a simultaneous distribution.

Distribution theorem. Any simultaneous distribution for emission surface ΔA remains a covering for ΔA and relates to the same time interval Δt, the time development time interval for the complete

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surface ΔA. This implies, there are no simultaneous distributions for Δt, except the distribution including only Δt. Distributions are also discussed in *comment B6*. Distributions of sets, in some cases termed partitions, when connected including this set and the empty set, are introduced in most textbooks on topology.

Assume a distribution for the space-like interval Δq(Δt) to exist, interpreted with simultaneous emission with limit simultaneous emission surfaces An = A(Δq(n)). This implies change of emission measurement place with each surface An, meaning qm(An) = qm(Δqn) to change to qm'(An') = qm'(Δqn') with qm' ≠ qm, due to the existence of the distribution for Δq(Δt), and this implies a distribution for time interval Δt, including certain numbers n' ≠ n with Δtn' ≠ Δtn. However, Δtn' ≠ Δtn is not allowed since Δt is to remain invariant with Δtn = Δt for all n or n', since Δt is the relevant event time interval for the limit surface A(Δt) defining simultaneous emission. Similarly, time interval Δt is not simultaneous with any of the Δtn and Δt ≠ Δtn. This confirms the distribution theorem.

Paragraph 6. Discussion. Time Interval Action Principle and ΔT-Equilibrium

A time interval only action principle, corresponding with Hamilton's action principle within the one moment time description, can be formulated by including a space like time interval integral for time variation while maintaining wave emission simultaneity. Eq. 20 to eq. 22 include time interval integration and averaging indicated with ∫|| Δt_set dΔt [ΔA] = < ΔA >|| Δt_set. |Δt_set|. Time interval quantity ΔA(Δt) does not depend on one moment time t. Integrated and averaged is over Δt_set, meaning all Δt within the time interval only set, not meaning all one moment time parameters t during Δt.

In this way the space and time averages theorem, defined in (Arnold, 1974), par. 1.5, is recovered with eq. 21. Due to eq. 20, for the time interval only set, it is implied when ΔdU = a1. Δt = a1/a2. Δq and Δq = a2. Δt there is a2 = 1. Equation Δq = a2. Δt, only for a2 = 1 agrees with conservation of energy, par. 4.2. Indeed the result for eqs. 20 and 21 equals ΔdU = "addition zero"|| Δt_set = Δq and Δt = Δq = ΔNC.

The dimensions of these quantities can be accommodated for by applying the dimensional multiplication theorem, theorem 1, which includes taking care of definitions of units, which amounts to equations like t0. t0 = t0 and M [Δt0, Δt0] = Δt0, from theorem 1, and discussed in par. 2.3, and when defining time intervals in one moment time description in (Hollestelle, 2020). The * indicates 'working to the right', *h*+*[A] is the operator version of *h*+, where the operator definition is, operator*[A] = M[D*||Δ(M[[|operator*|, A]), Δt], and |operator*| is the operator related quantity, e. g. within the one moment time description the operator p equals -1. i*h*. d/dq, and the quantity |p*| equals parameter p, from (Hollestelle, 2021). For situation (with- *), ΔH* = ΔdU = ΔNC remains invariant during any Δq or Δt. Derived in par. 4.1, there is ΔH = M[h+, Δti] = M[Δp, Δq] since ΔH = ΔL = 'addition zero'|| Δt_set.

20 ∫|| Δq_set dΔq [D*|| Δq [ΔdU]] = ∫|| Δq_set dΔq [a1/a2. Δq] = a1/a2. < Δq >|| Δq_set . |Δq_set| =

= a1/a2. Δq

= a1. < Δt >|| Δq_set. |Δq_set| = a1/a2. ∫|| Δt_set dΔt [Δt]. 1/|Δt_set|. (a2)^2. |Δt_set| =

= a1. a2. ∫|| Δt_set dΔt [Δt] = a1. a2. Δt = a1. Δq = ΔdU

21 ∫|| Δq_set dΔq [ΔdU] = ∫|| Δt_set dΔt [ΔdU]

< ΔH >|| Δq_set. |Δq_set| = < ΔH >|| Δt. |Δt_set|

ΔH. |Δq_set| = ΔH. |Δt_set|

22 *h*+*[Δt1] = D|| Δt*[M[h+, Δt1]] = M[M[Δp, Δq], Δt1]

h+ = M[ΔE, Δt] = M[A[ΔQ, ΔQ2iv], Δt] = ΔQ1

Paragraph 7. Discussion. Correspondences and Set Units

Within QM the correspondence postulate is part of the relations for QM concepts and their interpretation (Roos, 1978). In this paper with correspondence is meant something nearly similar.

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Correspondence for the one moment time set and the time interval only set is defined with set units and set zero's, the part of the time interval only description defined in Part1, (Hollestelle, 2024part1). Due to the multiplication closure theorem, discussed with theorem 1, and 4, in this paper, any time interval quantity Δq1 can be written equal to a scalar multiplication to Δt, meaning Δq1 = a1. Δt.

Time interval quantity units and zero's can be written equal to time interval only set units and zero's, due to theorem 4.

There are two different unit sets, the finite measure time interval subset, asymmetric and related to H time dependent, and the infinite measure time interval subset, symmetric and related to H time independent. Specified are several quantities units and zeros within Table 1. Introduced are h- = 1/2(A[M[Δp, Δq], M[Δq, Δp]i]) and h+ = 1/2(A[M[Δp, Δq], M[Δq, Δp]]) and their limit, and this implies when H time independent and Δt symmetric and infinite, h+ reduces to h and h- reduces to zero, 'addition zero'||Δt. The Δp and Δq are Δ* variances, which are equal to time interval quantities Δp and Δq, (Hollestelle, 2020).

Table 1. Time interval only set units and zero's, the time interval only description star source emission surface space-like interval set, the wave-particle mass set and the simultaneous emission energy set. Several time interval description intervals and one moment time description parameters are not well defined within their resp. sets. ΔU0 is not a well defined time interval, due to its zero value domain, similar to a one moment time parameter. 0. t0 is not a well defined one moment time time-like parameter. Multiplication inverse Δti is not a well defined time interval for relevant time interval Δt infinite. There is ΔEw = h. ν is a time interval quantity and M[#n, ΔEw] = ΔEw and similar for h. ν.

averages	units	time interval only set Δt	collective space-like ΔQ(n) / wave-particle mass Δm1	simultaneous emission energy ΔEs
Asymmetric time interval		Δt finite	Δm1 ~ < m >||Δt. |Δt|	ΔEs = M[Δm1, Δm2]
	'addition unit'||Δt_set		Δm1 = h. ν = 0. Δm1	Δm2 = #n. h. ν = ΔNC
t0	'addition zero'||Δt_set	t0 ~ Δt0 = ΔU	ΔQ0 = A[ΔQ(n), ΔQ2(n)iv] Δm1 = 0. Δm1	ΔEs = M[h+, Δti] = M[Δm1, Δm2] = ΔNC
< t >||Δt = t0 ~ Δt0 t0 ≠ 0. t0	'multiplication unit'||Δt_set	t0 ~ Δt0 = ΔU = Δt ΔU ≠ ΔU0	ΔQ0 = A[ΔQ(n), ΔQ2(n)iv] Δm1 = 0. Δm1	ΔEs = M[h+, Δti] = M[Δm1, Δm2] = ΔNC
0. t0	'multiplication zero'||Δt_set	0. t0 ~ 0. Δt0 = ΔU0	0. ΔQ0 = A[0. Δq0, 0. Δq0iv] = ΔQ0 Δm0	0. ΔEs = M[0. h+, Δti] = M[Δm0, Δm2]
Symmetric time interval		Δt infinite		
	'addition unit'||Δt_set			
t0 = 0. t0	'addition zero'||Δt_set	0. t0 ~ 0. Δt0 = ΔU0	0. ΔQ0 = ΔQ0 Δm0	0. ΔEs = M[0. h, Δti]

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< t >||Δt = t0 = 0.t0 ~ Δt0 = 0. Δt0	'multiplication unit'||Δt_set	1. t0 = 0. t0 ~ Δt0 = 0. Δt0 = ΔU = ΔU0	A[ΔQ(n), ΔQ2(n)iv] = ΔQ0 Δm1 = Δm0	ΔEs = M[*h*, Δti]
0. t0 = t0	'multiplication zero'||Δt_set	0. t0 ~ 0. Δt0 = ΔU0	0. ΔQ0 = ΔQ0 Δm0	0. ΔE = M[0. *h*, Δti]

Comment A. Zero and Non-Zero Mass Wave-Particles

Assume a non-zero mass m1 for wave-particles complementary to wave emission, and introduce time interval only description mass Δm1 and Δm2, dependent on mΔA and M[Δm1, Δm2]. Emission surface energy ΔEs is linear with M[Δm1, Δm2] and inverse linear with c(Δt) = M[Δq, Δti], the definition of the wave group-velocity, and equal to energy ΔEg, inverse linear with Δqi, eq. A1 and A2.

A1 ΔEs = A[cΔ(t)i, M[Δm1, Δm2]]

A2 ΔEg = M[Δqi, M[Δm1, Δm2]]

Addition A and multiplication M in these equations are equivalent within the time interval description, and both equations can apply A or M, (Hollestelle, 2024part1).

Recall c(Δt) is a time interval quantity, without writing the indication Δ, and similarly h. ν. In par. 1.2 and 1.5 discussed is current parameters being object rulers for which correspondence is defined by averaging. Time interval masses Δm1 and Δm2 correspond with m1 and m2 by averaging. Eqs. A1 and A2 define the possibly zero or non-zero quantity Δm2 to be interpreted with time interval quantity gravitational mass, and this allows the c(Δt) dependent emission energy ΔEs interpretation with A1, and the Δqi dependent gravitation energy ΔEg interpretation with A2, (Hollestelle, 2022).

In this case the space-time metric is assumed diagonal and symmetric in the space-like coordinates, to allow the above expression for c(Δt). One can re-write the definition for c(Δt) towards: Δqi equals c(Δt)i, due to Δti = Δt, the 'multiplication unit'||Δt_set, and one finds, par. 3.3, eq. A1 and A2.

Mass Δm2 is not assumed to be the time interval gravitation mass of the emission source. Δm1 or Δm2 remaining invariant does not mean derivatives D*||t[Δm2] or D*||Δt[Δm2] are necessarily equal to 'multiplication zero'||Δt, from theorem 4b, par. 3.8.

In the following applied is, I*||Δt1[Δt2] = M[Δt2, Δt1], I*||Δt1 time interval integration, equivalence with D*||Δt1[M[Δt2, Δt1]] = A[Δt2, Δt1], D*||Δt2 time interval derivative, and similar time interval relations include M[Δt2, Δt1] = A[Δt2, Δt1] and Δti = Δt, Δqi = Δq, from (Hollestelle, 2020, 2024part1). The time interval only description concept for addition, par. 2, allows to write I*||Δt1 or D*||Δt1 rather then I*||Δt_set or D*||Δt_set, when working on a time interval quantity.

For e.m. emission and zero mass wave-particle, i. e. photons with 'zero' time interval mass Δmp, there is Δm1 = Δmp = 'addition zero'||Δm_set = 'multiplication unit'||Δm_set, and it follows space-like acquired energy ΔEg = M[Δqi, Δm2], and time interval mass Δm2 = M[Δq, ΔEg] can be interpreted to be source related *apparent emission source space-like density*, writing otherwise, ΔEg = I*||Δq[Δm2], from theorem 6. When assuming a 'zero' or a 'non-zero' Δm1, one finds the complete expression ΔEg = I*||Δq[M[Δm1, Δm2]].

With zero or non-zero mass Δm1 wave-particle, from c(Δt) = M[M[Δm1, Δm2], ΔEsi], there is group-velocity c(Δt) = M[M[Δm1, Δm2], Δq] and M[Δm1, Δm2] = Δt, considering equivalence of energies implies M[ΔEg, ΔEsi] = 'multiplication unit'||ΔE_set, and there is M[Δm1, Δm2] = M[c(Δt), ΔEs] which can be interpreted to be emission related *apparent emission surface time-like density*, writing otherwise ΔEs = I*||Δt[M[Δm1, Δm2]].

The overall time interval cosmological space time '4-space' measure equals the |'multiplication unit'||Δt_set|, implying mNC = mA^2 and mΔNC = mΔA, and one finds the overall cosmological Noether charge equals ΔNC = M[Δm1, Δm2], where emission and emission surface are related by simultaneity. The time interval mass quantities, or densities, are inferred to occur as a reciprocal set

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of time interval mass commutation quantities, where addition equals an upper limit equivalent to the 'addition unit'||Δt_set or Noether charge ΔNC, the reciprocal quantities property for time interval only set commutations, from Part1.

Curie's principle of asymmetry. Reciprocal 'addition' can define invariants, and this approach can be applied to Curie's principle of asymmetry and Arnold's definition for equilibrium, *comment 1*, par. 1.

Theorem on Averages

Comment A1. Densities mostly are interpreted to be QM probability densities, e. g. related to the wave function. Such a density is not measurable rather connected with some observable phenomenon which can be measured, (Van Kampen, 1988). In the present paper, density refers to emission density, explaining the inter-dependence of both 'volume' mass and 'slow' mass, which at least derives from Newton, (Newton, 1686). This supports to independently derive and claim validity of the theorem on averages, discussed in par. 1.6.

Variations H+ and H- and Planck's Constant H

Within the time interval description, with time dependent Hamiltonian ΔH = A[ΔH0, ΔdH], where ΔH0 ~ H0, the invariant total energy one can choose equal to 'addition zero'||ΔE_set = 'addition zero'||Δt, theorem 4b. The time dependent Hamiltonian part ΔdH = ΔEs depends on #n. Assuming wave particle complementarity and relevant event time interval Δt, for simultaneous waves emitted and 'on the way' during Δt, energy ΔEs for the #n multiple wave function is:

A3 $\Delta Es = \#n.\ h.\ \nu = M\ [h+, \Delta ti]$

This time interval expression for simultaneous wave emission, originates from (Hollestelle, 2021). Wave function collapse and interaction due to one wave particle implies a change of energy ΔEw = *h*. ν. Recall in Part1, time interval energy ΔEw was indicated with Ew, leaving out the Δ.

The 'Planck-like' functions *h*+ and *h*- are defined with: *h*+/- = 1/2 (Δ*p. Δ*q +/- Δ*q. Δ*p), and both are variable within the one moment time description, with indication Δ* for variances, different from indication Δ for time interval quantities (Hollestelle, 2020). One moment time parameters tb and ta, included in Δt, occur in eq. A3 due to *h*+. Problematic occurence of one moment time parameters within time interval description relations were termed 'infinite regress' problems, which were encountered in (Hollestelle, 2020) and resolved in Part1. Wave emission surface energy ΔEs = #n. ΔEw, without interaction or wave function collapse during Δt, is an invariant during time interval Δt-equilibrium time development. Energy ΔEs, equal to ΔNC = *c*(Δt), also is equal to M[Δm1, Δm2] and one finds, following the arguments for the introduction of Δm1 and Δm2, energy ΔEs to be equal to a time interval set unit, 'multiplication unit'||Δt_set, i. e. one can describe the star source simultaneous emission collective starting with time interval only set units.

Comment A2. From eqs. A1 to A3 it follows *h*+ = M[Δm1, Δm2] within the time interval description, however a traditional dimension analysis does not apply, theorem 1, par. 3.8.

The multiplication dimension problem can be discussed from the definition for the 'multiplication unit'||t_set = < t >||Δt = t0 ~ 'multiplication unit'||Δt = Δt0, where t. t0 = t, t0. t = t and M[Δt0, Δt1] = Δt1, M[Δt1, Δt0] = Δt1 are valid.

Comment A3. Multiplication with t or with 'multiplication unit'||t_set = t0, does not give a dimension failure since all one moment time description coordinates, including t and t0 and multiplication t. t0, are defined with time elements [n] and [i] in (Hollestelle, 2020), due to which results occur in terms of a one moment time description parameter, an addition of their time element values, since these are counting values, which does give a resolution to the multiplication dimension problem (MDP), in (Hollestelle, 2020). From time element definitions one finds the correct multiplication and addition dimension results also for the time interval only set.

Comment A4. Including #n the number of photons, non-interacting emission surface energy ΔEs = #n. h. ν is linear in #n, however the overall emission wave-particle collective, for photons, with Δm1(#n = 1) = Δm1 = 'addition zero'||Δm_set, where Δm1(i) = A[Δm1(i − 1), Δm1(i = 1)] = Δm1(i = 1),

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for i =1 to i = #n, iteratively, with Δm1(i) remaining invariant and equal to Δm1(i = 1) = Δm1 = 'addition zero'||Δm_set, the time interval 'zero' photon mass Δmp. This is the addition equivalent of the similar multiplication result, with Δm1 = 'multiplication unit'||Δm_set. This does not correspond, from units, with the one moment time multiplication result, meaning Δm1(i = #n) = Δm1(i = 1) ~ #n. m1 ≠ m1.

Correspondence

One moment time mass m corresponds with time interval only mass Δm = < m(t) >||Δt. Δt = I*||Δt[m(t)]. M[Δti, Δt], following the definition by averaging of par. 1.5.

From *comment 4* it follows, for photons, time interval energy ΔEs = ΔEw due to ΔEs = Σ(i = 1 to #n)ΔEw = ΔEw, due to eq. 1. Within the time interval set and writing all time interval quantities with multiplication of two time interval quantities, emission surface energy measure mΔEs = |#n. *h*. ν| = mM[h+, Δti] = |*h*+|, and |*h*+| = mM[Δqi, Δm2] = mΔm2.

Comment A5. For events where time interval Δt approximates symmetry and ΔH time independence, quantity *h*+ approximates *h*, a result from (Hollestelle, 2020). This implies for a star-source collective, discussed in par. 4.3, at a infinitely 'remote' distance mA[ΔQ(n), Δqmiv], from average star source place ΔQ(n) to measurement place mΔqm, approximating infinity, wave emission energy measure mΔEs = |#n. *h*. *ν*| approaches measure mΔm2 and similarly |*h*+| ≈ |*h* | approaches mΔm2.

Comment A6. One can derive one moment time Noether charge NC = mA^2, while it is implied emission surface measure mA is proportional with m'. m, where m = m1 the wave-particle mass and m' = m2 the apparent emission source density, within the one moment time description, (Hollestelle, 2021). Within the time interval description it follows ΔNC = M[Δm1, Δm2], due to eq. 1, consistent with relations ΔEg = ΔNC and *h*+ = M[h+, Δti] = D*||Δt[*h*+].

Frequency Change

Comment A6b. One can give an independent estimate, from a measurement event including apparent emission source density Δm2, for Planck's constant *h*. Such events, related to internal interaction, with variable zero and non-zero mass wave-particle, can include an observable effect due to an occuring frequency change.

Assume measurement events with the following. In (Hollestelle, 2022) describing internal interaction, invariant energy ΔEs = #n. *h*. ν depends on both variable mass m1, frequency ν, and wave particle number #n. The variables depend on the (Q(n) − qm) property 'remote' due to the relevant measurement place qm, and Q(n) and Q2(n), par. 3.1, measurement place qm being at the emission surface A. The complementarity relation p = *h*. k remains valid for the time interval only description, and one derives |M[Δp, Δq]| = |*h*+|. It follows relation |M[Δk, Δq]| ≈ |*h*+|/|*h*| while *h*+ approaches Planck's constant *h* when Δt approaches symmetry and infinite measure, where the limit implies |*h*+|/|*h*| = 1 = 'multiplication unit'||scalar_set.

Time interval Noether charge measure mΔNC = mΔEs = mΔm2 = |*h*+|, when Δm1 = Δmp, the 'zero' photon mass, a result derived in (Hollestelle, 2021): 'the infinitesimal derivative difference transformations are equal to the infinitesimal ordinary Lorentz transformations *TL*. These transformations lead to differences equal to the second derivative of space-time coordinates. The Noether charge is directly related to specific Lorentz transformations TS, discussed in Part1, and this implies Noether charge measure mΔNC = |*h*+| is equal to the measure of the time interval only set structure constant mΔs, not regarding the multiplication scalars.

Addition and multiplication are approached similarly for the time interval only description, e. g. for energy ΔEs = #n. *h*. ν and ΔEw = *h*. ν, while mΔEs = mΔEw, assuming rightly #n to be an integer, since it is due to counting during measurement events.

The scalar multiplication relation for ΔNC and Δs, par. 1.1, can be resolved within the time interval only description in a similar way. Starting from the time interval only set being 1-dim. and writing Δs with a Taylor series in Δt, cn(Δt) = Σn an. [Δt]^(n) = (Σn an). Δt, with n = 1 to ∞, [Δt]^(n) =

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M[[Δt]^(n-1), Δt] = Δt for n > 1, the result is cn(a2. Δt) = cn(Σn a2. an. [Δt]^(n)) = cn(Δs). From Δs2 = a2. Δs, for any a2 integer, Δs2 and Δs fulfill the requirements for *the same* ΔNC and energy ΔEs, and measure mΔNC = mcn(a2. Δs) = mcn(Δs) for any integer a2. When it is argued Δs is linear in Δt, and with any Δt there is only one Δs, this implies a2 is integer.

The cn(Δt) and cn(Δt') = cn'(Δt) are the time interval description commutation quantities defined in Part1 to correspond with cn and cn' where t. cn' = cn. t. Recall from Part1 during time development Δt to Δt' overall energy ΔEs remains invariant, this is termed a specific Lorentz transformation TS of Δt to Δt' = TS*[Δt].

Time interval description measures, for ΔEs and for cn(Δs), can be rescaled when assuming this implies rescaling the tensor mij related to space-time expression (mΔEs)^2 = Σij (mij). (ci. cj) with i, j = 1, 4 space-time indices where ci = m(ΔEsi), and outer product measure |(ci. cj)| equals |*h*. ν| for #n = 1. This would mean a2 can be any scalar, since ΔEs is not a time interval and is without time interval requirement eq. 2. Rescaling does not mean energy invariance fails.

These quantities and measures can occur due to the result for the derivative difference transformations and the specific TS being quadratic in variation of Δt. In (Hollestelle, 2020) it is derived only certain scale factors for time intervals Δt are valid, that leave energy invariant. The valid scale factors can be organised or chosen to approximate a scale transformation towards "local", i. e. "timely", time intervals, meaning time intervals for which measures can by addition be derived. The latter resembles GR. The term timely is introduced since implied is a time-like, not space-like, place in space time.

Recall energy ΔEs is nonlocal where ΔEw is local after measurement, due to wave function collapse, which reduces, the integer number #n. The scalar multiplication differences only can be resolved considering the physical situation or measurement event. Without measurement event there is no measurement resultant for ΔEw, or for frequency ν. Noether charge and structure constant relate to overall energy and, otherwise, specific energy due to interaction. One can devise an experiment to decide on frequency ν, which can recover mΔEw = |*h*. ν| and #n from mΔEs. The specifics for internal interaction define properties of space-like and time-like interval measure mΔq and mΔt, depending on the asymmetry of Δt. Similarly absence of spherical symmetry in space-like space time is expected to be measurable considering Curie's principle. It is infered it is possible from measurements of emission frequencies in a spherical symmetric set-up, and from emission internal interaction, this can be verified to be valid, a result within the time interval only description only.

Internal Interaction

The mass property is not by definition related to 4-dim. space time coordinates in any description. Mass value, measure | m1|, can change with one moment time, however this is not likely for a property of a wave-particle, when it is a wave-particle in free motion, in this case |m1| is assumed invariant, and mass m1 remains independent of one moment time 4-dim. space time coordinates. Internal interaction for out-going emission implies a change of non-zero mass Δm1(Δt), such that when Δt approximates infinite Δt', Δm1 approximates Δm1(Δt') = Δmp and with frequency ν(Δt) approximately ν'(Δt').

Symmetry can occur from interdependence of N, w and r, in such a way that ΔEs = #n. *h*. ν remains invariant, when #n and *h*. ν change together. This is termed internal interaction, assuming a continuum frequency domain.

The example of internal interaction for apparent emission surface density Δm1 = *c*(Δt) or for apparent emission source density Δm2 = ΔEs, was introduced in (Hollestelle, 2021). The time interval quantities Δm1 and Δm2 depend on the 'multiplication unit'||Δt_set = Δt0 asymmetry where < t >||Δt = t0 ~ Δt0 = ΔU = Δt and t0 ≠ 0. t0 while ΔU ≠ ΔU0 for Δt finite, such that time development can imply a change of asymmetry and of average value < t >||Δt = t0 ≠ 0. t0 and for correspondence t0 ~ Δt0, resp. 'multiplication unit'||t_set ~ 'multiplication unit'||Δt_set.

Comment B. Example Approximation for the Emission Surface

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Paragraph B1. Emission Surface with an Invariant Number of Surface Parts, Construction I

Emission surface A(Δt) related to relevant event, measurement event, time interval Δt can be idealized with a regular sphere Q(Δt), however Q(Δt) does not fulfill the surface measure requirement (SR), paragraph 1.2. A(Δt) and Q(Δt) can be approximated with an indecomposable continuum surface Pu(Δt), the closed union of a constant number N0 of open, disjoint and dense, surface parts Pi = Pi(Δt), i = 1 to N0 > 1. In the following the one moment time decription is applied, in *comment B1* and after, more often the time interval description.

Each of the surfaces Pi is the limit for surface part Pi(tl^) where a current parameter t^ approaches continuously and increasingly, starting from t^ = t0^, to infinite limit tl^, while independent of one moment time parameter t and of t-equilibrium time development. The complete domain for t^ with Pi is dt = [t0^, tl^]. The surface parts Pi include a width parameter w, with domain [w = 0, w = w(t^)], where the metric surface measure mPi = mPi(N0, w, tl^) = mPi(N0, w0, tl^). w/w0, is linear with w. Together parameters w and tl^ are the domain limits for the 2-dim. space-like surfaces Pi. Due to a theorem by Kuratowski, it follows Pu, continuum surface and closed union of all open surface parts Pi, including boundaries, is a covering for Q and A, which at least implies covering 'least requirement' SR: mPu ≥ mA. There is a construction for the surface parts Pi, in (Hocking, Young, 1961), termed construction I in this paper, while the 2-dim. continuum approximates A. Assumed is Δt-equilibrium time development with time interval Δt for emission surface A(Δt) and all Pi(Δt), however variable Δt is left out for simplicity mostly. Time interval only description time development is defined with variable Δt, and due to time interval Δt-equilibrium (Hollestelle, 2024), including for time interval Δt-quantities that are not time intervals themselves.

Paragraph B2. Variable Number of Surface Parts, Construction II

Proposed is a new construction II, with instead of constant N0 a variable N of surface parts Pi, i = 1, N, with Pu, closed union of the Pi, being an indecomposable continuum surface, similar to construction I. There is current parameter w, an indication for surface width of surface part Pi or, similarly, measure mPi in one direction, dimension d1, due to which mPi = mPi(N, w0, tl^^). w/w0, and current parameter t^^, dimension d2, approaches infinite limit tl^^ of surface Pi, the domain being [t0^^, tl^^]. Current parameters w and tl^^ are domain limits for resp. dimension d1 and d2, such that domain dPi = dw x dt^^, the x indicating direct product. In this way w and t^^ are object rulers for the individual surfaces Pi.

Current Parameter or One Moment Time Space-like Parameter with Time Development?

The time interval only set is one dimensional (Hollestelle, 2020). This means time reversal is not possible within the time interval only description, which agrees with the dimension d1 and d2 current parameters to be object rulers. Arguments for current parameters related to equilibrium time development, however much this seems problematic, are discussed in *comment B1* and in par. 1.2 and 2.8.

Comment B1. The time interval description current parameters Δw and Δt^^ are defined by averaging, par. 1.5, meaning Δw(Δt^^) = < w(t^^) > | | Δt^^. Δt^^, averaging for Δt^^ instead of Δt, since t^^, instead of t, is the variable for w

Parameter w is finite, while tl^^ is infinite. A possible relation with Δt is provided by time interval description unities Δw1 = 'multiplication unit' | | w and Δt1^^ = 'multiplication unit' | | t^^. The time interval quantities Δw1 and Δt1 correspond with w(tl^^) and tl^^ resp.

Comment B2. Time interval current parameters Δw or Δt^^, when independent of one moment time t, and when dependent on Δt^^, even when Δt^^ dependent on Δt-equilibrium time development, remain to be written with the usual time interval indications Δw and Δt^^.

Within the time interval description, the complete current parameter domain Σi dwi, i=1, n, writing for any i, Δwi = wi. Δt, for a surface of dimension n, with a parameter set for every dimension, that reduces to time interval set Σi wi. Δt. In the case of construction II and Pi, i = 1, 2 current parameter

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domain Σi dwi = dw x dt for w1 = w and w2 = t^^ and their limits w(t^^) and tl^^. Introduced is, in par. B3, the variable limit process with a new current parameter t^^ with domain limit tlim^^, to avoid singularity problems. The one moment time domain indication dw and dt apply the indication dΔw and dΔt within the time interval description.

Theorem B1. With construction II with t^^ defined are surface parts Pi(N, w, tl^^) that fulfill within the time interval description the covering least requirement SR for emission surface A, when the closed union surface Pu(N0, w, t^) from construction I fulfills SR. See also *theorem B3*.

Paragraph B3. Parametrization with Current Parameters, the Ordinary and Variable Limit Process

The ordinary limit process

Construction I and II include current parameter t^ and t^^ resp. to approach infinite domain limit tl^ and tl^^. With ordinary current parameter limit process is meant current parameter t^^, for construction II, increasing continuously towards a specific infinite limit tl^^. This is similar for time interval current parameter Δt^ and Δt^^.

However, the ordinary limit process for t^^ or Δt^^ is not necessarily related to one moment time description time like coordinate t or time interval Δt and their time development, regarded fundamental for any equilibrium, and for any change guided by equilibrium such as e. g. for emission surface A(t) or ΔA(Δt).

A current parameter is similar to a measurement parameter, when measurement implies the concept of counting being the result of successive measurement results achieved within time development, however not necessarily dependent on it. Within GR measurement parameters are defined introducing the concept of simultaneity and measuring rod, (Einstein, 1905), another term, in this paper, is object ruler.

It is not meant to imply the current parameter limit process is a discrete process like counting natural numbers, it is not a space like continuous equilibrium particle 'path', it is only to describe continuous change of parameter t^^ towards limit tl^^, where tl^^ is infinite, within d2 dimension domain dt = [t0^^, tl^^], for parametrizing space like surface parts Pi within construction II.

There is no factual, coordinate wise, change of current parameters t^ or t^^, all values of domain dt occur simultaneous, surface part Pi is similarly one simultaneous object, with closed union Pu an approximation for the real simultaneous emission surface A. This property resembles a type of space like symmetry transformation for Pi, where all space like symmetry expression invariances similarly and simultaneously exist. However, time reversal, being a one moment time description and a time interval description time like transformation, is not a symmetry transformation for Pi or ΔPi.

Variable Limit Process

Consider domain limits tl^^ = tl^ and w(II) = w(I) = w, and assume construction I fulfills mPu >> mA.

B1 (const. I) mA << mPu(N0, w, tl^) << mPi(N0, w0, tl^). N0. w/w0

B2 (const. II) mA. N/N0 << mPu(N0, w0, tl^^ = tl^). N/N0. w/w0 = mPu(N, w, tl^^)

Parameter w, while current parameter t^^ is progressing to a certain infinite tlim^^ < tl^^ and not yet to tl^^, is to approach a sufficiently small limit value w(tlim^^) = 1/N such that surface part measure mPi(N, w, tlim^^) remains invariant when changing linear with N and w and tlim^^, and with t^^ << tlim^^ << tl^^.

Together with decreasing parameter w = w(tl^^) the infinite parameter tlim^^ is to be 'sufficiently' towards infinite parameter tl^^ while t^^ progresses to tlim^^.

In this way the variable limit process for t^^ towards tlim^^ can be adjusted together with variables N and w within mPi(N, w(tlim^^), tlim^^) such that mPu(N, w, tlim^^) >> mA, the covering least requirement SR. One can introduce infinitesimal scalar ε, to describe tlim^^ and similarly w(tlim^^). Write mPu in terms of multiplication, mPu(N, w, tl^^) = mPu(N, w, tlim^^). (1+ε), with scalar ε defined with tl^^ = tlim^^. (1+ε).

B3 mPu(N, w, tlim^^) = mPu(N0, w0, tl^^). N/N0. w/w0. tlim^^/tl^^

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The Number of Degrees of Freedom

One can generalise the 2-dim. surface part construction for Pi(N, w, tlim^^) with w1 and w2, to arbitrary dimension nd for Pi and Pu. Dimension d1, and domain parameter w1 = w, allows the introduction of a current parameter w^^, similar to dimension d2 current parameter w2 = t^^. A realistic cosmology in physics includes nd+nt dim. space time within one moment time description, where time interval only set properties suggest nd = 3 and nt = 1 for space and time dimensions resp, (Hollestelle, 2020, 2021). The overall relation for the degrees of freedom for (nd − 1) dim. surface Pu is ((nd − 1) + nt) which equals 3 for the 2-dim. space-like surface A in space time. One degree of freedom nt is due to the 1-dim. time interval set, i. e. from ΔN and Δw(ΔN) together. This is consistent with the construction II example surface in par. B10/B12, except for parameter ε. When including ε the number of degrees of freedom is 4.

Paragraph B4. Parametrisation for Surface Pu in Construction II

For surfaces Pi, within construction II including variable parameter N, parameter w is the limit parameter for d1 space-like interval [0, w], with w = w(t^^), meaning w depends on t^^ from domain dt = [0, tlim^^]. For N = N0 invariant, one recovers construction I. Continued is with construction II.

Theorem B2. Within the time interval description, for any two surface parts ΔPi, ΔPk, for addition A[ΔPi, ΔPk] any overlap cancels since the Pi are open surface parts.

Necessarily required is mPu(N, w, tlim^^) ≥ mA, for any realistic example of emission surface approximation Pu. The application of the variable limit process to include tlim^^ is defined with linear multiplication from eq. B1 and B3 by introducing domain averages for w(t^^).

B5 mPi(N, w, tlim^^) = mPi(N, w, tl^^). < w(t^^) >||tlim^^. 1/< w(t^^) >||tl^^ = mPi(N, w, tl^^). tlim^^/tl^^

One always can find a carefully chosen r = tlim^^/tl^^ such that:

mPi(N, w, tlim^^). N0. w0/w. tl^^/tlim^^ > mPu(N0, w0, tl^^) ≥ mA, for this choice with tlim^^ < tl^^. The last unequality applies the transition to construction II from construction I, for which mPu(N0, w0, tl^) ≥ mA by initial requirement, par. B2. Applied is t^^ = t^ and trial least requirement N0/N. w0/w = 1 due to current parameter w(t^^) to be variable with variable N.

Some choices tlim^^/tl^^ < 1 can provide mPi(N, w, tlim^^) < mA, however this is not a necessary requirement. With choices r = tlim^^/tl^^ > 1 or r = tlim^^/tl^^ < 1, considered are all possible constructions II.

Paragraph B5. Dimensional Domain Definition for Current Parameters

The domain dt with r = tlim^^/tl^^ > 1 can be reducible, due to t^^ being an object ruler and assumed non periodic. Reducible domains, domains that can be reduced to a subset, are discussed in par. B8.

Assume tl^^ < t^^ < tlim^^, where both tl^^ and tlim^^ are infinite. This requires a non trivial definition for current parameter t^^. A solution is t^^ is a parameter from a domain that is an ordinary product space of several, at least 2, independently variable parameters spaces, and depends by variation on all of the product space parameters. Within a 2-dim. product space one can define t^^ equivalent to e. g. a 2-dim. surface measure, similar to a 2-dim. metric.

More specific, current parameter t^^ = tv. tw can fulfill resp. t^^ >> tl^^ = 'multiplication unit'||t^^ when tv = tl^^, tw > tl^^ and t^^ = tl^^. tw, where for t^^ << tl^^ fulfilled is t^^ << 'multiplication unit'||t^^, with t^^ = tl^^. tw with tw < tl^^.

Definition 5. The dimensional domain definition for domain dt^^ = dt(n' = n-1) x dt(n'' = 1), for an n-dim. domain and current parameter t^^ = tv. tw, the usual scalar multiplication . , where tv from dt(n' = n-1) and tw from dt(n'' = 1), the product space of sets with cardinal number different from the set of real numbers, to allow tlim^^ > tl^^ or tlim^^ < tl^^, due to both tlim^^ and tl^^ being infinite. The definition with n = 2 is introduced in par. B12(A3).

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Paragraph B6. Covering Least Requirement for Current Parameters

Introduced are surfaces Pi(N, w, tlim^^) with r > 1 and where 2-dim. space-like measure mPi(N, w, tl^^). N0. w0/w > mA, however with the 'equal' sign when the Pi are disjoint, all other variables remaining the same. The 1 or 2 indicates construction I or II in most of the following.

For construction II, the covering least requirement RS for union surface P2u(N, w, tlim^^) to be a covering for A, is:

B6 a = (1/mA) . mP2u(N, w, tlim^^) with scalar a > 1

From linear relation mP2u(N2). 1/N2 = mP1i(N0). N2. 1/N0 and dw(for tl^^) << dw(for tlim^^) for tl^^ >> tlim^^, one finds, applying trial least requirement RT for P2u, i. e. w(tlim^^)/w0. N/N0 = 1:

B7 mP2u(N, w, tlim^^) = mP2i(N0, w0, tl^^). N. tlim^^/tl^^. w(tlim^^)/w0. N/N0
= mP1i(N0, w0, tl^). N. tlim^^/tl^ = mP1u(N0, w0, tl^). N/N0. tlim^^/tl^ > mA. N/N0. tlim^^/tl^

With eq. B7 interchanged is construction II and construction I, with tl^^ = tl^ and mP2i(N0, w0, tl^^) = mP1i(N0, w0, tl^). Assuming the validity of construction I there is mP1u(N0, w0, tl^) ≥ mA, i. e. with construction I surface P1u fulfills requirement SR, which can be written:

B8 d = (1/mA). mP1u(N0, w0, tl^) = (1/mA). mP1u(N, w, tlim^^). N0/N. w0/w. tl^^/tlim^^ with scalar d > 1

The two covering least requirement expressions together imply:

B9 a/d = tlim^^/tl^^. w/w0. N/N0

There is all P1i are disjoint, and all P2i are disjoint, due to which all measure equation signs are equal signs. Besides this there is N/N0 > 1, with w/w0 < 1, and, the variable limit process in this case assumes r = tlim^^/tl^^ >> 1, in other cases r = tlim^^/tl^^ << 1. Eq. B6 is a covering least requirement for P2u(N, w, tlim^^) to be a covering for A and improvement to trial requirement RT where a/d = 1 starting from r = tlim^^/tl^^ = 1.

Paragraph B7. Periodical Current Parameters

Assuming a periodical limit process implies the following issue: emission surface coordinate multiple occurences in space-time with *multiple and different relevant event time interval Δt*, and multiple measurement events, for the same emission surface. Recall relevant event time interval Δt simultaneous distributions can not occur, par. 5. Multiple occurences, measured separately at different places at different P2i would mean multiple wave function collapse occuring more than once and non-simultaneous with several different Δt, where wave function collapse is interpreted to be an interaction phenomenon, at the overall emission surface. In *par. B8*, discussed is 'wave-group collapse', with similar properties.

A periodic limit domain for current parameter t^^ with M-fold multiple occurences in space-time however with *the same overall relevant time interval Δt* seems possible, when M-fold multiple occurences are at the same one moment time 2-dim. space-like domain, with current parameter w domain dw = [0, w = w(t^^)] and t^^ domain dt = [t0^^, tl^^]. The current parameter domain for w and t^^ are assumed similar for all surface parts P2i. These are different domains than for the variable limit process where dt = [t0^^, tlim^^], par. B3, although both imply tlim^^ > tl^^, however with the periodic limit process the 2-dim. space like domain remains the space like 1-period domain [t0^^, tl^^].

When the number N of surface parts N ≤ M, it can be argued N-fold periodicity for current parameter t^^ can be related to N-fold multiple wave function collapse occurence for the series P2i, within the one moment time description.

Within the time interval description the N-fold series ΔP2i is simultaneous with wave emission during relevant event time interval Δt. The N = M periodicity implies surface parts ΔP2i are simultaneous with Δt, which can always be arranged with a certain r > 1, while current parameter Δt^^ and time development related to Δt are assumed independent.

Comment B3. Parameter t^^ is a current parameter, it is assumed not to be related to t-equilibrium time development. However, this is an assumption, it is possible to relate t^^ with one moment time parameter t or time interval Δt, this is discussed in par. 1.2 and par. 2.6. This would imply the wave

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emission surface A(Δt) is divided into parts fragmented in time, non simultaneous among each other, however remaining simultaneous with Δt.

Paragraph B8. Reducible Current Parameter Domain for R > 1

Assuming tlim^^ >> tl^^, the current parameter domain is reducible to Δt, in the time interval description. Defined within infinite domain dt = [t0^^, tlim^^], is invariant domain D1 = 'addition unit'||D = [t0^^, tl^^] with current parameter units 'addition zero'||t^^ = t0^^ and 'addition unit'||t^^ = tl^^. There is tl^^ = multiplication unit'||t^^. Domains can similarly be defined for construction I current parameter t^.

Introducing New Domain Indications for Simplicity

Current parameter t^^ domain dt is an independent and infinite scalar domain, dt = [t0^^, tlim^^] with tlim^^ = r. tl^^ >> tl^^, and successive current parameter units and domain parts Di can be defined: successive current parameters with u(i+1) = u(i) + u(1), for u(0) = t0^^ till u(r) = r. tl^^ = tlim^^, starting from u(1) = tl^^ = 'addition unit'||t^^, with a series of natural number values i = 0 to i = r, from u(i = 0) = 'addition zero'||t^^ = t0^^ = u(0) till u(i = r) = tlim^^, and successive domain parts D(i+1)=[u(i), u(i+1)] starting from domain D1 = D(i = 1) = [u(0), u(1)] = [t0^^, tl^^].

The domains D(i) do not necessarily belong to the time interval only set, and natural numbers i indicate the current parameter series u(i), not the surface parts P2i, or star sources i, the i does not imply mutiplication inverse.

Comment B4. Only generalized coordinates are included in traditional equilibrium equations, not current parameters or object rulers. However one could interpret one moment time parameter t to be a current parameter, while assuming the time development concept introduced in (Hollestelle, 2024part1): within the one moment time description invariant time development implies any invariant 'time-lapse' change introduces an invariant 'time-lapse' change for a one moment time parameter, while for the time interval only set it implies addition A[Δt1, Δt1] = Δt1 for any time interval Δt1.

Within the time interval only description one can define correspondence for domain dt = [t0, tlim] with time interval quantity ΔD1 ~ D1 = [t0^^, tl^^] and r >> 1, starting from time interval relation eq. 2, or equivalently from time elements [n] and [i] and their properties (Hollestelle, 2020). Due to time interval addition property eq. 1 it follows from correspondence ΔD1 ~ D1, ΔDi can be reduced to a irreducible least set, in this case implying a 1-dim. set remains, linear in ΔD1, meaning ΔD(i+1)=A[ΔDi, ΔDa] = ΔDi with invariant domain 'unit' ΔDa = 'addition unit'||Δt^^ = ΔD1. The set ΔDi can be infinite, since natural number value i has upper limit r = tlim^^/tl^^, which is undecided. This is valid in the time interval and in the one moment time description.

Comment B5. Representation, and representation reduction, seems artificial since wave emission is not reversable, i. e. time development is not reversable, and star source wave emission is assumed to only once encounter a specific one moment time space like coordinate, (Hollestelle, 2021). These arguments seem valid in both the one moment time description and the time interval only description similarly. However, time development and wave emission as argument are not decisive to conclude tlim^^ >> tl^^ is not realistic, due to the discussion following comment B7.

Comment B6. Due to the time interval distribution definition, *comment 23*, time interval Δt distributions do not exist, a result from (Hollestelle, 2024). Δt is relevant event time interval and a Δt distribution would mean Δt is reducible to a time interval Δt' with mΔt' < mΔt, in this case Δt can not be completely simultaneous with Δt'. A Δt distribution is not consistent with the definition of a relevant measurement event related to Δt, due to which Δt is required to be 'simply measurable' or 'simultaneously measurable' rather than equal to a distribution series.

Comment B7. Wave function collapse is discussed within the time interval description as a measurement event phenomenom, where before the measurement event, simultaneous wave emission including emission surface A(Δt) is regarded to be a unity and nonlocalizable, being part of

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a description of wave emission from star-sources with emission symmetric in all space like directions, evenwhile with time development and finite Δt essential for emission.

Within the traditional one moment time description the measurement event implies wave function collapse from the overall emission surface to one specific measurement place, termed qm, i. e. in this paper the 'collapse' of wave emission surface A to a certain measurement place, place qm on A, defined in par. 3.1, and (Hollestelle, 2018), e. g. the one moment time description of the photo-electric effect event and wave emission. In the case of simultaneous emission from multiple star sources, par. 3, one can consider 'wave-group collapse' to imply multiple wave function collapse and measurement events simultaneous at multiple places qm(i) at surface A(Δt).

Within the time interval description one can relate the reduction, of current parameter domain parts ΔDi to ΔD1, to 'wave-group collapse', which can require connecting the ΔP2i and the qm(i).

The (i) relates to surface parts ΔP2i and current parameter t^^(i), and connects with time interval domain ΔDi, the i indicating domain parts for t^^, and with measurement places Δqm(i) on the ΔP2i. Current parameter t^^(i) can be different for each ΔP2(i) with qm(i) however the reduction for any domain ΔDi = ΔD1 should match the surface parts for ΔP2u. Overall 'wave-group collapse' of ΔA(Δt) implies localization towards wave emission surface measurement places Δqm(i) simultaneously during Δt.

Paragraph B9. the Current Parameter and the Overall Covering Least Requirement RS

Scalar factor (1+ε) remains infinitesimal different from 1, to resolve the singularity at tl^^, which is discussed in paragraph B12.

When r < 1 implied is the original limit process, with r = 1/(1 + ε) < 1. The singularity is the argument for choosing domain dt = [0, tlim^^] with surface parts P2i(N, w, tlim^^) rather than domain dt = [0, tl^^] = D1 with surface parts P1i(N, w, tl^^) in eqs. B6 to B9.

B10 r = tlim^^/tl^^

a/d = N/N0. w/w0. r

Independent Parameters

When r > 1, the reducible variable limit process from par. B5, with tl^^ = 'addition unit||t^^ = u(1), with t^^ within both the one moment time description and time interval description. One gains the free parameter r related to ε, since r = tlim^/tl^ > 1 equals any natural number, increasing the number of degrees of freedom to 3 + 1: parameters a, d, N and w remain independent except for relation eq. B10, while any infinitesimal ε or any r > 1 different from r = 1 does not alter construction II. One can choose other combinations to describe the parameter inter-dependence.

The overall covering least requirement RS for any r ≠ 1 is eq. B10, where r = 1 together with a/d = 1 equals the unrealistic RT trial covering least requirement. The trial requirement RT is a simplified estimate for the interdependence of N and w.

Domain Dt and Parameter R

With construction II, for r different from 1, within eq. B10 there is N = N(N0, w, tlim^^), and w = w(N, w, tlim^^). While N0 and w0 relate to construction I, with indications 1 and 2 for constructions I and II resp, the overall covering requirement is: a/d = < w(t^^) >||P2i(dt). 1/< w(t^) >||P1i(D1). N/N0. r

Averages are applied to derive the multiplication factor for measure mP2i(dt) due to parameter w(t^^), a function of t^^ along the d2 dimension for P2i, assumed to be the same for any i. There is for construction I and II, w(t^) = < w(t^) >||P1i(dt) and w(t^^) = < w(t^^) >||P2i(D1) with resp. D1 = [t0^, tl^] and dt = [t0^^, tlim^^], from eqs. B7 and B8.

Applied is tl^^ = tl^ and tlim^^ = tlim^ and it follows w(t^) = w0. The degree of freedom due to scalar r seems artificial, however following *comment B7* discussed are arguments to consider r an ordinary degree of freedom related to the star group simultaneous emission concept of par. 3.

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The reducible current parameter domain part D1 upper bound is tl^^, for tlim^^ >> tl^^, due to which domain dt can be re-found from D1 by domain addition and dt is reducible to ΔD1 = Δt due to theorem 4b.

Paragraph B10. A Construction II Emission Surface Approximation Example

The construction II example, being an approximation for A(Δt), is proposed to argue the wave emission surface is a realistic and physically possible concept. One can find examples with 4 independent parameters with construction II. Only construction II, not construction I, allows for variation of parameters N, w and tlim^^ and r, while the P2i remain open, dense and disjoint, for P2u to fulfill the covering least requirement RS.

Introduced are integration domain D1 and dt for current parameters t^ and t^^ from construction I and II resp. with upper bounds tl^^ and tlim^, which in eq. B11, result from eq. B10, cancel to N0/N.

B11 $< w(t^{\wedge\wedge}) >||P2i[dt].\ 1/< w(t^{\wedge}) >||P1i[D1] = \int||dt\ dt^{\wedge\wedge}\ [w(t^{\wedge\wedge})].\ 1/N.\ 1/\int||D1\ dt^{\wedge}\ [w(t^{\wedge})].\ N0 = a/d.\ 1/r.\ 1/N.\ N0$

When averages are equal to the averaged parameter, meaning $< w(t^{\wedge\wedge}) >||P2i[dt] = w$, this implies $w(t^{\wedge\wedge}) = w$, invariant within domain dt = [t0^^, tlim^^], however dependent on tlim^^, construction II, and similarly w(t^) = w0 invariant within dt = D1 = [t0^, tl^], however dependent on tl^, construction I.

This allows the introduction of time interval quantities Δw within the time interval description, from correspondence Δw ~ w and averaging, par. 1.5. Define time interval quantity $\Delta w = < w >||\Delta t^{\wedge\wedge}.\ \Delta t^{\wedge\wedge}$ with $m\Delta w \sim m< w(t^{\wedge\wedge}) >||P2i[dt].\ mdP2i[dt]$, which includes the choice for solution $w(t^{\wedge\wedge}) = w$ for all t^^, the d1 dimension surface part P2i parameter, with t^^ domain dt for d2 dimension surface part P2i, where mdP2i = mdt = m[t0^^, tlim^^]. Recall mN. mdw. mdt is an invariant, when the parameters are variables. The i indicates time interval multiplication inverse in eq. B12. The covering least requirement RS for time interval quantity ΔN, due to eq. 1, can be re-written from eq. B9.

B12 $\Delta N(\Delta w) = \Delta N(< w(t^{\wedge\wedge}) >||\Delta t^{\wedge\wedge}.\ \Delta t^{\wedge\wedge}) = a/d.\ 1/r.\ M[\ M[\Delta w0, \Delta wi], \Delta N0]$

$= M[\ M[\Delta N, \Delta N0i], \Delta N0]$

This example does not apply to the reducible current parameter domain with tlim^^ > tl^^, however the choices r > 1 or r < 1 can be approached similarly, this is discussed in par. B8.

Paragraph B11. Example Surfaces from Transformations

Within the time interval description there are time interval quantity ΔN ~ N, with N the number of P2i surface parts, and time interval domain dt for current parameter t^^, which are neither one moment time or time interval quantity. Current parameters are specific parameters that require new definitions. A start for these definitions was included in par. 1.2.

One can define for construction II the 2-dim. surface parts ΔP2i with the same current parameters w and t^^ and domain dw = [0, w], and dt = [u0, r.u1] = [u0, tlim^^], from par. B8 and u1 = 'multiplication unit'||t^^, and applying the 2-dim. domain direct product **x** for domain dP2i = dw x dt, or dP2i = [0, w] x [u0, r.u1].

One moment time domain D1 = [u0, u1] includes units u0 and u1, which should correspond with time interval description current parameters that remain the same as one moment time current parameters. These units however should not be confused with time interval set units, e. g. ΔU ='multiplication unit'||Δt, since current parameters not necessarily are equilibrium time development parameters. Correspondence should be defined with averages, meaning $\Delta w = < w(t^{\wedge\wedge}) >||\Delta t^{\wedge\wedge}.\ \Delta t$ and $\Delta t^{\wedge\wedge} = < t^{\wedge\wedge} >||\Delta t^{\wedge\wedge}.\ \Delta t$. One finds Δw = w. Δt and Δt^^ = mdt. Δt, since w is defined as average $< w(t^{\wedge\wedge}) >||P2i(dt)$ and $< t^{\wedge\wedge} >||P2i(dt)$ equals multiplication unit mdt = mM[Δt^^, Δti].

Construction II with surface parts P2i with tlim^^ = tl^^ and a/d = 1 and r = 1, implying dP2i = [0, w] x [u0, u1], does not resolve the singularity that remains at u1, even when defined within the one

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moment time description. For a valid construction II the singularity can be resolved with dt = [t0^^, tlim^^], with r ≠ 1, following par. B12.

P) Only one surface part Pi, i = 1, is assumed with N = 1, while Pu = Pi. To remain with a infinite tl^^, introduce variable parameter w = w(t^^) decreasing towards zero when tlim^^ increasing towards tl^^, which are both infinite. The requirement, surface parts Pi are open, is relevant even with only one surface part, however the disjoint property is trivially fullfilled, i. e. not well defined, no other surface parts occuring. The covering property is well defined however, even without disjoint property.

PP) Two surface parts Pi, i = 1, 2, are assumed with N = 2. In this case the covering least requirement RS is necessary. P1 and P2 are to remain disjoint, open and dense, and mPu ≥ mA.

This is a simple example with 2 surface parts, surface part domain dPi = dw x dt, with d1 dimension finite domain dw = [0, w(tlim^^)] and d2 dimension infinite domain dt = [t0^^, tlim^^]. Surface part Pi acquires d1 dimension measure mdw = w, and w = w(tlim^^) approaches zero, where measure mdPi = mdw x mdt = w x tlim^^ remains invariant with one moment time measure mdw = w(tlim^^) = < w(t^^) >| | dt. Time interval measure mdΔw = m(< w(t^^) >| | dt. Δt) = m(w(tlim^^). Δt) = w(tlim^^).

Overview

The domain dPi = dw x dt is transformed towards regular sphere Q, which is an approximation, being regular, for the real wave emission surface A. Introduced in par. B12 are transformations TU and I, which in combination transform the domain dw x dt = [0, 1] x [0, r] towards dTU*I*[dw x dt] = [0, 1] x [0, r], with r ≠ 1. One derives any TU*I equals the identity transformation.

Transformation TU*I is regarded to 'work to the right' on separable parameters w and t^^. For parameter t^^, domain dTU*I*[dt] = [u0, r.u1] = [0, r] where r = tlim^^/tl^^ ≠ 1, from eq. B10. For parameter w, domain dTU*I*[dw] is discussed in par. B12(A6). TU*I is followed by transformation TQ to transform dTU*I*[dw x dt] = [0, 1] x [0, r] to the regular sphere, par. B12(A9). When scaling for r combination TU*I transforms the regular square to the regular square. In the following continued is to take care parameters w and t^^ are properly combined since they represent two different, i. e. normal to each other, dimensions d1 and d2 of surface parts Pi.

Paragraph B12. Singularities

One writes any TU*[t^^] to be a function of 1/t^^ to change to finite the infinite t^^ = tlim^^ occuring in dt and the infinite t^^ = tl^^ occuring in D1. In par. B12(A1) it is argued lowest order terms are sufficient to describe TU*[t^^]. Any transformation TU can be reduced to Taylor series TU*[t^^] = 1 + Σn Tn. (1/t^^)^n, n=1 to n infinite, the Tn constants.

Consider the time interval version for transformation TU for time interval domain dΔt^^, i. e. TU*[Δt^^] = Σn Tn. Wn. Δt^^i, n=1 to n infinite, the Taylor series being linear in multiplication inverse Δt^^i due to property eq. 1. The Wn are addition constants due to time interval derivatives. The set generator approach for the time interval set gives the same result, par. B12(A4). Recall the time interval current parameter Δw ~ w can be defined from the averages definition for correspondence or from the set units and zero's, even though Δw does not follow equilibrium time development. TU*[dw] for domain dw is defined in B12(A6).

For surface parts Pi(N, w, tlim^^), for N = 2 in example (PP), the two parameters w and tlim^^, or similarly the domains dw and dt, remain inter-dependent to assure the surface domain measure mdTU*I*[dw x dt] = m(dTU*I*[dw] x dTU* I*[dt]) remains invariant, which means TU*I equals a specific Lorentz transformation TS. This is valid for TU*I equal to the identity, trivially. Assumed is the diagonal metric for one moment time space time to simplify the measures. This choice is legitimate since, with specific Lorentz transformations TS, surface measure remains invariant, at least for the time interval description, due to which measures remain to fulfill the covering least requirement. Followed are the usual terms, with transformation is meant coordinate change without

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property change, e. g. covariant coordinate change due to Lorentz transformations, with operator is meant property change e. g. one moment time description position change.

A1. Transformation TU for domain dt with transit parameter ε for singularity t0

With TU any transformation, TU[t^^] = 1 + Σn. Tn. (1/t^^)^n, n=1 to n infinite, with current parameter t^^ from domain dt, a singularity exists at t^^ = t0^^ = u0. Chosen is transformation TU*[t^^] = (1/t^^) for example construction II, which seems universal due to the arguments in comment B8.

To resolve the singularity, domain dt = [t0^^, tlim^^], is written as an addition, assuming addition trivially can be applied to domain sets, considering *comments B12 to B14*. dt = dMt + dPt = [0, ε'] + [ε', tlim^^], and similar for surface parts Pi indicated with M and P: Pi = PMi(N, w, tlim^^) + PPi(N, w, tlim^^), with dPMi = H[ε']. dPi and dPPi = (1 − H[ε']). dPi, with H[ε'] the usual Heaviside function with infinitesimal transition parameter t^^ = ε'. Transformation TU*[1/t^^] can be written with lowest, linear, terms only, *comment B8*.

Comment B8. There is an argument, where a solution of a functional equation, completely separable in say two variables, f(a + b) = f(a) + f(b), is 'nearly always' of linear form f(x) = m. x, with m constant and a, b, x the variables. The 'nearly always' implies 'always' when the solution is bounded over the two interval domains for a and b, (Hocking, Young, 1961). This is similar to the canonical property for f(x), x the variable, e. g. x = dq/dt, with q the generalized space like coordinate within the one moment time description. The canonical property mostly refers to multiplication rather than addition. It allows for the introduction of set or group generators for the functional f(x).

A linear terms approximation for TU is valid when separable domains dw and dt are assumed (Arnold, 1974). This can be applied when considering generators G, in terms of exponents f(x) = exp(x. G) for the solution set for functionals f(x), par. B12(A4), and in (Hollestelle, 2020). Within the time interval only set there is exactly one generator, time interval Δt, due to the multiplication linearity theorem (Hollestelle, 2024part1).

The second part, due to transition parameter ε', for domain dt = [0, tlim^^], is dtP = [ε', tlim^^], transformed to domain dTU[dtP] = [1/tlim^^, 1 − (1/ε')]. When domain [ε', t^^lim] is open, [1/tlim^^, 1 − (1/ε')] is open similarly. The first part of dt is dtM = [0, ε'], transformed to dTU[dtM] = [1 − (1/ε'), tl^^] with tl^^ = 'addition unit'||dt. Transition parameter ε' is consistent with parameter ε = ε', with r = 1/(1 + ε), par. B9 and eq. B10, including ε = tlim^^, derived in par. B12(A3), without loss of universality.

A2. Transformation I

Transformation I is introduced to interchange t^^ values t0 and tl, with dt = [t0^^, tlim^^], and for which I*[tl^^] = t0^^ << I*[t0^^] = tl^^, with tl^^ outside dt since r = tlim^^/tl^^ < 1, solving the singularity problem of TU for t^^ = t0^^ in par. B12(A1) applying TU*I, when domain t^^ is defined with dt instead of D1 = [t0^^, tl^^].

Transformation I is followed by TU and one secures domain dI*[dt] = [I*[t0^^], I*[tlim^^]] = [tl^^, ε] = [ε, tl^^], with definition I*[tlim^^] = ε > I*[tl^^] = t0^^, for transit parameter ε from A1. Transformation I does not change parameter w from domain dw.

A3. Transformation I and the dimensional domain definition for current parameter t^^

For transformation I the inverse is I', with I'*I*[w] = α. w with α invariant scalar. Scalar invariant α can be interpreted to scale domain dt = [t0, tlim], such that singularity I*[t0^^] = tl^^ is not within, rather outside dt, where transformation TU resembles inverse I' for domain dt.

A complication is the dimensional domain definition of current parameter t^^. Any t^^ from D1 can be written t^^ = t^^[tv, tw] = tv. tw, with multiplication indication . and both tv and tw from D1. This is to solve the infinities occuring with the definition of t^^ within domain D1, due to the cardinal number of the specific scalar set S1, the set that includes the infinite values of tl^^ and tlim^^. This includes some intricate evaluation of the current parameter t^^ domain.

There is a difference in multiplication for t^^ finite and t^^ infinite. Meant is domain D1 = [t0^^, tl^^] includes two parts, the finite part with dt(finite) = [t0^^, tlim^^] and infinite part with dt(infinite) = [tlim^^, tl^^]. Eq. B13 is an expression for I*[t^^] when defining t^^ = t^^[tv, tw]. Indication v or w occurs for tv or tw, while indication letter l occurs for tl^^.

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Comment B9. Inferred is: both tv and tw can be from dt(finite) or dt(infinite), however one from each domain, and t^^lim can be from both domains. Transformation I exchanges values to inverse values. Examples are given with eq. B13, where eq. B15 is the overall relation.

B13 I*[t^^] = I*[tv, tw] = (1/tv. tlim^^). (1/tw. tl^^)

t0^^ =I*[tl^^] = 1/tl^^. tlim^^, from dt(infinite) to dt(finite)

tl^^ = I*[t0^^] = tl^^. tlim^^. 1/tlim^^. tl^^, from dt(finite) to dt(infinite)

With 'addition zero'||t^^ = 'multiplication unit'||t^^ = tl^^ from dt(infinite), par. B8, and with tlim^^ from dt(finite) there is I*[tlim^^] = I*[tv = tl^^, tw = tlim^^] = (1/tl^^. tlim^^). (1/tlim^^. tl^^) = 1/tl^^. tl^^ = r. 1/tlim^^, belongs to dt(finite), while I*[tlim^^] = I*[tv = tlim^^, tw = tl^^] = tl^^, belongs to dt(infinite). This is consistent with eq. B14.

One can define multiplication t^^ = [tv, tw] from domain dt(finite) and dt(infinite) to avoid contradiction.

B14 t^^ = t^^[tv: dt(finite), tw: dt(infinite)], remains in dt(infinite)

t^^ = t^^[tv: dt(infinite), tw: dt(finite)], remains in dt(finite)

tlim^^ = r. tl^^, remains in dt(infinite)

tlim^^ = tl^^. r, remains in dt(finite)

The multiplications can be applied for the definition of I for the one moment time version from correspondence with the time interval version. With transformation I applied to t^^ = tv. tw, the domain dt(finite) and dt(infinite) are exchanged. The special t^^ = tlim^^ can be from dt(finite) or dt(infinite). The time interval version units and zero's can be derived due to eq. 1, meaning e. g. M[Δt3, Δt] = M[Δt, Δt3] = Δt3 and M[Δt3, Δt3] = Δt3.

With the definition tl^^ = 'multiplication unit'||t^^ for any current parameter t^^ from domain dt(finite) = [t0^^, tlim^^], there is t^^. tl^^ = t^^ remains in dt(infinite) and tl^^. t^^ = t^^ remains in dt(finite).

For any t^^ from domain dt(infinite) = [tlim^^, tl^^], with r = tlim^^/tl^^ < 1, there is tl^^. t^^ = t^^. tl^^ = t^^ in dt(infinite).

There is, even though multiplication not being well defined for t^^ from dt(infinite), however tl^^ = 'multiplication unit'||t^^, and t^^ = tlim^^ in dt(infinite) implies tlim^^ = tlim^^. tl^^ remains in dt(infinite), while I*[tlim^^. tl^^] = tl^^. tl^^ >> I*[tl^^. tl^^] = t0^^ = 1/tl^^. tlim^^, as it should be.

Define within domain dt(finite), ε = 1/tlim^^ = 1/tlim^^. tlim^^, and 1/tlim^^ = tlim^^ = multiplication unit'||t^^, while within domain dt(infinite) defined is ε = 1/t0^^. tlim^^ = tl^^ = 'multiplication unit'||t^^.

When t^^ = tlim^^ in dt(finite) and tlim^^ = tlim^^. tlim^^, there is I*[tlim^^. tlim^^] = 1/tlim^^ in dt(infinite).

For dt(finite) =[t0^^, tlim^^], the following expression is consistent with t^^ = t^^[tv, tw] from eq. B13.

B15 I*[t^^] = 1/t^^. tlim^^

TU*I*[t^^] = TU*[1/t^^. tlim^^] = 1/(1/t^^. tlim^^) = t^^. 1/tlim^^ = t^^

A4. Time interval operators, scalar multiplication, and set generators

Theorem B3. from (Hollestelle, 2024part1). For set generators G and set elements t^^, and transformations T*(t^^) = exp[t^^. G], there is addition A equals multiplication M when set generators equal set elements, and this is precisely the case for the time interval only set.

One can apply generators for the one moment time set and for the time interval set. Group or set generators are widely and diversely applied, and introduced in representation theory in e. g. (Veltman, 1974), (De Wit, Smith, 1986).

Comment B10. Where the usual one moment time description time parameter operator is a derivative, the definition for the corresponding time interval operator is from (Hollestelle, 2021): the time interval operator 'working to the right' on a quantity A1, not necessarily a time interval quantity, is defined with:

operator*[A1] = M[D*||Δt[|operator*|. A1], Δt] = A[|operator*|. D*||Δt[A1], D*||Δt[|operator*|]].

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The expression |operator*| indicates the operator quantity, D*||Δt[A1] the time interval derivative of quantity A1, and both occur in the overall time interval operator definition. The 2nd step is due to the non linear time interval derivative 'set rule' for the time interval derivative of a multiplication of any time interval Δt1 and any scalar a, derived in (Hollestelle, 2024part1) and discussed in par. 1.

D*||Δt[a. Δt1] = A[a. D*||Δt[Δt1], D*||Δt[a]]

The one moment time derivative 'set rule' provides usually the derivative definition for a multiplication of any one moment time quantity q1 and any scalar a. Recall the expressions in par. 1.

d/dq*[a. q1] = c1. d/dq*[a]. q1 + c2. a. d/dq*[q1] = c2. a. d/dq*[q1]

The d/dq is the one moment time derivative, c1 and c2 are scalar constants dependent on the associative property, usually assumed is c1 = c2 = 1. Assumed is d/dq*[a] = 'multiplication zero'||q_set for an invariant scalar a, for the one moment time parameter q set.

Due to theorems 1b and 1c, par. 3.8, applied within the one moment time description, an equation in terms of scalar a with space-like parameters can be changed to one in terms of time-like parameters. One recognizes scalar a to 'moving to the left' for both the one moment time description and the time interval description.

*The one moment time version for transformation TU*I*

Within the one moment time description the canonical property is valid for combination transformation TU*I with 1-dim. current parameter t^^ and only one generator, equal to 1/G. One can write the one moment time transformation TU*I 'working to the right' on t^^ for simplicity with the generator termed 1/G, with eq. B16. Usually operators are defined to be 'working to the right', indicated with *, transformations in this papaer are defined in a similar way with indication *. One can disregard the usual one moment time description space-like coordinate dependent commutation brackets relation [G, G]||q = 'addition zero'||q_set, and one can define the 1st derivatives d/dq*[t^^] = 1/α, with α scalar, and d/dq*[1/G] = β, equal to 'multiplication zero'||q_set for 1/G invariant, where higher orders cancel. Applied is the derivative 'set rule' for one moment time derivative d/dq. It follows G = c1/α.

B16a TU*I*[t^^] = exp[t^^. 1/G]

exp[t^^. 1/G] = c1. 1/α. 1/G. exp[t^^. 1/G]

<u>*Comment B11.*</u> The one moment time derivative d/dq*[t^^] = 1/α equals the scale transformation due to transformation I. This scale transformation depends on the current parameter t^^ being dependent on one moment time space like coordinate q. The other way around, when coordinate q related with current parameter t^^, time development occurs for all t^^ and q synchronously. Scalar parameter d/dt^^*[q] = α equals the object ruler scale calibration which is measurement dependent and finite, in this case G = c1/α, well defined for c1 finite. One can choose α = 'multiplication unit'||scalar_set, and q = α. t^^ = t^^, and for transformation TU*I the result is:

B16b TU*I*[t^^] = t^^

*The time interval version for transformation TU*I*

Within the time interval description, where the time interval only set is 1-dim. and the time interval generator is ΔG, defined is, for object ruler t^^ dependent on one moment time space like coordinate q: D*||Δq[Δt^^] = Δαi and D*||Δq[ΔG] = Δβ, with Δαi or Δβ not necessarily equal to 'multiplication zero'||Δq. Applied is the time interval derivative 'set rule', while ΔA1 = Δt^^ and scalar r = tlim^^/tl^^.

<u>*Theorem B5*</u>. The theorem on averages applies since α is measurement dependent, scale calibration dependent, when the derivative of current parameter w and t^^ to one moment time parameter t or time interval Δt can be derived. When the current parameters, being object rulers, are assumed to follow equilibrium time development, they are simultaneous, and with their derivatives to Δt equal to 'multiplication unit'||Δt within the time interval description. This was discussed in par. 1.2, and assumes calibration of object ruler type measuring ΔPi and measuring emission energy at surface ΔA.

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Since for the time interval only set the canonical property is valid, and including only 1st order derivatives, and with time interval commutation brackets, where e. g. [Δt, Δt]||Δt = Δt and [ΔG, ΔG]||Δt = ΔG, one can write in all cases [Δt1, Δt2]||Δt = M[A[TS*[Δt1], Δt1i], Δt2] = M[I*||Δt1 [Δt1], Δt2] = Δt2. Time interval commutation brackets are defined in (Hollestelle, 2024part1).

TU*I*[Δt^^] = exp[M[Δt^^, ΔG]] = exp[M[A[Δαi, Δβ], ΔG]] =

exp[M[Δt^^, ΔG]] = exp[M[M[Δαi, Δq], M[Δβ, Δq]]] = exp[M[Δαi, ΔG]] = M[Δt^^, Δt^^] = Δt^^

Applied is generators equal set elements. It follows Δt^^ = M[Δt^^, Δαi] where Δαi = Δt^^ and Δβ = ΔG. This implies D*||Δq[ΔG] = ΔG, i. e. ΔG equals time interval Noether current ΔNC, considering Δt = Δq due to D||*Δt[Δq] = 'multiplication unit'||Δt, par. 4.2.

*The time interval version for operator TU*I*

From the derivative 'set rule' applied to *operator* TU*I, one finds TU*I*[Δt^^] = A[d1. Δαi, D*||Δq[d1]] with in this case parameter d1 = |TU*I*| equals 'multiplication unit'||Δt^^_set, when assuming correspondence by units with one moment time description TU*I*[t^^] = t^^, where one moment time operator TU*I equals the identity.

One can define ΔM with exp[M[Δt^^, ΔG]] = exp[ΔM], with a Taylor series in Δq. Multiplication of two time interval quantities M[Δt1, Δt2] = Q3, where Q3 is again a time interval quantity, Q3 = Δt3i. due to *theorem 4*, the multiplication closure theorem. The original time interval derivative 'set rule' definition does not include time interval multiplication M[Δt1, Δt2], rather scalar multiplication, M[a1, Δt1] = a1. Δt1, however it is assumed applicable to M[Δt1, Δt2]. Introduced is the term s − 1 = Σ(k ≥0) 1/k! − 1.

D*||Δq [ΔM] = D*||Δq [M[Δt^^, ΔG]] = M[Δt^^, ΔG] = ΔM

exp[ΔM] = 'addition unit'||Δt^^_set + Σ(k ≥ 1) 1/k!. M[M[ΔM, exp[ΔM]], M[ΔM, exp[ΔM]] =

= A[(s − 1). M[ΔM, exp[ΔM]]i, M[ΔM, exp[ΔM]] = (s − 1). Δt^^

In this case ΔM equals ΔNC and Δt^^, and Δq is dependent on the object ruler and Δt^^, not on Δt or equilibrium time development. Remain the following 1st order equations:

exp[ΔM] = (s − 1). Δt^^ = M[exp[ΔM], A['addition unit'||Δq_set, ΔM]] =

= (s − 1). Δt^^ = A['addition unit'||Δq_set, ΔM] = 'multiplication unit'||Δq_set = Δt^^

Again applied is, generators are set elements and vice versa. Trial solution is Δαi = Δα = 'multiplication unit'||Δq_set = Δq and it follows D*||Δq[Δq] = Δq and ΔG = Δq.

This is consistent with the time interval operator result, D*||Δq[ΔG] = ΔG, i. e. ΔG = ΔNC. And, it confirms the assumption that for multiplication of two time interval quantities the time interval derivative 'set rule' is applicable.

B17 TU*I*[Δt^^] = exp[ΔM] = (s − 1). Δt^^ = Δt^^

Time interval operator TU*I is found to be equal to the time interval current parameter Δt^^ identity operator, identity mapping, TU*I*[Δt^^] = Δt^^. This corresponds and is consistent with one moment time current parameter results eq. B16, i. e. Δt^^ ~ t^^, and TU*I*[t^^] = t^^.

The canonical property is valid for the time interval only set. Correspondence can be derived from the units and zero's, however the current parameter set for Δt^^ or t^^ does not have to depend on Δt or one moment time parameter t, and Δt^^ ~ t^^ is not the same as Δt ~ t.

Theorem B4. One can apply higher order approximations for TU*I*[Δt^^] in terms of the Taylor series in Δt^^, to find the time interval version of TU*I*[Δt^^] = exp[ΔM], while applying eq. 1. One finds eq. B17 is universal for any operator TU*I, and both any time interval and one moment time description TU*I operator is equal to the identity operator.

Comment B12. Time interval operator TU*I*[Δt^^] allows space reversal symmetry, while time reversal symmetry is not allowed, Δt^^ being related with Δq = M[Δαi, Δt^^] and where D*||Δt[Δq] = Δt. To find TU*I*[Δt^^] from Kramers relation directly, par. 2.4, seems not feasible since Δt and Δt^^ are not related, assuming the current parameters remain independent of equilibrium time development. Some cases where however dependence can be assumed have been discussed in par. B8, e. g. 'wave-group collapse' within Δt, where the order of any occuring wave function collapse can be interchanged.

A5. The combination TU*I and specific Lorentz transformations TS

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The choice for TU leaves mdTU*I*[dt] invariant, since the specific Lorentz transformations TS, which are coordinate transformations for domain dw and dt, preserve surface measure at the emission surface A, (Hollestelle, 2021). This means TS preserves quadratic measures at surface A, the metric being diagonal or non diagonal. It follows any TU transformation is a TS transformation. With eq. B18 it is assumed variables dw and dt can be separated, due to comment B13. Assumed is transformation I leaves dw invariant.

B18 dTU*I*[dw x dt] = dTU*[dw] x dTU*I*[t0, tlim]

B19 mdTU*I*[dw x dt] = mdTU*[dw]. mdTU*[tl, ε] = mdTU*[dw]. m[1/tl, 1/ε]

The x means 2-dim. direct product in terms of surface part Pi dimensions d1 and d2, while trivialy domain [1, 0] equals domain [0, 1].

Comment B13. In terms of measures for dimensions d1 and d2 for Pi, assumed is measures mPi of the disjoint Pi can be added like scalar numbers to derive mPu.

Comment B14. Assumed is domain dq = |q|. dw for q = |q|. w, linear with any parameter q from any domain, including domain dw or domain dt.

Comment B15. Required is surface part TU*I*[Pi], for i = 1, 2, has to be disjoint, open and dense. However TU*I*[dw x dt] is always open when dw and dt open, being continuous transformations, a theorem from (Hocking, Young, 1961).

A6. Transformation TU*I with variable space-like domain dw and singularity w = w0

Transformation TU*[w] = (1/w) is similar to the TU*[t^^] linear in 1/t^^, it includes a singularity at w = w0 = 'addition zero'||w, and similarly for Δw = Δw0 ~ w0, valid in one moment time description and time interval description, a property for w and dw not necessarily mentioned in the following. Write domain dw = [w0, w] with the series dw = [w, w/2] + Σ(z=2, Z) [w/z, w/(z+1)], which for Z infinite reduces to domain dw = [w, w/2] + [w/2, w0] = [w0, w]. For Z finite dw = [w/2, w] + [w/(Z + 1), w/2] = [w/(Z + 1), w], and singularity w = w0 is avoided. This is different from the approach for domain dt and singularity t0.

A7. Inter-dependence of the parametrisation for Pi with variable domain limits

Inter-dependence of w and tlim^^ is indicated with new independent parameters w(r1) and tlim(r2) with r2 = tlim^^(r2)/tl^^ defined in par. B4 related through parameter r. Both new parameters depend on r, the independent parameter for domain dw(r1) x dt(r2). For any TU*[Δw] the Taylor series is approximated with the terms linear in Δwi, valid in the time interval only description, and due to this can be inferred to be valid for the one moment time description with w and dw from correspondence Δw ~ w.

There is w(r1) = 1/r1. w, with specific value TU*I*[w(r1)] = w(r1) and TU*I*[tlim(r2)] = TU*I*[r2. tl] = r2. tl. Recall, from par. 1.2., for dt, and multiplication from par. B12(A3), there are alternatives, due to dimensional domain definitions, for finite t^^ from dt(finite) = [t0^^, tlim^^] and for infinite t^^ from dt(infinite) = [tlim^^, tl^^].

Surface part Qi = Pi[N, w, tlim^^], with w = w(r1) and tlim^^ = tlim^^(r2). The dw and dt are separate domains, domains follow direct products, measures of domains follow multiplication.

B20 dTU*I*[dQi] = dTU*[([w(r1), w(r1)/2] + [w(r1)/2, w(r1)/Z+1])] x dTU*I*[dt(r2)]

mdTU*I*[dQi] = mdTU*[[w(r1)/Z+1, w(r1)]]. mdTU*I*[dt(r2)]

mdTU*I*[dQi] = 1/w(r1). Z. = Z. r1. 1/w. (|1/tl^^ − 1/ε(r2)|)

B21 dTU*I*[dPi] = dTU*[([w, w/2] + [w/2, w/Z+1])] x dTU*I*[dt]

mdTU*I*[dPi] = mdTU*[[w/Z+1, w]]. mdTU*I*[dt]

mdTU*I*[dPi] = Z. 1/w. (|1/tl^^ − 1/ε|)

Requirements are, mQi = mPi and mdTU*I*[dQi] = mdTU*I*[dPi]. It follows series parameter Z, introduced for the current parameter w singularity, can be solved from the other parameters, where 1/r1 = w(r1)/w, and r2 = tlim(r2)^^/tl^^ are the independent variables. Recall TU*I equals the identity transformation.

From one moment time equation mdTU*I*[w(r1)] = w(r2) it follows 1 − r1. 1/w(r1) = w(r2).

When r2 = tlim(r2)/tl^^, with tl^^ invariant, tlim^^(r2) is linear with r2, while w(r1). r1 = w remains invariant when w(r1) is linear with 1/r1. There is r1 = 1/(1 + ε1) = (1 − ε1) and r2 = 1/(1 + ε2) =

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(1 − ε2). One can derive from the requirements one moment time description eq. B22, where r1 and r2 both approximate r to evaluate solutions. Parameters r1 and r2 can be adjusted independently, however make sense only when related through r1 = r2 = r.

B22 w(r1) = r1. r2 = (1 − ε1). (1 − ε2)

The solutions w(r1) and tlim^^(r2), when r1 = r2 = r, together add one extra degree of freedom from parameter r. Besides d2 parameter tlim^^(r), there is number of surface parts N, d1 parameter w(r), and transition parameter r equivalent to parameter ε(r). Eq. B23, quadratic, describes the same requirements, and reduces the number of degrees of freedom with one.

For the time interval description, due to eq. 1, there is to all orders of Δw(r1), the series TU*I*[Δw(r1)] = M[Δt, (Σn Tn). Δw(r1)] = M[M[Δw(r1)i, (exp[ΔGw] − 1). Δt], M[Δw(r1)i, Δw(r2)]] = Δw(r2), the transformation being equal to the identity except when r1 and r2 not yet adjusted to be equal to r. There is time interval generator ΔGw for the current parameter Δw set, similar to generator ΔG for the current parameter Δt^^ set defined in par. B12(A4), due to theorem 1c, par. 3.8.

B23 M[M[(exp[ΔGw] − 1), Δw(r1)], Δw(r2)] = M[(exp[ΔGw] − 1), w(r1). w(r2). Δt] = Δt

To retrieve a solution different from the trivial one, one can start with independent r1 and r2. One gathers the quadratic terms, the linear terms cancel.

Assumed is commutativity of the current parameter set and the other parameter sets, since these are not dependent on one moment time or time interval only equilibrium time development or one moment time parameter t or time interval Δt. The time interval only set is assumed non-commutative, (Hollestelle, 2020). Eq. B23 is quadratic in the current parameter domain measures.

When tlim^^ is assumed infinite, it follows, for dt(finite) = [t0^^, tlim^^], par. B12(A3), mw = ε(r) = |1/tlim^^| is a solution. This solution seems realistic for infinitesimal ε(r). The number of degrees of freedom does not change for surface parts ΔPi, with mdw x mdt invariant while parameter r varies, within eq. B23.

For dt(infinite) = [tlim^^, tl^^] there is solution mw = |tlim^^| = |t0^^| = |'multiplication zero'||w_set|, meaning emission surface measure mΔA, due to time development, does not change and develop away from the star source, valid for all Δt, where mΔt = |'multiplication unit'||Δt_set| remains valid for all Δt.

Theorem B6. The specific Lorentz transformations TS being quadratic in coordinates, and for which surface measure remains invariant, is defined in (Hollestelle, 2020), where specific TS are described to be an alternative to the usual Lorentz transformations TL, and one finds mdTU*I*[dw x dt] = md[[w/(Z + 1), w] x [t0, tlim^^]] and mdTU*I*[Pi] = mdTU*I*[Qi] = m[dw x dt], i. e. the domain measure remains invariant. This is the same result as *theorem B7.*

Theorem B7. Transformation TU*I, being equal to the identity, equals a specific Lorentz transformation TS. One moment time description identity equation mdTS*I*[dw x dt] = m[dw x dt], with tl^^ = 'multiplication unit'||t^^_set has only one solution, with mdw. mdt = mdw(r). mdtlim^^(r) = mw(r). r. mdtl^^ = w(r). r, which implies mQ, for regular sphere Q, equals w(r). r = w = 'multiplication unit'||w, while mPu ≥ mQ = mA.

Theorem B8. For equation mdTS*I*[dw x dt] = 'multiplication unit'||t, unlimited number of solutions for dw(r) x dt(r) are possible, different from and not equal to the trivial solution dw x dt, due to the n =2 dimensional domain definition t^^ = [tv, tw] from B12(A3). The transformation TU*I being equal to the identity transformation implies an addition to the fundamental theorem on polynomial equations, according to which at least one solution exists, possibly complex, for a n-degree polynomial, (Hocking, Young, 1961), (Arnold, 1974), where any application of TU*I increases the number of solutions, in this case with t^^ and n = 2, and the quadratic polynomial t^^ = tv. tw.

A8. Solution P(N)u with increasing number of surface parts

When a solution Pu(N), with number N surface parts Pi(N), i = 1 to N > 2, is known, one can continue to define Pi(N+1) from Pi(N). Parameter w(N+1) is chosen different from the known w for the Pi(N) due to the required disjoint property, however current parameter t^^(i) is chosen t^^(i) = t^^, the same for all surface parts Pi(N+1).

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Comment B16. Solutions with N > 2 can be related to the multiple n star-source collective from par. 3. To find an example surface Pu(N), apply parameter Z = N = n, with n the number of star sources, N the number of surface parts, while not considering Z equal to infinity since in that case singularity w0 remains unsolved.

Pi(N = Z) defined with dw(Z) and dt are disjoint when open, considering parameter w = w(N), for finite Z, they re-adjust places in space-like space time for the Pi to remain disjoint from the transition N = Z to N = Z + 1.

A9. Transformation from unit square to regular sphere and the emission surface

A transformation TQ from unit square domain dq = q1. d1 x q2. d2 to a regular sphere, can be chosen with 2 of the 3 space-like parameters for TQ*[dq] the same as the parameters from dq, for dimensions d1 and d2.

There is: TQ*[dq] = q1′ . d1 x q2′ . d2 x q3′ . d3, with space-like parameters q(i)′ = S. q(i), i = 1, 2, and q3′ = S. (1 − (q1)^2 − (q2)^2))^(1/2). Transformation TS includes a scale transformation, scaling parameter with S = mΔq = S. mΔt, however in par. 3.8 and par. 6 it is derived scaling parameter S equals 1 due to conservation of energy. Transformation TQ 'works to the right' towards the Pi domain with current parameters w and t^^, which are assumed not to depend on one moment time t or time interval Δt.

For current parameters w and t^^, when they are not considered one moment time equilibrium quantities, a corresponding time interval quantity can be found from t^^ ~ Δt^^ = < t^^ >| |Δt^^. Δt^^. This is discussed in par. 1.5 and 2.7.

With transformation TQ*TU*I an example is constructed from current parameter domain dq = dw x dt for all ΔP(N)i, and the example approximation ΔPu for wave emission surface ΔA(Δt). The original Pi current parameter domain is dq = dw x dt = [w. 1/(Z + 1), w] x [t0, tlim], assumed similar for all Pi, to result in covering least requirement SR, mPu ≥ mA, with Pu, with scalar s = 1, the scaled regular sphere. This result is valid similarly within the time interval description, where ΔPi current parameter domain dΔq = dΔw x dΔt^^ corresponds with dq.

Comment B17. Scalar scaling parameter S equals 1, scaling according to mΔq = S. mΔt = mΔt, not is meant scaling with S = mΔq. The time interval description measure mΔq can be defined by averaging, i. e. mΔq = mΔQ(n) = | < qi >| |n |= < qi >| |n, n the number of star-sources within the star source group. Another relation can be found from the wave group velocity, $c(\Delta t) = M[\Delta q, \Delta ti]$. This approach is interesting considering the discussion for the theorem on averaging, par. 1.6.

Comment C. Specific Lorentz transformation TS

Comment C1. In terms of specific Lorentz transformation TS, there is invariance TS*[ΔdU] = ΔdU, where ΔdU = ΔNC. The acquired energy exists with units ΔNC = ΔEs, as it should be for a Noether charge related to the star source collective cosmology, and suggests a QM interpretation for energies ΔEs or ΔEg with units ΔNC = M[Δm1, Δm2].

This seems to indicate how a coupling between energies can be expressed with a multiplication of densities. This can be applied to introduce other energy types, e. g. with open, non-zero and closed, zero equilibrium discussed in par. 3.

Star-source wave emission, gravitation energy, and the time interval only set

Commutation properties for certain time related sets, i.e., the one moment time set and the time interval only set, were defined in (Hollestelle, 2024Part1). Depending on the dimension d of the set, commutation properties define quantities within reciprocal d-pairs, for the time interval only set, being a one-dimensional set with d = 1, the d-pairs are 1-pairs meaning ordinary pairs. Where the number of degrees of freedom increases with d, maintaining equilibrium means a reduction of the number of degrees with 1, and depending on all quantities within the d-pair, one can define the invariant overall time interval Noether charge ΔNC. The Noether charge turns out to be equal to a structure constant for the time interval only set. It is argued, because of this there exists a 1-pair of equivalent energies, meaning emission wave energy ΔEs and gravitation energy ΔEg, with one moment time description time development each opposed to the other.

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The 1-pair of time interval only description commutation quantities are cn(Δt) and cn'(Δt), and the specific Lorentz transformation TS*[cn(Δt)] = cn(Δt') = cn'(Δt) are related to invariance for cn'(Δt) = cn(Δt'). One finds an energy equivalence relation with a1 = ΔEs and a2 = ΔEg.

C3 TS*[a1] = a2

TS*[a2] = A[a1, A[I*||Δt[a2], D*||Δt[a2]iv]]

C4 |A[ΔEg, ΔEsiv]| = | A[I*||Δt[ΔEg], D*||Δt[ΔEg]iv] |

Commutation relations assume the complexity of the time interval set. The d-pair of reciprocal quantities can be regarded similar to the d-pair of boundaries for some time interval: in this case there is applied only one pair: 1-pair one moment time parameters t and only one relevant event time interval Δt, to derive the derivative 'set rule' eqs. for the time interval only derivatives to t and Δt respectively, (Hollestelle, 2024part1). These eqs. make sense with a non-zero function Rest(a1), with non-trivial commutation relations.

Specific Lorentz transformation TS invariance

Time interval description acquired energy ΔdU is introduced in par. 3.5.

A) When one moment time energy dU* is introduced, closing to zero of non zero equilibrium equation 5, situation (with-*), including ΔEs* = A[ΔEs, Δt*] = D*||Δt*[A[ΔEs, Δt*], is assumed to imply interaction with duration equal to relevant event time interval Δt*, the same time interval within time interval derivative D||Δt*[ΔEs] and the same time interval for the specific Lorentz transformation invariance. This applies ΔEs = ΔNC. The specific time interval derivative of any one moment time quantity A2(t) to one moment time parameter t, D*||t[A2(t)] = -1. A2(t). 1/t, for a decreasing positive one moment time quantity A2, where Es changes to Eg within Δt, is derived in (Hollestelle, 2020), With time interval quantity [a. Δt1] = M[ΔEs, Δt*], and TS*[ΔEs(Δt)] = ΔEs(Δt*) this results in eq. C5a.

B) For closure to zero of non zero equilibrium equation 5b, energy within the accent situation (with-') is ΔEg' = M[ΔEg, ΔdU']. Only when eq. 5 and eq. 5b are assumed to imply the same physics this would mean Δt* = ΔdU', except for the uniqueness issue, in other cases these quantities can be assumed to differ. The acquired energy ΔdU' is the energy acquired due to space like interval measure mΔq, related to specific Lorentz transformation change TS*[Δq] = Δq'. The energy ΔEg is acquired energy, and space like Δq dependent, where ΔEs is Δt and Δq dependent. With TS*[ΔdU(Δq)] = ΔdU(Δq') this results in eq. C5b.

C5a TS*[ΔEs] = ΔEs* = -1. A[ΔEs, D||Δt*[ΔEs]]

C5b TS*[ΔEg] = ΔEg' = -1. A[ΔEg, M[D||Δq[ΔEg], D||ΔdU'[Δq]]]

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