Article

Not peer-reviewed version

The Time Interval Only Set, Part 2

Harmen Hollestelle *

Posted Date: 1 September 2025

doi: 10.20944/preprints202509.0057.v1

Keywords: time interval only set; (a-)symmetry; wave emission propagation surface; Noether charge; star source emission cloud; non zero equilibrium; dark matter; wave emission zero temperature; fundamental theorem of polynomials; Kramer's equation; time reversal; wave emission zero temperature

The Time Interval Only Set, Part 2

Harmen H. Hollestelle

Independent Researcher, Bandung 50391, Indonesia; harmhollestelle@yahoo.com

Abstract

This paper is part 2 continuing from publication part 1 from 2024. Part 1 tried to set, on the basis of two theorems, an axiomatic approach to the time interval only description. The two theorems, fundamental and nearly equivalent, are the multiplication linearity theorem and the multiplication closure theorem. Both these theorems claim the multiplication of two time intervals results in a time interval. The present paper includes a construction of an example to the 'wrinkled' propagation surface for spherical symmetric wave emission, being an alternative for a well known construction for an indecomposable continuum. A series of comments and theorems is included that discuss the 'wrinkled ' surface concept and related subjects. From the propagation surface there are two new results, one defining non zero equilibrium and acquired energy, and one defining zero temperature, by introducing zero temperature being a lower bound temperature. These results depend on the concept of the current parameter, which is new in this paper, however resounds some related definitions for simultaneous measurements from General Relativity (GR), and depends on the (a-)symmetry of finite time intervals and evaluating Curie's principle. The current parameter concept allows for a comment on the fundamental theorem on polynomials. A collective of wave emission star sources provides several universal results including some comments on the gravitation constant.

Keywords: time interval only set; (a-)symmetry; wave emission propagation surface; Noether charge; star source emission cloud; non zero equilibrium; dark matter; wave emission zero temperature; fundamental theorem of polynomials; Kramer's equation; time reversal; wave emission zero temperature

---

Paragraph 1. Introduction

1.1. Introduction

The time interval description finds several arguments that do not apply to the one moment time description, which is the usual one including in present physics. The definition and arguments for the time interval description in contrast to the Newtonian tangent approach, are defined in and originate from (Hollestelle, 2020). These arguments have been studied in earlier publications, while intervals themselves have been subject of philosophy earlier. Some of the results in this paper are time interval description only results, this is indicated within the text.

Within the time interval description one can disregard the infinitesimal limits of the tangent method of Newton. However, within Hamiltonian time independent events, results for both the time interval description and the one moment time description are the same.

A main concept applied in part 1 is the time interval description Noether charge, derived for a star-source emission cloud interpreted as one collective, to be a unit for the simultaneous wave emission energy measure (Hollestelle, 2024), (Noether, 1971). The description of the wave emission energy for the emission propagation surface applies the closed sphere-like surface energy concept originating from an earlier paper (Hollestelle, 2017).

The Main Question

A question remaining from part 1, when wave propagation surfaces are to be exemplary to describe overall physical phenomena, what is to be exemplary for such surfaces. The example in *comment B* is the main result of this paper, for this question. This example is the complete version to the 'wrinkled' wave propagation surface proposed in (Hollestelle, 2021, 2022). Two decisive theorems, *propagation theorem 1 and 2*, are included in par. 1.7, while their proof is included in *comment B*. This paragraph includes the introduction of a time interval gravitation constant.

The Outline of This Paper Is as Follows

Within three comments at the end of the paper, are included the following subjects, *comment A*: zero or non zero mass for complementarity wave particles, *comment B*: an example approximation for the wave emission propagation surface, *comment C*: The method to approach the main question, surface measure preserving specific Lorentz transformations.

Asymmetry

Not considering other arguments, asymmetry for time interval Δt relates to asymmetry within time interval equilibrium. One moment time average < t >||Δt = t0 equal to 'multiplication unit'||t is defined to correspond with time interval Δt0 = 'multiplication unit'||Δt, and from 'multiplication zero' units correspondences can be found for any set units and set 'zero' units and a relation for Δt and time interval Noether charges and structure constants, (Hollestelle, 2024). In this way asymmetry, non zero symmetry, within the time interval description is related to several of the results in this paper. *Comment 1.* Equilibrium can be proposed to relate to invariance of some parameters where other and different parameters are variable, following (Arnold, 1989). In this way time interval equilibrium can be included in and become part of Curie's principle which refers to the occurence 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. This paper, both part 1 and part 2, concerns time intervals and the subject is finite asymmetric time intervals, which implies a time dependent Hamiltonian.

Wave Emission

Internal interaction, par. 5. and *comment A*, seems to be similarly relevant for acquiring gravitational mass from zero mass for the wave particle. Zero mass photons and wave emission by time development propagating away from the source, do not acquire mass by internal interaction. A related, albeit different, argument is from (Hollestelle, 2018). In this reference's discription, due to internal interaction, outgoing photons, starting with zero mass, do not acquire mass and the Higgs mechanism does not apply to these photons. The opposite process, ingoing or free falling wave particle, the zero mass photon or non zero mass wave particle, can acquire mass from internal interaction, without the Higgs mechanism.

Within par. 3.8 several theorems are gathered that consider the time interval set and star source emission cloud collectives within the time interval description. These theorems, theorem 3b and 3c in particular, claim the addition property is valid for time interval quantity sets. The addition property being valid for the star source wave emission cloud, is crucial to regarding this addition property universal when applied to any collective cosmology.

Non Zero Equilibrium, and Acquired Energy

The time interval wave emission energy, *comment* A, was confirmed to be valid and equal to wave emission described with qm fields, (Sakurai, 1978), (Hollestelle, 2021). Defined is time interval non zero equilibrium, par. 4. and 5, different from time interval zero equilibrium such that where wave emission energy remains confirmed by measurements, gravitation energy can be different from it's equivalence relation in *comment* A, or otherwise the acquired extra energy related to the non zero equilibrium situation is independent and not to be interpreted to be an addition for gravitation energy or wave emission energy.

 doi:10.20944/preprints202509.0057.v1

1.2. Current Parameters, Object Rulers

The introduction and application of current parameters in this paper is new for the time interval set. Current parameters are introduced to be similar to an object ruler to describe a stationary object occurring in space-time. Measuring implies counting current parameter bias or scale for the object. Current parameters describe an object that is not reduced to a one moment time coordinate, with one value, or space coordinates, the object is at a place, meaning it has a non zero dimensional domain in 3+1-dim. space time. They resemble an invariant 'displacement' field in field theory.

Comment 2. Current parameters, different from space time coordinates, are a special type of property indications. One can define properties according to their symmetries. One symmetry is whether property values can be negative or positive or both. For space time the properties are the coordinates within the one moment time description. However within the time interval description there are differences, e. g. time intervals depend on counting time in two ways, even though the time interval set is 1-dim. Time intervals, e. g. [tb, ta], apply one moment time parameters tb < 0 and ta > 0, where 0. t0 = 'multiplication zero'||t from the one moment time parameter set. Current parameters, interpreted to be object ruler, can not have such domains, rather 0. t0 = 'multiplication zero'||t^^ is the set lower bound, the domain being chosen with this property. This is due to their definition depending on counting. In this way temperature T is an object ruler, even while not directly related to other object rulers, or current parameter t^^, *comment* B, and mass similarly is an object ruler.

Definition 1. Any object ruler is defined with its domain being a one sign only set. Counting starts from 'addition zero', when calibrated. One counts by successive addition. A recent discussion of numbers related to counting is found in (Murawski, Bedürftig, 2010).

Current parameters are not equilibrium time development dependent one moment time parameters, e. g. the usual Newtonian coordinates or Lagrange equilibrium generalized coordinates, one moment time description space like parameter q and one moment time momentum p from Hamiltonian equations, with usual one moment time derivatives d/dt*[p] = -1. ∂/∂q*[U(q)], U acquired, "potential", energy, and when assuming mass m invariant, (Goldstein, 1950), (Arnold, 1989). Current parameters are introduced in *comment B*, to describe 2-dim. surface parts in 3-dim. space.

A 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 necessarily the emission wave propagation surface relevant event time interval Δt should somehow be related to the calibration event, 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 is not to be inconsistent with the traditional measurement description, regarded are two different measurements, the object ruler measurement, and the object equilibrium time development measurement. Most of *comment B* is within this assumption, except par. 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, par. B12(A3) and in *comment* B, par. B5 and *definition 5.* This definition implies domain t^^ is a multiplication of n different 1-dim. product spaces, in this case t^^ is equal to multiplication t^^ = tv. tw with n = 2, while the resulting t^^ domain is divided in domain parts for t^^ finite and t^^ infinite.

Within *comment* B derived is, an addition 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* or *less than or equal to n* for a polynomial equation of degree n, (Hocking, Young, 1961), (Arnold, 1989).

Comment 3. With any nth degree polynomial equation P(n)(t^^) = 0 for t^^, apply the m dimensional domain definition, introduced in *comment B*, par. B12(A3), with m = 2 and t^^ = tv. tw, with special attention to t^^ with respect to infinities. This can be extrapolated to any dimension m, e. g. to include (m – 1)-dimensional tv and 1-dimensional tw, 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 related to the surface parts ΔPi and ΔPu discussed in *comment B*, the example propagation surfaces. It depends on the parameters, related to the construction of the ΔPi and ΔPu, that can constrain the dimensional domain definition. Where the combination TU*I equals the identity, the single tranformations TU and I do not, and thus, to the mentioned at most n solutions, add new solutions for the same polynomial equations.

1.3. Spherical Symmetric Wave Propagation 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 within the time interval only set, with A meaning time interval only set addition and Δt = 'addition zero'||Δt, according to the addition properties. Similarly M[Δt1, Δt] = M[Δt, Δt1] = Δt1, with the same Δt = 'multiplication unit'||Δt. Relevant time interval

Δt relates to the specific description of spherical symmetric wave propagation, 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 propagation is considered exemplary for this. Not assumed is parallel wave propagation, however emission is assumed to have a source and a time development limit surface, i. e. surface ΔA, time interval Δt dependent.

Wave propagation implies complementary wave particles of zero or non zero mass with group-velocity *c*(Δt). Finite time interval Δt is indicator for measurement events and interaction events. The wave propagation spherical symmetric surface within the time interval description, where propagation surface energy implies simultaneous emission energy during Δt, was discussed earlier in (Hollestelle, 2021).

Star-source emission, interpreted with wave propagation spherical symmetric surfaces, is different from parallel wave propagation. The space-like surface measure mA, not meaning the usual line element dependent metric, for wave propagation surfaces A(Δt), where Δt indicates the relevant event time interval, is invariant with change of Δt, the variable for equilibrium time development within the time interval only description, due to overall energy conservation.

From quantum mechanical e.m. field theory within the usual one moment time description, for instance (Sakurai, 1978), (De Wit, Smith, 1986), the time interval only description version of qm concepts only the following are included; zero or non zero mass wave particle 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.

Spherical symmetric surfaces and thermodynamic properties are discussed starting from the surface concept in (Hollestelle, 2017). It's surface includes a second, lower, layer, such that surface interaction within the second layer, decides on its properties. Within the time interval description and applying the sphere-like surface concept, one finds the time interval qm version for e.m. energy and equivalence with gravitation energy, (Hollestelle, 2021).

To assume wave propagation surfaces does not imply complementary particle paths. The discussion of wave propagation starting from the concept of paths in qm is not the subject of this paper.

The wave emission energy equals emission propagation surface energy Es related to surface A(Δt) and is equal to its metric surface measure mA. Specific Lorentz transformations TS can be defined that leave metric 2-dim. surface measures including mA invariant, rather than metric 1-dim.

 doi:10.20944/preprints202509.0057.v1

measures, invariant with traditional Lorentz transformations TL. TS transformations respect energy conservation during time interval equilibrium time development as it should be.

The Three Dimensional Simultaneous Propagation Volume

The time interval version for overall 3-dim. simultaneous wave emission propagation surface Ac is indicated with ΔAc such that its measure is mΔAc = d x mΔA, including surface normal measure d estimated equal to mΔq, considering simultaneous wave emission only. Surface normal estimate d = mΔq(Δt), introduced in (Hollestelle, 2020, 2021), equals mΔt, and depends on the 'simply measurable' property for Δt, par. 1.4.

1.4. 'Simply Measurable' Relevant Event time Interval Δt and Specific Lorentz Transformations TS

Time interval simultaneous emission, when measurement event dependent with time interval Δt, is defined due to wave propagation, assuming finite group-velocity, and emitted and 'on the way' during relevant event time interval Δt. Within this definition, Δt is termed 'simply measurable', meaning the time interval measure mΔt can be measured within time interval Δt itself, a property derived to be always valid in (Hollestelle, 2021, 2024). The property 'simply measurable' could be introduced to define why a relevant event time interval is relevant.

A reciprocal pair of one moment time commutation quantities cn and cn' is defined: 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 wave propagation surface energy ΔEs, which is as should be when no interaction occurs, and implies invariance for measure mΔA proportional with mΔEs for wave propagation surface ΔA, meaning mΔA'(Δt') = mΔA(Δt), the defining property for TS in (Hollestelle, 2021), meaning TS is different from the usual Lorentz transformation TL. In terms of one moment time coordinates infinitesimal transformations TS equal linear equilibrium transformations and the metric distance measure remains preserved together with the concept of covariance, similar with the usual TL. The complete non-infintesimal TS is a equilibrium transformation quadratic in the change of one moment time description 3+1 dim. space-time equilibrium coordinates q(t) and t, (Hollestelle, 2021). Within the time interval only discription non-infinitesimals TS always are linear, due to time interval properties similar to M[Δt1, Δt1] = Δt1, while still preserving surface measure mΔA.

1.5. The Time Interval Only Description, Time Interval Quantities and Correspondence

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

A measurement related interaction, e. g. wave function collapse, includes a change for wave emission energy from non- localizable to localizable, where the time interval only description, rather than the one moment time description, can give meaning to this difference (Hollestelle, 2020, 2021) and in *comment* B, par. B7, discussing 'wave-group propagation collapse', meaning multiple wave function collapse, and the simultaneous property.

Correspondence

Time interval quantities ΔA1(Δt) relate to one moment time quantities A1(t), and correspondence, indicated with ~, is the term for relations ΔA1 ~ A1. 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 = I*||Δt [A1(t)]. M[Δti, Δt], however this is not the regular definition for time interval quantity correspondence. One can write time interval integration I*||Δt with ΔA1 = ∫||Δt dt [A1(t)]. M[Δti, Δt].

The definition of correspondence, from part 1 (Hollestelle, 2024), is dependent on units and zero's from both time interval and one moment time sets. Starting with average < t >||Δt = t0, the one moment time description 'multiplication unit'||t, where t0 ~ Δt0 = ΔU and M[ΔU, Δt1] = M[Δt1, ΔU] = Δt1. There is 'multiplication zero'||Δt = ΔU0, with M[Δt1, ΔU0] = A[ΔU0, Δt1] = ΔU0. For finite relevant event time interval Δt, ΔU ≠ ΔU0.

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

External Interaction

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

With external interaction and wave function collapse, energy ΔEs is not an invariant time interval quantity. One can write

ΔEs as a function of #n, for t during Δt, however #n = #n(t) time dependent during Δt, ΔEs(t) in this case does not belong to the time interval only set. For the original discrete #n with #n(tb) >> #n(ta) >> 1, an approximation of #n with continuous function n(t) can be assumed valid, while Es(t) = (n)^(t/ t0), with example values ta = 2. t0 and tb = 1. t0, leaving out t0 = 'multiplication unit'||t 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). (n)^(t/t0+1)]||Δn. Δt = (1/3. (n)^3 - 1/2. (n)^2). Δt.

For ta/t0 >> tb/t0 >> 1, and with #n(tb) >> 1, there is ΔEs is quadratic in n, where n = #n, and linear in ν.

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

A time interval only version of a qm measurement of wave function properties is described, while the stationary property remains valid, in par. 1.6 and for interaction discussing zero temperature, par. 4.2. With energy relation Es ~ ΔEs = #n. *h*. ν, this was discussed, among other results, to find energy density ϱ = α/β. ν^2. T, with constants α and β, including frequency ν, and temperature T, in (Hollestelle, 2021), which originates from Planck's relation, for lower frequencies. Recall frequency ν and number #n are quantities that can only be measurable during a certain finite measurement event time interval, an argument of its own to consider, finite, time intervals instead of one moment time tangents.

1.6. Theorem on Averages

The relations from par. 1.5 quadratic in #n and quadratic in ν seem compatible when considering the assumption of countable properties, one for the simultaneous wave emission propagation surface, i. e. for counting simultaneous space like occurrences, and for counting in time, i. e. counting simultaneous time like occurrences within a time interval. This is a unexpected measurement dependent approach and result, which can be applied to support the theorem on averages, an approach not mentioned in e. g. (Arnold, 1989).

The theorem on averages implies equivalence of integration over space and time within space time phase space and is usually introduced within textbooks on mathematical mechanics, e. g. (Arnold, 1989).

 doi:10.20944/preprints202509.0057.v1

Space time considerations, e. g. Lorentz transformations, seem to be overall related to the development of this theorem, that appears similar to equilibrium with generalized coordinates. The time interval version for the theorem on averages has value for the discussion of many equilibrium related concepts, e. g. measurements in physics, of qm phase space, entropy change, and Noether charge.

Another argument related to the theorem on averages is the time interval description itself. Simultaneous space like and time like parameters are related by assuming time interval description equilibrium, independent from 'one value' one moment time coordinates and one moment time description equilibrium, such that a 'discrete' concept for space time is not necessary. A discussion of qm and discontinuity can be found in (Beller, 1999). Newton's approach applies the center of weight concept which seems useful for the tangent method in ordinary one moment time 3+1 space time to reduce multiple coordinates to one value space time coordinates (Newton, 1729). The one moment time description and time interval only description are introduced together in earlier papers, correspondence to relate these descriptions is introduced in (Hollestelle, 2024).

Stationary Events

The term 'stationary' implies a 'stationary event property' where a possible interaction variance for the energy is considered to be much less, infinitesimal with respect to the energy itself, (Merzbacher, 1970). This can be applied to a measurement event including wave function reduction, introducing two different time intervals, one to describe on-going wave propagation invariance and one to describe interaction and the measurement event. A universal stationary event, also without interaction or measurement, implies invariant entropy.

The description of a stationary wave emission event and a wave function collapse measurement event for wave emission propagation within the time interval description originates from (Hollestelle, 2021). The assumption of the occurrence of stationary wave 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, defined 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 resultants collecting procedure, which is part of the operational type of interpretation of qm, relating to the EPR argument, (Roos, 1978), (Omnès, 1994), (Beller, 1999).

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 for a specific qm measurement event, (Roos, 1978), (Van Kampen, 1988). The discussion how experiment and phenomenon influence each other within or outside physics, is not the subject of this paper, neither is meant the discussion of sketches of laboratory situations which have been studied elsewhere.

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 '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.

Any event, including equilibrium time development and Hamiltonian time dependence, to change due to time development into a state with H time independence, implies reaching an asymptotic stationary event. This is consistent with the interpretation of Van Kampen related to reaching a macroscopic situation from a qm situation.

1.7. Preliminary Results

The Wave Emission Propagation Surface

Within *comment* B the construction of the example includes time interval description surface ΔPu, a union of surface parts ΔPi. ΔPu is constructed to be a covering of emission propagation surface ΔA. The Δ indicates 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 is with a combination transformation TU*I transformed to the regular square and successively by transformation TQ to a regular sphere ΔQ.

Propagation theorem 1. Any transformation TU*I is equal to the identity transformation. It's proof is included in the main part of *comment B*.

This property implies TU*I provides extra degrees of freedom by iteration of its application: transformations TU*I can be applied iteratively and an extra degree of freedom can be added to the description. The specific example surface and

ΔPu are introduced originally in c*omment B*.

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 wave propagation surface ΔA, remains fulfilled, meaning mΔPu' ≥ mΔA remains valid due to mΔPu ≥ mΔA. When surface measure is preserved this means any TU*I equals some specific Lorentz transformation TS. Surface measure preserving TS, different from the usual Lorentz transformations TL, are defined in (Hollestelle, 2021, 2024).

Propagation theorem 2. Any transformation TU*I, i. e. equal to the identity transformation, 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 B, par. B12(A4).*

Number of degrees of freedom. Due to the independent parameters introduced with construction 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 extra degrees of freedom: when introducing current parameters due to iteration and the dimensional domain definition. The mentioned interation for TU*I applies to introduce an extra degree of freedom. The reduce the domains of the current parameters applies similarly to an extra degree of freedom, *comment B, par. B3* and *B8*. In this way D can be considered to increase, however not to D infinite, which would imply a transition to a Newtonian description. When introducing (a-)symmetry with parameter N, i. e. the number of surface parts ΔPi for the example propagation surface

ΔPu, and when introducing lower bound temperature ΔT_zero, both can be applied to provide an estimate for the actual number of degrees of freedom D, par. 4.3.

Gravitation Constant, Describing Energy with Wave Emission Energy or Gravitation Energy

Derived is within the time interval only description, the gravitation constant is |g| = mΔt = mΔNC, while ΔNC is the time interval Noether charge. Simultaneous qm wave emission energy and gravitation energy are interpreted to be equivalent and represent the same energy with two different interaction constants.

In *comment A*, eq. A1, introduced is wave propagation surface energy ΔE = ΔEg = M[Δqi, M[m1, m2]], equal to ΔE = ΔEs = M[*c*(Δt)i, M[Δm1, Δm2]] with *c*(Δt) = [Δq, Δti], the former energy allows for the interpretation of Δm2 to be a gravitational mass, the latter allows to consider a finite group-velocity *c*(Δt) to be of wave emission origin. Δm1 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*(Δt) = M[Δq, Δti], implies multiplication with a quantity, indicated with ΔEm and equal to Δt, and since Δt = ΔNC, with ΔEm equal to the time interval Noether charge. There is M[ΔEm, ΔEs] = ΔEg and M[ΔEmi, ΔEg] = ΔEs, with ΔEmi time interval multiplication inverse for ΔEm, which indicates ΔEm is a time interval energy due to the multiplication closure theorem derived in part 1.

The time interval description wave emission constant Δv, with zero or non zero mass wave particle, equals Δt, and the time interval description gravitation constant Δg = 'multiplication unit'||Δt from the above expressions, and trivially Δg = M[ΔEm, Δv]. Set units including the time interval unit 'multiplication unit'||Δt are defined and discussed in par. 7.

From multiplication factor ΔEm = Δt it follows 2-dim. expressions [ΔEgi] = [*h*+, ΔE], and [ΔEsi] = [*c*(Δt), ΔE] with i = 1, 2, can be included into a 4-dim. quantity ΔE4(s, g) = [[ΔEsi], [ΔEgi]], the i = 1, 2, instead of indication i meaning multiplication inverse. In this way an internal transformation is enough to define the two energies ΔEs and ΔEg to be the transformed of the other. ΔEs and ΔEg both equal ΔE = M[Δm1, Δm2] where h+ and c(Δt) equal 'multiplication unit'||Δt = Δt, derived in *comment* A. This allows the interchange of Es and Eg within average brackets, when the average is over the same set ΔE_set. This results in the following relations for the one moment time and time interval energy parameter set.

< Es >||ΔE_set = < Eg >||ΔE_set

< ΔEs >||Δt_set = < ΔEg >||Δq_set

From 4-dim. time interval quantity ΔE4(s, g) = [ΔEsi] x [ΔEgi] and resultant ΔE'4(s, g) = Oij* [ΔE4j] due to transition or interaction, which follow from, e. g. particle decay description, with the usual conventions for matrices ε and δ, and transition tensor ΔZ4 with scalar parameters L1 to L3, (Veltman, 1974). Within the time interval description one finds, from eq. 1, (indices ijkl, writing upper and lower indices all with lower indices, for reading purpose).

ΔZ4ij = M[ΔE'4i, Oij*[ΔE4j]] = < L >. A[m[ΔEsi], m[ΔEgi]]. δij = < L > M[ΔE4, ΔE4] =

= M[M[ΔL, Δg], M[ΔE4, ΔE4]]

With interaction tensor Oij = L1. δij + L2. εik. δkl. εlj + L3. εik. εkj, there is Oij = < L >. δij, considering the usual symmetry properties of the matrices ε and δ. When Oij is the 4 x 4 matrix element for the transition with invariant trace Tr[Oij] = 4. < L >, there is ΔL = < L >||Δt. Δt. The time interval multiplication factor ΔEm, the 'multiplication unit'||Δt, is equal to Δv = Δt when ΔEm = M[ΔEg, ΔEsi] and ΔEm = M[Δg, Δvi], the wave emission constant Δv being to ΔEs what Δg is to ΔEg.

The transition parameter ΔZ4 does not have to be necessarily invariant depending on properties before and after transition, e. g. zero or non zero mass for the wave particle, meaning change of Δm1 or Δm2.

Another way to describe the transformation follows from the 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. Indication Δt_set indicates the complete time interval only set, etc.

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, 2024). Conservation of energy is achieved for scalar a2 = 'multiplication unit'||a_set, par. 4.2, par. 6, and Δq = Δt, and then a2 equals the multiplication factor ΔEmi = ΔEm from ΔEg = M[ΔEm, ΔEs]. Time interval wave 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[m1, m2].

Gravitation Constant, Wave Emission Properties and the Wave Emission Propagation Surface

Due to the construction of example surface ΔPu with N ≥ 1, it follows overall equation |Δg| = |mΔPu – 1/N| = |mΔt - 1/N|, which includes a relation for mΔt and mΔq, and includes the specific case N = 1.

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 = |M[|Δqi|, ΔNi]| and |Δq| = |A[|ΔNi|, mΔPi].

One applies the relation mΔPi = mΔPu, included in *preliminary propagation theorem 3,* 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 propagation theorem 3* seems contradictory recall the ΔPi are open, disjoint surface parts of closed continuous example surface ΔPu.

Comment 4. The gravitation constant value ǀΔgǀ equals ǀ'multiplication unit'ǀǀΔt ǀ = ǀΔtǀ = ǀΔNCǀ, i. e. ǀΔgǀ 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, par. 6.

Comment 5. Within the time interval only description, ǀgǀ = ǀΔtǀ is a direct argument for the indivisibility or unit property for gravitation constant ǀgǀ, since distributions do not exist for Δt, *comment* 23.

Wave particle energy ΔEw = M[D*ǀǀΔq [Δt], Δm2] = *h*. ν when Δm1 = 'multiplication unit'ǀǀΔt, valid for zero mass wave particles, photons, *comment A*. It follows ǀΔqǀ = ǀM[Δm2, Δm2i]ǀ = ǀ'multiplication unit'ǀǀΔt ǀ = ǀM[Δm2, ΔNCi] ǀ= ǀΔm2ǀ when N >> 1, which is an approximation for the time interval space like measure ǀΔqǀ = ǀΔqiǀ, i indicates 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 gravitational mass, inferred to be similar to a type of renormalised source mass. The overall relation is, from *comment B*, par B12(A6).

ǀΔEwǀ = ǀ*h*. νǀ ≤ ǀ*h*+ǀ. ǀ*c*(Δt)iǀ. ǀΔqǀ = ǀ*h*+ǀ. ǀ*c*(Δt)ǀ. ǀmΔA/N – 1/(Z+1)ǀ

This relation implies the specific value ǀ*h*. νǀ = ǀ'addition zero'ǀǀΔtǀ for certain mΔA = ǀmultiplication unit'ǀǀΔt ǀ, and is a possible solution when (ǀ1/N – 1/(Z+1)) = ǀ'addition zero'ǀǀΔt ǀ.

From this it is derived ǀΔgǀ = ǀ1/N – 1/(Z+1)ǀ. ǀΔNCǀ, where N and Z+1 are construction parameters, *comment B*. A continuous domain for ǀΔgǀ can occur when N or Z both >> 1 and approximately infinite, however due to construction requirements, parameter Z has to remain finite. This does not prevent any value for ǀΔgǀ can be reached within any sufficiently small margin. The time interval measure ǀΔgǀ = ǀ'multiplication zero'ǀǀΔtǀ is reached for ǀ(1/N – 1/(Z+1))ǀ. ǀΔNCǀ = ǀ'multiplication zero'ǀǀΔtǀ when ǀ1/N – 1/(Z + 1)ǀ = ǀ'addition zero'ǀǀt ǀ regardless the value of ǀΔNCǀ including ǀ'multiplication zero'ǀǀΔtǀ. Within the one moment time description, which applies to N and Z, 'addition zero'ǀǀt = 'multiplication zero'ǀǀt. This time interval measure ǀΔgǀ does not necessarily imply the one moment time measure ǀgǀ equals ǀ'multiplication zero'ǀǀtǀ = 0. t0 since *preliminary propagation theorem 3* does not apply in this case.

Non Zero and Zero Equilibrium

Introduced in par. 3 and 4 is the concept of non zero equilibrium. Non zero equilibrium can be transformed into zero equilibrium, the usual equilibrium, by introducing an un-known and yet un-interpreted time interval energy ΔdU, while the corresponding one moment time energy dU(t) is variable with one moment time parameter t, or it is an acquired energy, e. g. gravitation energy, acquired since variable with one moment time 3-dim. space like coordinate q. The un- interpreted energy can be an addition to gravitation energy ΔEg, thereby altering equivalence with wave emission energy ΔEs, or ΔdU is a new energy independent of wave emission energy or gravitation energy, which is a different occurence. Both ways, however different, can imply an acquired mass.

Zero Temperature

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

Paragraph 2. Time Development and Wave Propagation

2.1. What Is Time Development? Time Development and the Functions of Addition and Multiplication

To describe change within the usual one moment time description, derivatives depend on addition and the method of tangents (Newton, 1729), (Goldstein, 1950), (Arnold, 1989). One moment time Lagrange 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 like 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 introduced within the time interval description, (Hollestelle, 2020, 2024).

Due to the existence of unresolved difficulties with the one moment time description and the method of tangents, the time interval description is introduced to be an alternative. In a number of papers this alternative is discussed including how it relates to quantum mechanic field theory (qm) and to general relativity (GR). The following properties for time development applying the time interval only set, independent of the one moment time description, are derived in (Hollestelle, 2022, 2024). Time interval description equilibrium depends on the 'mean speed theorem' including the graphical method originating from medieval researchers, and in this paper termed 'mean velocity theorem' MVT, (Hollestelle, 2020).

To describe time development it is argued (Hollestelle, 2024), 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 includes the property: any finite time interval 'addition' the same finite time interval, remains the same finite time interval.

1 A[Δt1, Δt1] = Δt1, for any time interval Δt1

Δt1 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' | | Δt = Δt0 such that A[Δt0, Δt1] = A[Δt1, Δt0] **=** Δt1. For sets with finite, i.e. asymmetric, time intervals, implying H time dependent, there is Δt0 = Δt. It is derived, (Hollestelle, 2024), 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.

2.2. Time Intervals

Consistency for any time interval depends on relation eq. 2, for finite time intervals Δt1 = [tb, ta], introduced in (Hollestelle, 2020). This relation does not define a causality relation for tb and ta. The one moment time parameters t = tb and t = ta belong to the one moment time description where time development implies tb << ta. Coordinate q is the one moment time description 3-dim. space-like coordinate q(t), part of the usual 3+1 dim. covariant space time coordinate q4 = (q, i*c*t), similarly in par. 2.4. Due to equilibriumq(t) is dependent on one moment time parameter t, while invariant scaling quantity n_ is defined such that scalar product (n_. q) remains dimensionless, where the value | n_| can be chosen as a scaling parameter for 3-dim. one moment time space like space time 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. When Δt1=[tb, ta] is defined from eq. 2, this implies it relates to space-like interval Δq1 = [q(tb), q(ta)]. The one moment time parameters tb = tb(ta) and ta are defined starting from certain 'elements' [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. 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 with eq. 2.

 doi:10.20944/preprints202509.0057.v1

From the definition of parameters being related to eq. 2, one can not 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, 2024). 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 addition zero, 'addition zero' | | Δt = Δt, with A[Δt1, Δt] = A[Δt, Δt1] = Δt1. There is correspondence Δt ~ 0.t0 where 0.t0 + t1 = t1+ 0.t0 = t1. Within the time interval only description, MVT equilibrium assumes Hamiltonian ΔH and Lagrangian ΔL are related by the same Legendre transformation as H and L in the one moment time Lagrange equilibrium description, (Hollestelle, 2021).

2.3. Wave Propagation, Parameters, Time Interval Only Description

Assuming wave propagation group-velocity *c*(Δt) = M [Δq, Δti] invariant during Δt, *c*(Δt) is a time interval quantity linear in Δt, with M indicateing time interval multiplication. Space-like time interval quantity Δq relates to relevant event time interval Δt, including measurement events for deriving *c*(Δt).

Theorem 1. To resolve the multiplication dimension problem (MDP). Any space-like time interval quantity ΔA1 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 1c, par. 3.8, and derived in (Hollestelle, 2024).

Comment 6. For instance space-like time interval Δq1 = M[Δq1, Δt] = a1. Δt, since time interval only set 'multiplication unit' | |

Δt = Δt0 = Δt, and for Δq1 = Δq there is a1 = *c*(Δt) considering Δt finite. Assumed is the first associative, series, multiplication property (series), M[M[Δt1, Δt2], Δt3]] = M[Δt1, M[Δt2, Δt3]]. The problem of theorem 1, (MDP), can be reduced to the dimension problem t1. t0 = t0. t1 = t1 for any one moment time parameter t1, where t0 = 'multiplication unit' | | t, and Δt0 ~ t0, (Hollestelle, 2020, 2024).

Star source wave propagation is assumed to imply a limit spherical symmetric surface A, meaning the wave propagation space like limit for waves emitted and 'on the way' simultaneous, from the star source within time interval Δt, depending on Δt and *c*(Δt), discussed in par. 2.4. For star source emission there remains a wave composition for emission symmetric in all directions, where qm relations energy E = *h*. ν and complementarity relation wave momentum p = *h*. k 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 wave momentum *h*. k with 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 wave propagation surface energy ΔEs = #n. *h*. ν equals ΔNC = #n. *h*. ν, corresponds with the invariant one moment time Noether charge, where ΔEs equals the relevant event time interval, i. e.

Δt = 'multiplication unit' | | Δt, being non-divisible and defining simultaneous wave propagation.

Time interval quantity ΔNC refers to simultaneous wave function energy #n. ΔEw = #n. *h*. ν, instead of to wave propagation surface energy ΔEw for one wave-particle. This applies for zero mass photons, and multiple addition of photon mass remains 'addition zero' | | Δt. The time interval wave propagation 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 emission cloud, ΔEs is the relevant phenomenon in physics, a cosmological unit, related to collective simultaneous wave propagation and energy for Δt. Time interval energy density ΔEw = *h*. ν remains un-known unless through some measurement event or wave function collapse event, occuring with e. g. the photo-electric effect.

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

The property simultaneous can be defined for time interval Δt' related measurement events, depending on Δt' being 'timely', which is assured by Δt itself being 'timely', while Δt' occurs during

Δt, (Hollestelle, 2020). 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, 1952). 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, due to 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 itself 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, 2024).

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 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, 1980). They derive e.m. field equations from the Lagrangian and the action principle, to decide on time reversal properties in terms of Lorentz transformations. Their approach is not an approach within GR.

Within the qm version of the time interval description for equilibrium MVT 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 with respect to time reversal, 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, 2024).

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 MVT equilibrium is 1- dim. and does not allow the canonical property for addition or multiplication, a property that could relate 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'.

When through some process 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 description with MVT equilibrium means linear and canonical infinitesimal time development equations and does not allow time reversal symmetry, (Hollestelle, 2024). Within general relativity (GR), equilibrium time development equations are quadratic, i.e. nonlinear, (Jauch, Rohrlich, 1980). Recall 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 Δti = Δt.

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, 2024).

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 = τ, due to invariance for the traditional e.m. field equations, is nonlinear and follows Kramers equation, τ*[q4]. τ*[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 indication . implies inner or scalar product. Within the time interval only description, Kramers equation is M[τ*[Δt1], τ*[Δt1]] = M[Δt1, Δt1]. Solution τ*[Δt1] = -1. Δt1 for any Δt1, 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 τ*[Δt1] = Δt1, implying τ equals the, linear, identity transformation. This time interval description τ does not agree, following correspondence, with the traditional one moment time solution τ*[q4] = τ*[(q, *ic.* t)] = q4′ = (q, -1.*ic.* t). This is not the identity transformation, however when squared is a solution that equals identity, τ*τ*[q4] = q4 and τ*[q4]. τ*[q4] = q4. q4, (Jauch, Rohrlich, 1980).

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 transformation or operator 'working to the right', not is meant Hermitian conjugate *. With e.m. field theory with field variables A and A′, one finds τ*τ*[A] = A and τ*τ*[A′] = -1. A′, within the one moment time description. Due to these properties a 'super selection' rule decomposes A, A′ overall phase space and is complete and indefinite (Jauch, Rohrlich, 1980).

Within the time interval description, the wave equation is D*||Δt*D*||Δt*[ΔNC] = ΔNC, (Hollestelle, 2024). Within this description the difference for the two equivalent energies ΔEs and ΔEg depends on the group-velocity c(Δt) = M[Δq, Δti], where Δti = Δt, while one moment time description (dt)i = -1. dt. The wave equation can be written including I*||Δt instead of one of the D*||Δt, 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(Δt) and Δq within the equations for ΔEs and ΔEg, *comment A,* meaning c(Δt) = M[Δq, Δt] invariance differs from Δq non invariance due to Δt dependence. The Dirac equation is linear in D*||Δt 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 and D*||Δt resp. within the one moment time and time interval description.

2.5. Wave Propagation Surfaces

An example for a spherical symmetric wave propagation surface, approximation to a realistic wave propagation surface, star source emission dependent, is discussed in *comment B*. Assumed is time development of wave propagation surfaces depends on relevant event time interval Δt and wave group-velocity *c*(Δt). Starting from stationary state properties, a time interval description for wave propagation was introduced in (Hollestelle, 2021), where it was derived surface energy is equivalent to wave emission energy following usual qm field theory, although including zero and non zero mass wave complementary particles, and is similarly equivalent to gravitation energy.

The time interval version, with surface energy for wave propagation 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 wave emission energy with the time interval description version of qm, introduced is necessarily the

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

requirement 2-dim. space like surface measure mΔA(Δt) to remain invariant for variable Δt, to maintain energy conservation within time development, (Hollestelle, 2021, 2024).

2.6. Example Approximation Surface for Spherical Symmetric wave Propagation Surface ΔA Parametrization

For wave propagation surface ΔA, assumed is approximation surface ΔPu, a union of a variable number 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 itself. More specific, parameters for the 2-dim. surface parts ΔPi are: parameter w(t^^), domain limit for w^^ domain dw = [w0, w] 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. 1.5 and in the next paragraph on time development.

Time Development

For the 'object', one moment time description 'surface part Pi', parameters w(t^^) and t^^ are assumed not to depend on one moment time parameter t, not to depend on 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 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.

Construction of an Example

The variable number N allows for a new construction II for approximation surface Pu, introduced in *Comment B*. It is an example approximation for a wave propagation surface, starting from the 2-dim surface parts Pi and union Pu and a transformation applied to transform Pu to the regular sphere Q while mPu ≥ mA is the covering least requirement for Pu to be a covering for A. The regular sphere is the most simple spherical symmetric wave propagation surface due to star source emission, i. e. symmetric in all directions, and this remains even though the introduction of the qm photon wave function concept c.q. wave particle equivalence and the photo-electric effect explained with photons, (Beller, 1999).

Construction II resembles well-known construction I for which N = N0 invariant, and applies a theorem from topology for indecomposable media to argue the resultant is a covering for the wave propagation surface, (Hocking, Young, 1961). 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 wave propagation surface A, depending on the identity transformation in two dim. An addition to the fundamental theorem on polynomial equations, mentioned in par. 1.2, relates to this identity transformation, and in comment B, par. B12(A7), theorem B8.

Interpretation A: Symmetry Transformation with N Changing, Interpretation B: Zero Temperature

With Δt and A(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. Least requirement for union surface Pu to be a covering for regular sphere Q(Δt) and wave propagation surface A(Δt) is, surface measure mPu ≥ mA. Time interval Δt is left out of indications, for simplicity, in the following.

Two interpretations are mentioned in (Hollestelle, 2024). 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 Pu remains a covering for wave propagation surface A. 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 unspecified energy is necessary, this is discussed in par. 3, starting from the concept of closure of non zero equilibrium introducing acquired energy.

Interpretation B: implied is *zero temperature* for wave emission, discussed in par. 4. A star source emission cloud within the time interval description including overall and zero temperature is applied in par. 3, and par. 4.

2.7. Results: Symmetry Transformations Symmetry Transformations

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

When ΔPu is the union of all ΔPi, 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, or A for addition for time interval quantities. 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 including one moment time quantities P(i=1) and P(i=2) follows from the expression including 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 mΔPi = m(Δw(Δt^^) x Δt^^) = mdw. mdt to define all possible domain dΔw(Δt^^) and dΔt^^, for ΔPi. Similarly N is variable with w and tlim^^ when invariance of measure mΔPu is regarded, such that mΔPu = N. mΔw. mdt remains invariant.

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[ΔP1, ΔPN-1]] = A[ΔPN, ΔP1] = ΔP1 due to A[ΔP1, ΔPi] = 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 Pi, 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 Pi for A(Δt), for all N, and due to this result, there is time interval measure mΔPu = N. mPi ≈ 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 mQ, and independent of N. These arguments result in the following *preliminary propagation theorem 3*.

Preliminary propagation theorem 3. The surfaces ΔPu and ΔP(i) for all i ≤ N fulfill the covering least requirement RS for surface A(Δt). Surface measure mΔP(i) = mΔPu ≥ mQ, required is invariance of surface measure mΔP(i=1) during addition of successive ΔP(i). The result is valid within the time interval only description.

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

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

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 mPu = mPi, 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 equilibrium dependent parameters during Δt', which is discussed in par 1.2, and par. B12(A4).

2.8. Parameters and Completeness

Not necessarily, when contruction II is applied to find an approximation example for a spherical symmetric wave propagation surface, which is a fundamental phenomenon in physics, it includes a hidden symmetry or hidden parameter. The parameters needed to describe surface parts Pi and the example construction, are defined in *comment B*. Hidden parameters are those that are not field variables. It is not investigated whether the parameters with construction II are complete or are sufficient to create a 'path' narrative for qm.

The Example Construction

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], and d2 dimension parameter t^^ with domain dt = [t0^^, tlim^^]. Both the limit tl^^ and tlim^^ are infinite. By changing limit tl^^ to tlim^^ for domain dt the singularity at tl^^ can be solved, therefore parameter r is introduced, however r is not undecided. In *comment B* included are the covering least requirement for r and the other free parameters.

There is, ΔNC is 'multiplication unit'||Δt and equal to 'addition zero'||Δt 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 surface wave propagation energy ΔEs, however change of N implies possibly change for parameter Δw and other parameters and for 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 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 emission cloud collective.

Current Parameters

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.

1.4. However it seems not valid averaging one moment time current parameter w during time interval Δt, since surface part Pi being a real factual surface part is assumed to remain time independent. One can write ||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 during Δt^^ which itself depends on averaging with Pi for 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 the same for Δw ~ w. Including these comments, one derives:

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

The average for wi, wi0 = < wi >| |Δt^^ or wi0 = 'multiplication unit'| |Δt^^, can be expressed in terms of parameter r, assuming mD1 = 'multiplication unit'| |t^^. When during Δt^^ the parameter wi remains asymmetric while wi0. w differs from wi0, and wi0. wi = wi. wi0 = wi can be defined non trivially valid, one finds wi0 = 'multiplication unit'| |Δt^^, due to the definitions for units and zero's in (Hollestelle, 2024). 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. Interpretation A. (A-)Symmetry, Zero and Non Zero Equilibrium and Acquired Energy

3.1. Star Source Emission Cloud

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

With an emission cloud from star-sources 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 equilibrium time development, define with i.*c*. t the usual 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 wave propagation surface A, when chosen is q0 remains at A(Δt). By definition q0 = 'addition zero'| |q 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 matter of extensive research within astrophysics, which is within the usual one moment time description, (De Theije, e. a., 1995), (Hollestelle, 2017b).

Star-sources are emission sources, together they are assumed to one collective source for wave propagation including collective wave propagation 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 wave propagation surface A changes from A(Δt') to A(Δt''), 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), Zero Equilibrium

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 ~ ΔQ0 = '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 ~ ΔQ(n) - ΔA(n) = ΔU0

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 of Emission Wave Energy and Gravitation 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 overall wave propagation 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 cosmological 'volume' ΔR3 ~ R3 which then should equal a unit, 'multiplication unit'||Δq. This depends on time interval description eq. 1. Thus, mΔR3 equals mΔq = mΔt, measure for

Δt = 'multiplication unit'||Δt.

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

Eg = M[1/|Δq|, M[m1, m2]] = D*||Δq*[M[m1, m2]], and Es = A[1/|c(Δt)|, M[m1, m2]] = D*||Δt*[M[m1, m2]]

where the first expression refers to time interval gravitation interpretation energy ΔEg, the second one to time interval qm emission wave interpretation energy ΔEs = #n. ΔEw = #n. *h*. ν. Two related expressions are 'apparent emission density' Δm2, and 'apparent wave density' Δm1 = *h*. ν, both in terms of density, while energy measures mΔEg = mΔEs imply two different interpretations with the same energy value. Due to the unit value of universe volume measure mΔR3 = mΔt these time interval densities equal quantities, apparent emission mass Δm2 and apparent wave mass Δm1 = *h*. ν.

Comment 11. The existence of time interval 'addition zero'||Δq can be assumed, independent of existence for the one moment time set 'addition zero||q, 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 equilibrium and time interval addition properties.

The following theorem is valid due to regarding eq. 4 to be an equilibrium equation rather than a equation with zero value result.

Theorem 2. Correspondence canonical property. Due to regarding eq. 4 to define equilibrium, and applying equilibrium theorem c, which originates from (Hollestelle, 2017), 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.

Comment 12. For e.m. wave propagation with 'zero' complementary particle mass Δm1 = Δm0 = 'addition zero'||Δm, it follows wave emission energy ΔEs = A[*c*(Δt)i, Δm2] = A[Δqi, Δm2], which can be interpreted to be *apparent emission density Δm2 = #n. h. ν*. Wave group-velocity *c*(Δt) = M[Δqi, Δm1], with Δm1 = 'multiplication unit'||Δm and *c*(Δt)i = Δqi, can be interpreted to be *apparent wave group density Δm1 = h. ν*. The time interval mass quantities Δm0 = 'addition zero'||Δm equals Δm0 = 'multiplication unit'||Δm, which is rather similar, however not necessarily, to Newton's equivalence relation for gravitation mass from weight, and slow mass from acceleration, (Newton, 1729).

Including a non-zero mass Δm1 one finds Δt = M[Δm1, Δm2] and ΔEw 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 object energy change during free fall, implying gravitation and kinetic energy exchange.

 doi:10.20944/preprints202509.0057.v1

Recall field energy requires some type of change to be meaningfull, the field wave. Wave energy, within the wave interpretation of qm, for free waves without interaction, depends on the frequency momentum relation described by wave density functions for dispersion free, stationary events (Hollestelle, 2021). This situation can be interpreted to imply 'zero' temperature, par. 4. Some of these relations, e. g. internal interaction, are discussed in *Comment A*, and originate from (Hollestelle, 2021).

3.4. Kinetic Energy and Acquired Energy

From Newton's second law retained is d/dt*[p] = -1. ∂/∂q*[U], with p and q generalized coordinates within the one moment time description and acquired energy U. Acquired energy U occurs due to coordinate dependence of energy, the term acquired since an object occurs within space-time. Change of one moment time space like coordinates means a change of U explaining the usual term potential or non-mechanical energy. This is the conservative system energy description to include kinetic energy T quadratic in one moment time coordinate p for a one particle situation.

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 wave energy equals ΔEs, wave particle energy ΔEw = *h*. ν 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 describe the *same* energy ΔEs. This depends on the non distribution property for Δt, par. 5, comment 23.

Usually and in general in any one moment time description T is considered quadratic in p, however in the time interval description ΔT quadratic in Δp implies, due to conservation of energy and due to eq. 1, conservation of time interval 'velocity' Δx ~ x, with one moment time quantity x = d/dt*[q] defined from Newton's second law, rather than conservation of momentum Δp = M[Δm1, Δx], including mass Δm1 of the wave-particle, possibly a variable. This seems to imply a change of mass Δm1 does not change time interval kinetic energy ΔT. Velocity Δx to be a constant of the motion, does not imply Δx invariance during transformations of coordinate systems, however during space time coordinate transformations due to time interval equilibrium time development. The relation of Lorentz transformations, including covariance conservation, with equilibrium time development, depends on the commutator relations of time intervals, defined in (Hollestelle, 2024), discussed 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 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 particle concept, while localizable properties are expected to exist after measurement, i. e. after wave function collapse. The time interval description of wave function collapse and measurement events was introduced in (Hollestelle, 2020). Kinetic energy ΔT = ΔEs equals the wave propagation surface energy unit 'addition unit'||ΔE, 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, 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 = 'addition zero'||Δt.

3.5. Non Zero to Zero Equilibrium with a Situation Change Energy dU

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-*)

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

= 'addition zero'||E in the (no-*) situation, while dU* not necessarily equals 'addition zero'||E* in the (with-*) situation. This is the one moment time description.

Introducing energy dU* adiabatically 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.

<u>*Definition 2.*</u> *Non zero (no-*) to zero equilibrium (with- *) with new energy dU*.* The proposed, one moment time description, interpretation is, the original (no-*) situation describes energy with non zero, open, equilibrium and acquired energy dU* can be assumed to occur due to zero, closed, equilibrium in the (with-*) situation.

<u>*Comment 14.*</u> 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, 2024), derived was equivalence of the two ΔEs and ΔEg interpretations of the same energy, similar to equivalence within GR of gravitation and kinematic energy. Wave propagation surface energy ΔEs and gravitation energy ΔEg, with mΔEg = mΔEs, are both time interval expressions derived from the wave propagation surface description, par. 3.3. When some 'non zero' acquired energy ΔdU* is necessary for zero equilibrium, this can imply equivalence falls short.

Interpretation A for ΔdU*

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

Change of eq. 4 (no-*) and eq. 5 (no-*) and resultant ΔU0 and ΔEs*, i. e. change to closure (with-*) with resultant 'addition zero'||E* = ΔU0*, means including ΔdU* within situation (with-*), while for (no-*) Lagrangian L = T - U does not close eq. 4 or eq. 5 to resultant 'addition zero'||E = ΔU0 or 'addition zero'||E = ΔU0*. Recall in this case (no-*) implies dU* = 'addition zero'||E = U0 and (with-*) implies dU* differs from 'addition zero||E* = ΔU0.

The Lagrangian L is applied to define zero or non zero equilibrium since it appears in the action principle, where for equilibrium, L is related to Q(n) – Q2(n) = 'addition zero'||E. The application of invariance of L to derive equilibrium equations is an accepted guiding principle within the 4-dim. covariant Lorentz approach, (Sakurai, 1978).

*3.6. Non Zero to Zero Equilibrium Due to Including Extra Energy dU**

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*= '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' -1/+1. dU*.

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

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

 doi:10.20944/preprints202509.0057.v1

zero’||E*, and due to L = T – U = T = Es, follows 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*. Addition inverse is indicated with iv, different from multiplication inverse indicated with i and star source parameter i = 1 to n.

6 Q(n)* – Q2(n)* = ‘addition zero’||E* = L* = L – dU*

7 Q(n)* – Q2(n)* ~ ‘addition zero’||ΔE* = ΔL* = A[ΔT, A[ΔU, ΔdU*]iv]

Comment 15. From eq. 4 to eq. 7 one can define 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 equilibrium resultant change should cancel, for variations to this zero equation equilibrium principle, since dU = ‘addition zero’||E and L* = L.

Applied, within eq. 7, is associative property (series property), par. 2.3. Time interval description eq. 7 depends on application of *theorem 1*, while time interval 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 equilibrium, time interval only description equilibrium is defined with the MVT theorem, 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. Solutions differ with description when H time dependent and Δt asymmetric and finite, where results for 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 with Independent Quantities Q’ and Q2’

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, 2024). In par. 3.5 the quantities Q and Q2 were defined being inter-dependent.

Assuming time interval 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’. When ‘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. Non zero to zero equilibrium (by accent) by addition 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 is not meant a physical change, rather a change of concept of description, from open equilibrium to closed equilibrium in both cases.

This paragraph includes several concepts that depend on the time interval only description. Introduced is a equilibrium type starting from a cloud of star sources, defined from the space like coordinates of individual stars in it. Then, introduced is wave propagation dependent energy in terms of Noether charges. An equilibrium can be asymmetric, similar to the relevant event time interval Δt, where asymmetry is included within 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.

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 earlier discussed in (Hollestelle, 2020) and in *Comment A*.

Asymmetry is applied to describe wave propagation, regarding star source emission clouds and acquired energies, par. 3, and regarding zero temperature, par. 4. Independence for ΔQ' and ΔQ2' can be applied to the set of star-source time interval quantities Δqi which remain with the average < Δqi >||n unaltered with ΔQ(n) equal to ΔQ'(n), while there is possibly a change ΔQ2(n) towards ΔQ2'(n) = ΔA'(n).

Similar to interpreting the occurence of (with-*) situation energy ΔdU*, one can argue the difference Q' and Q2' to become zero equilibrium to mean gravitation energy and wave propagation surface energy should be approached

independently within the (accent-') situation, i.e. energy ΔdU' is an un-recognised energy to give zero equivalence to ΔEg and ΔEs.

3.8. Theorems Related to the Time Interval Only Set

The time interval space-like Δqi, the variation of individual star-sources, is integral with wave propagation time interval Δt and wave group velocity *c*(Δt), responsible for the property simultaneous, and star-source emission from one star is considered to be simultaneous within Δt. It is assumed 'addition zero'||Δq = Δq0 exists and is well defined. Several theorems for the time interval set and star-source emission cloud can be derived, while partly dependent on theorems from (Hollestelle, 2024). *Theorems 1* and *2* are included in par. 2.3, and par. 3.3. They are repeated here for completeness.

Theorem 1. To resolve the multiplication dimension problem (MDP). 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*, and derived in paper 1, (Hollestelle, 2024). This is discussed also in *comment 6*.

Theorem 1b. All emission cloud 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, *theorem 4*.

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 Δy0 = 'addition zero'||Δy = 'addition zero'||Δt = Δt, applying *theorem 1b* and with Δy = D*||Δt[Δz], with time interval quantity Δz, while for any other Δy1(Δt) a similar equation, up to some scalar constant a1, 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 issue.

Theorem 1c. Due to *theorem 1b*, 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 3. According to (Arnold, 1989), equilibrium can be proposed to relate to invariance of some parameters where other and different parameters are variable, and in this way equilibrium can be included in and become part of Curie's principle for 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-source emission cloud center 'addition' any other emission cloud center, remains invariant and equal to 'addition zero'||Δq.

This seems however contradictory. It seems to imply a star-cloud 'addition' any one star-source, remains with the same, thus invariant, star-cloud 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. two the same, star-source emission cloud center Q1 and Q2, can be 'added' to each other to result in the un-changed center Q1 = Q2, according to this argument.

Theorem 3c. Within the time interval only description a union ΔPu of several ΔPi corresponds with excluding 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 a one multiple star-source emission cloud where double star entries are avoided. This means for time interval quantities, e. g. star-source emission cloud properties, theorem 3 is valid, even while the relativation by theorem 3b, the quantity, center in theorem 3b, have to be similar, does not apply.

Theorem 4. Multiplication closure theorem, originating from (Hollestelle, 2024): for any multiplication M[ΔA2, ΔA3] = A1, where ΔAi, i = 2, 3, are time intervals, a1 scalar, there is A1 = a1. Δt is time interval, implying closure of multiplication within the time interval only set. Multiplication linearity theorem, equivalent to it, is introduced in the same paper.

The multiplication closure theorem, is derived within the time interval only description for multiplication, however similarly valid for 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 5. There is an argument for the usual one moment time description definition of the 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. Definition of TDL: The thermodynamical limit (TDL) includes enlarging the complete 'system' with its overall volume V including the number N of objects occuring, however not the average value N/V or individual mass values (Fetter, Walecka, 1971) .

Theorem 6. Time interval set theorem, originating from (Hollestelle, 2024). 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 supported by time interval derivative and integral of any time interval quantity being equal in value similarly.

Theorem 7. Time interval complementarity relation. Due to the theorem on averages there is D*||Δt[ΔA1] = D*||Δq[ΔA1], and due to the wave equation D*||Δt*[D*||Δt*[ΔA2]] = ΔA2 implying 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 star source emission cloud. This suggests the usual complementarity relation, ΔEs = #n. *h*. ν and Ew = *h*. ν, is due to similar considerations. Within the time interval description structure constants and Noether charge are the same and follow both from the wave equation, disregarding the multiplication scalar, (Hollestelle, 2024).

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 GR and qm both, 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).

To render the theorems in this paragraph universal, depended is on the star source emission cloud properties being valuable reduction of a cosmological universe properties. *Theorem 2* is included in 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.

Correspondence of time interval derivative and one moment time derivative, D*||Δt[a1] ~ D*||t[a1], for one moment time invariant scalar a1, 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 wave propagation energy, proportional to wave propagation surface measure mA, which equals, due to eq. 1, wave propagation group-velocity c(Δt). Specific Lorentz transformation TS, preserving surface measures including mA, differs from the usual Lorentz transformations TL that preserve the metric line element, where ΔEs and ΔNC both remain TS invariant, (Hollestelle, 2024).

Paragraph 4. Interpretation B. Zero Temperature

4.1. Zero and Non Zero Equilibrium

For a change from (no-*) situation to (with-*) dU* situation with Hamiltonian H changing to H* = H + dU*, the extra 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 (series), and *theorem 6*, (Hollestelle, 2024). Within 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 equal to one moment time description energy 'addition zero'||t ~ 'addition zero'||Δt 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* effectively for any situation. Eq. 8 reaches closure, i.e. zero equilibrium, in the (with-*) situation through addition with dU*: H* = H + dU*.

8 H* = H + dU* = H0* + dH* = dH* = 'addition zero'||t* ~ M[Δp*, Δx*] = A[ΔL*, ΔH*] = A[ΔL, ΔH]

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

There is M[Δp, Δx] = M[Δp*, Δx*] = M[Δp, Δx]iv, and M[Δp, Δx] remains invariant 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 = 'addition zero'||t*.

Due to correspondence there is H0 = 'addition zero'||t ~ ΔH0 = 'addition zero'||Δt = ΔU0. From eq. 8 and with A[ΔH, ΔH*] = ΔH* there is A[A[ΔL, ΔH], ΔH*] = A[ΔL, A[ΔH, ΔdU*]] = A[ΔL, ΔdU*] = ΔdU* and:

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

Theorem 4b. Due to *theorem 4*, there is unit 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. This theorem is also included in par. 3.8.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

With eq. 8, and A[ΔL, ΔH] = 'addition zero' | | Δt*, and *theorem 4b,* it follows eq. 11. For space-like interval Δq and spacetime interval Δp, eqs. 12 are valid, i.e. the *canonical time interval MVT 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*.

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

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 wave propagation 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' or, similarly, indicates 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, 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, a 'frozen' situation, where however interaction is assumed necessarily to imply action and increased energy.

The dispersion free star source emission cloud is described, instead of with plane waves, with sphere-like propagation surfaces. This makes sense for a multiple star-source emmision cloud including simultaneous wave propagation, where no interaction is meant to imply continuous and invariant simultaneous emission from the star-sources and invariant simultaneous wave 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, 1978), (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 the emitted wave propagation, not is meant star-source temperature 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.

Wave Emission Propagation Energy and the Constant of Planck h

The simultaneous emission energy ΔEs is a multitude of wave function energy ΔE = *h*. ν, for wave propagation 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|, where variance can be assumed equal to weight function width, i. e. |Δ*k| = 2u, (Merzbacher, 1970). 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 m1 wave particle mass related to kinetic energy T, where zero temperature does not imply zero energy, due to application of averages. The third part of eq. 13 includes a singularity for m1 = 'multiplication zero'||m_set, e. g. for m1 equal to zero photon mass, 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 different from zero mass m1 = m0 photons.

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|

Equilibrium and Interaction Time Development

Comment 18. From the discussion in this paragraph one can infer that more symmetrical time intervals could 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 star-source emission cloud with independent Q'(n) and Q2'(n), with interaction implying change different from 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 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

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 (Hollestelle, 2024). In the same ref. is derived 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, 2024).

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. Zero Temperature and Star Source Emission Cloud Properties

A cosmology describing a star source emission cloud, where defined is a cloud propagation surface A 'nearby' all star sources, was introduced in (Hollestelle, 2021). For a 'fuzzy' cloud one defines the places qi for the star-sources, with qi + qbiv = ∂i and m∂i << mqb, qb the one moment time 3-dim. space like coordinate for the center of the emission cloud collective, indication iv for addition inverse, mqb = < qi >||n = < qb + ∂i >||n with i = 1 to n for n the number of star- sources. The term collective can indicate a singular or multiple cloud collective. Within this paragraph T indicates wave emission, or measurement, temperature, not kinetic energy.

There exists a transition temperature Tc, such that for T >> Tc there is |qb + q0iv| << qb infinitesimal, and for T << Tc there is |qb + q0iv| >> qb, with q0 one moment time space-like coordinate zero place, which is defined to be on surface A in par. 3.1, (Hollestelle, 2017).

The above reference is written within the one moment time description, and Tc is proportional with |qb|^4. Proceeding within the time interval description, one finds: mΔTc is proportional with mΔt^4, where there is mΔt^4 = mΔNC, applying mΔA = mΔt and mΔq = mΔt.

This can be combined with par. 4.2: Noether charge |NC| = mA^2 ~ ΔNC = M[ΔA, ΔA] = ΔA. One finds: T_cloud / T_star-source ~ < |ni| >||m. #ncloud / #nstar-source. The ni refers to the cloud (i) star source number, number #n refers to the star-source emission wave function number. The ni is to facilitate multiple clouds (i = 1, m) and originates from (Hollestelle, 2021), however is left to mean m = 1 and ni = n, i. e. one star-source emission cloud including n star- sources. When overall emission cloud zero temperature, to imply T_zero = 'lower bound' domain dT with T_zero = T_cloud = < |n| >||t = 'addition zero'||t = 0. t0, is not possible to apply, one can introduce time interval quantities with averages, ΔT_zero = ΔT_cloud = < |n| >||Δt = < t >||Δt = ΔU, following theorem 4b, which can be 'non zero', different from ΔU0, for Δt finite. The overall emission cloud zero temperature ΔT_zero result is, from theorem 9:

17 Δq_cloud(ΔT_zero) = M[Δq, Δq]_cloud = ΔNC_cloud = Δt_cloud(ΔT_zero)

This result is valid only within the time interval description. Applied is, *h*. ν_cloud = *h*. ν_star-source and m = 1, with n for the overall star-source emission cloud equal to the number n of star-sources.

Collective Emission Temperature T, an Estimate for Temperature Lower Bound

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 propagation surface, with the radius interval Δq_cloud = Δt_cloud, and *k* the constant of Boltzmann. One finds eq. 18 with time interval zero temperature ΔT_zero for the overall emission cloud 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 by 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 the star-source emission cloud, with one collective overall propagation surface, ΔEs = Δq, eq. 14, is proportional with Δt, 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 collective wave 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, and for emission temperature ΔT, linear with Δqi and Δt, this means ΔT_zero = ca. 0.50 K. Any degree of freedom adds ca. 0.5 K or ca. 0.4 10^(-4) eV value of energy to T_zero. The marges to these results are not derived. Applied constants are 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 propagation 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 emission cloud collective, similar to the resultant of theorem 3b, and 3c, par. 3.8.

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) meter = ca. 52 AE 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. 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 value zero and both finite, i.e. related to ΔU and different from ΔU0.

Paragraph 5. Discussion. Zero temperature

Zero Temperature

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-cloud emission wave propagation surface A. Time interval description temperature follows correspondence ΔT ~ T.

Wave emission temperature T is similar to a current parameter, par. 1.2, and can be assumed independent of 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 Wave Propagation Internal Interaction

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

<u>*Comment 20.*</u> 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 and symmetries remain complete and with similar zero transition elements.

<u>*Comment 21.*</u> 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 = Δt0 = ΔU0 differs from the H time dependent event, however rather consistent with finite asymmetric Δt with relation 'addition zero'||Δt = Δt0 = ΔU.

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

<u>*Comment 22.*</u> In this way any type of non zero mass wave particle emission propagation would appear to be zero mass particles, photons, at the emission limit, i.e. propagation 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 H remains time independent. Adiabatic energy transfer is an interaction where H remains time independent, at least stationary, with |Δ*dH|. 1/|Δ*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 energy invariance. Time interval Noether charge ΔNC equals wave propagation group-velocity *c*(Δt), 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 equilibrium time development derived in (Hollestelle, 2021).

From par 4.3, ΔT_zero = < |n| >| |Δt = n, for a singular collective with m = 1, which means T_zero equals ΔU0, for H time independent and Δt symmetric, however differently, T_zero equals ΔU = Δt for H time dependent and Δt asymmetric. The situation with m = 1 can easily be extrapolated to more complex star source emission from a multiple cloud collective with m > 1, due to theorem 3b and 3c, par. 3.8.

Thermodynamical Limit TDL and Reversability

In par. 3, propagation 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 propagation 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 propagation 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 propagation surface energy remains invariant.

Infinite time intervals are not well defined, for these time intervals < t >| |Δt = 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 gravitation energy fails since the infinite Δq and Δt, with H time independent, not allow external, only internal, interaction. Gravitation energy is inverse linear with Δq, *comment 9,* with consideration of the discussion from (Van Kampen, 1988), this implies an invariant ΔEs can change to ΔEg, while entropy changes similarly to ΔEg. Acquired energy, e. g. gravitation energy

ΔEg, does not contribute to entropy. For this theorem a consistency with Higss mechanism can be evaluated. This is possible also for acquired energy interpreted with an un-known phenomenon like dark matter.

This is consistent with the interpretation of emission propagation moving 'away from' and gravitation 'propagation' moving 'close' toward their resp. sources, i.e. to explain the occurrence of action at a distance meaning opposite propagation, Newton's third law. This subject is discussed within another respect in (Hollestelle, 2018).

Comment 23. Simultaneous distribution property

doi:10.20944/preprints202509.0057.v1

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

Any distribution for propagation surface A remains a covering for A and relates to the same time interval Δt, the time development for the complete surface A. When a distribution for the radius is interpreted with wave propagation towards surface A, writing from Qm to Q'm, this implies a distribution for time interval Δt, including a certain number of Δti different from Δt, which is not allowed since Δt is to remain invariant, it is the relevant event time interval for the complete surface A(Δt) defining simultaneity. Similarly, the complete Δt is not simultaneous with Δti when Δti different from Δt. Distributions are also discussed in *comment B6*.

Paragraph 6. Discussion. Integration Approach to the Time Interval Action Principle and 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 propagation 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, 1989), 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 derivative eq. 20 and 21 equals ΔdU = "addition zero" | | Δt = 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*+* is the operator version of *h*+, where the operator definition is in *comment B10*. Recall 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.

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. |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. Correspondence 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.

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 description defined in part 1, (Hollestelle, 2024), to which this paper is part 2. Due to the multiplication closure theorem, discussed with theorem 1 in this paper, any time interval quantity Δq1 can be written equal to a scalar multiplication to Δt: 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. One can specify units for several quantities 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, meaning H time independent and Δt symmetric and infinite, implies *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 Δp and Δq quantities, (Hollestelle, 2020)

Table 1. ΔU0 is not a well defined time interval, 0.t0 is not a well defined one moment time. Multiplication inverse Δti not well defined for Δt infinite.

averages	units	time interval set	time interval collective q set / wave particle mass set	time interval wave emission energy set
Asymmetric interval		Δt finite	Δm ~ < m >||Δt. |Δt|	
	'addition unit'||Δt			ΔNC = #n. *h*. ν = ΔEs
	'addition zero'||Δt	t0 ~ Δt0 = ΔU	ΔQ0 = A[ΔQ(n), ΔQ2(n)i] Δm1	M[*h*+, Δti] = ΔEs = M[Δm1, Δm2]
< t >||Δt = t0 ~ Δt0	'multiplication unit'|| Δt	t0 ~ Δt0 = ΔU = Δt	ΔQ0 = A[ΔQ(n), ΔQ2(n)i] Δm1	M[*h*+, Δti] = ΔEs = M[Δm1, Δm2]
	'multiplication zero'|| Δt	0. t0 ~ 0. Δt0 = ΔU0	0. ΔQ0 = A[0. Δt0, 0. Δt0i] Δm0	M[0. *h*+, Δti] = M[Δm0, Δm2]
Symmetric interval				
	'addition unit'||Δt			
t0	'addition zero'||Δt	0. t0 ~ 0. Δt0 = ΔU0	0. ΔQ0 = ΔQ0 Δm0	ΔE0 = M[0. t0, Δti] = ΔEs
< t >||Δt = t0 = 0.t0 ~ Δt0 = 0. Δt0	'multiplication unit'|| Δt	1. t0 = 0. t0 ~ Δt0 = 0. Δt0 = ΔU = ΔU0	A[ΔQ(n), ΔQ2(n)i] = ΔQ0 Δm0	ΔE1 = M[*h*, Δti] = ΔEs
t0	'multiplication zero'|| Δt	0. t0 ~ 0. Δt0 = ΔU0	0. ΔQ0 = ΔQ0 Δm0	ΔE0 = M[0. t0, Δti]

Comment A. Zero and non-zero mass wave particles

Assume a non-zero mass m1 for wave particles complementary to wave propagation, and introduce mass Δm2, dependent on mΔA and M[Δm1, Δm2]. Wave propagation surface energy ΔEs = ΔEg is linear with M[Δm1, Δm2] and inverse linear with Δq, or inverse linear with *c*(Δt) = M[Δq, Δti], the wave group-velocity, eq. A1 and A2.

doi:10.20944/preprints202509.0057.v1

A1 ΔEs = A[*c*Δ(t)i, M [Δm1, Δm2]] A2 ΔEg = M[Δqi, M [Δm1, Δm2]]

The addition A and multiplication M in these equations are equivalent within the time interval description and followed is with both equations writing M.

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. Masses m1 and m2 correspond with Δm1 and Δm2 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 to differentiate the wave emission energy ΔEs interpretation with A1, and the Δqi dependent gravitation energy ΔEg interpretation with A2, (Hollestelle, 2022).

The time interval description group-velocity depends on the space-time metric. 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) to Δqi = M [Δti, *c*(Δt)i], which equals *c*(Δt)i due to Δti = Δt, the multiplication unit'||Δt, and one finds, par. 3.3, eq. A1 and A2.

This does not mean mass m2 is assumed to be the mass of the star source. Δm1 or Δm2 remaining invariant does not mean derivatives D*||t[Δm2] or D*||Δt[Δm2] should be equal to 'multiplication zero'||Δt, from theorem 4b, par. 3.8. In the following applied is the equivalence I*||Δt1[Δt2] = M[Δt2, Δt1], with I*||Δt time interval integration, and D*||

Δt2[M[Δt1, Δt2]] = A[Δt1, Δt2], which was, together with other time interval relations, derived in (Hollestelle, 2020, 2024).

For e.m. wave propagation and a zero mass waveparticle, i. e. photons with Δmp = Δm1, there is Δm1 = 'addition zero'||

Δt = 'multiplication unit'||Δt = ΔU, and it follows ΔEg = M[Δqi, Δm2], and Δm2 = M[Δq, ΔEg] can be interpreted to be source related *apparent emission density,* writing otherwise, ΔEg = I*||Δq[Δm2], theorem 6.

With zero or non zero mass Δm1 wave particle, from *c*(Δt) = M[M[Δm1, Δm2], ΔEsi], group-velocity *c*(Δt) = M[Δm1, Δq] and Δm1 can be interpreted to be wave propagation related *apparent wave group density,* writing otherwise ΔEs = I*||Δq[Δm1].

Theorem on Averages

Densities mostly are interpreted to be qm probability densities, e. g. related to the wave function. Such a density is itself not measurable rather connected with some observable phenomenon, (Van Kampen, 1988). In the present paper, density refers to emission and wave group density, explaining the inter-dependence of both 'volume' mass and 'slow' mass, which at least derives from Newton, (Newton, 1729). 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 wave propagation emitted and 'on the way' during Δt, energy ΔEs for the #n multiple wave function is:

A3 ΔEs = #n. *h*. ν = M [*h*+, Δti]

This time interval expression for simultaneous emission wave propagation, originates from (Hollestelle, 2021). Wave function collapse and interaction due to one wave particle implies a change of energy ΔEw = *h*. ν. Recall in paper 1, 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*+. Wave propagation surface energy ΔEs = #n. ΔEw, without

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

interaction or wave function collapse during Δt, is an invariant during time interval 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, with which one can describe the star source emission cloud collective starting with time interval units.

Comment A1. 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 = < 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 A2. Multiplication with t or with 'multiplication unit'||t = t0, does not give a dimension failure since all one moment time coordinates t and t0 and multiplication t. t0 are defined with time elements [n] and [i] due to which results occur with one parameter, an addition of element values since they are counting values, to solve the multiplication dimension problem (MDP), (Hollestelle, 2020). From time element definitions one finds the correct multiplication and addition dimension results also for the time interval only set.

Comment A3. Including #n the number of photons, non-interacting wave propagation 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, where Δm1(i) = A[Δm1(i - 1), Δm1(i = 1)] = Δm1(i = 1), for i =1 to i = #n, iteratively, with Δm1(i) remaining invariant and equal to Δm1(i = 1) = Δm1 = 'addition zero'||Δm, the time interval 'zero' photon mass Δmp. This time interval result equals the one moment time result, Δm1(i = #n) = Δm1(i = 1) ~ #n. m1 = m1.

Correspondence

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

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, wave surface energy ΔEs = #n. *h*. ν = M[h+, Δti] = *h*+, and *h*+ = M[Δqi, Δm2] = Δm2.

Comment A4. For events where quantity *h*+ to approximate *h*, time interval Δt approximates symmetry and ΔH time independence, a result from (Hollestelle, 2020). This implies for a star-source emission cloud collective, discussed in par. 4.3, at a infinitely 'remote' distance qn, from average star source to measurement place qm, approximating infinity, wave propagation energy ΔEs = #n. *h*. *ν* approaches quantity Δm2 and similarly *h*+ ≈ *h* approaches Δm2.

Comment A5. One can derive one moment time Noether charge NC = mA^2, while it is implied propagation surface measure mA is proportional with m'. m, where m = m1 the one moment time wave particle mass and m' = m2 the apparent emission density (Hollestelle, 2021). Within the time interval description it follows ΔNC = M[Δm1, Δm2], due to eq. 1, consistent with ΔEg = ΔNC and *h*+ = M[h+, Δti] = D*||Δt[*h*+].

Frequency Change

One can give an independent estimate with the apparent emission density Δm2 for Planck's constant *h*. Such events are related to,internal interaction, with variable zero and non-zero mass wave-particle, which can include an observable effect due to frequency change.

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 (qn - qm) property 'remote' due to the relevant measurement place qm, and Q and Q2, par. 3.1, qm being at the wave propagation 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 mM[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.

Time interval Noether charge ΔNC = ΔEs = Δm2 = *h*+ when Δm1 = Δmp, the zero photon mass, a result derived in (Hollestelle, 2021): 'the infinitesimal Noether charges are equal to the infinitesimal derivative difference transformations'. These differences equal the second derivative, and this implies Noether charge ΔNC = *h*+ is the same as the time interval structure constants.

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 being an elementary particle in free motion, in this case |m1| is an invariant, and mass m1 remains independent with one moment time 4-dim. space time coordinates. Internal interaction for an out-going emission wave group implies a change of mass Δm(Δt) such that for Δt approximately infinite Δt', Δm approximately Δm1(Δt') = Δmp and frequency ν(Δt) changes to ν'(Δt').

Internal Interaction

Symmetry can be possible due to 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 can be due to internal interaction, assuming a continuum frequency domain. There is the example of change for apparent wave group density Δm1 = c(Δt) or for apparent emission density Δm2 = ΔEs, mentioned in (Hollestelle, 2021). The time interval quantities Δm1 and Δm2 depend on the 'multiplication unit'||Δt = Δt0 asymmetry where < t >||Δt = t0 ~ Δt0 = ΔU = Δt for Δt finite, such that time development can imply a change of asymmetry for the average value < t >||Δt = t0 and for Δt0 = 'multiplication unit'||Δt.

Comment B. Example approximation for the wave propagation surface

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

Wave propagation 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, where 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 current parameter t^ approaches current wise, starting from t^ = t0^, infinite limit tl^, while independent of one moment time parameter t and 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, construction I in this paper, (Hocking, Young, 1961), while the 2-dim. continuum represents A. Assumed is equilibrium time development with time interval Δt for wave propagation surface A(Δt) and all Pi(Δt), however Δt is left out for simplicity mostly. Recall time development was defined with the variable Δt in (Hollestelle, 2024), including time interval quantities that do not belong to the time interval only set, related due to time interval equilibrium MVT.

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, indecomposable continuum surface, similar to construction I. There is current parameter w, an indication for surface width of surface part Pi or, similarly, measure

 doi:10.20944/preprints202509.0057.v1

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 outer-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 = < 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 equilibrium time development, they 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 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 propagation 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, which is regarded as fundamental for equilibrium and for change guided by equilibrium such as e. g. for the wave propagation 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, 1952), 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 wave propagation 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^^

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.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

Necessarily required is mPu(N, w, tlim^^) ≥ mA, for any realistic example of wave propagation 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).

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. Periodic Current Parameters

Assuming a periodic limit process implies the following issue: propagation surface coordinate multiple occurences in space-time with *multiple and different relevant event time interval Δt*, and multiple measurement events, for the same emission wave propagation. 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 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 wave propagation surface. In *par. B8*, discussed is 'wave-group propagation 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 propagation 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 equilibrium time development. However, this is an assumption, it is possible to relate t^^ with one moment time parameter t or one moment time interval Δt, this is discussed in par. 1.2 and par. 2.6. This would imply the wave propagation 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. Usually only generalized coordinates are included in equilibrium equations, not current parameters or object rulers. However one could interpret one moment time parameter t to be a current parameter itself, while assuming the time development concept introduced in (Hollestelle, 2024): 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 propagation is not reversable, i.e. time development is not reversable, and star source emission wave propagation 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 propagation 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 propagation including propagation surface A(Δt) is regarded to be a unity and nonlocalizable, being part of a description of wave propagation 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 propagation surface to one specific measurement place Qm, i. e. in this paper the 'collapse' of wave propagation surface A to a certain measurement place Qm on A, defined in par. 3.1, and (Hollestelle, 2018), e. g. the one moment time description of the photo-electric event and parallel wave propagation. In the case of simultaneous emission from multiple star sources, par. 3, one can consider 'wave-group propagation 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 propagation 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 propagation collapse' of ΔA(Δt) implies localization towards wave propagation surface measurement places ΔQm(i) simultaneously during Δt.

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

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- cloud emission concept of par. 3.

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 Wave Propagation Surface Approximation Example

The construction II example, being an approximation for A(Δt), is proposed to argue the wave propagation 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.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 September 2025 doi:10.20944/preprints202509.0057.v1

B11 < w(t^^) >||P2i[dt]. 1/< w(t^) >||P1i[D1] = ∫||dt dt^^ [w(t^^)]. 1/N. 1/∫||D1 dt^ [w(t^)]. N0 = a/d. 1/r. 1/N. N0

When averages are equal to the averaged parameter, meaning < w(t^^) >| |P2i[dt] = w, this implies w(t^^) = 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 Δw = < w >| |Δt^^. Δt^^ with mΔw ~ m< w(t^^) >| |P2i[dt]. mdP2i[dt], which includes the choice for solution w(t^^) = 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 ΔN(Δw) = ΔN(< w(t^^) >||Δt^^. Δt^^) = a/d. 1/r. M[M[Δw0, Δwi], ΔN0]

= M[M[ΔN, ΔN0i], ΔN0]

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 outer-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

Δw = < w(t^^) >| |Δt^^. Δt and Δt^^ = < t^^ >| |Δt^^. Δt. One finds Δw = w. Δt and Δt^^ = mdt. Δt, since w is defined as average < w(t^^) >| |P2i(dt) and < t^^ >| |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 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 itself an approximation for the real wave propagation 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 Yn. (1/t^^)^n, n=1 to n infinite, the Yn constants.

Consider the time interval version for transformation TU for time interval domain dΔt^^, i. e. TU*[Δt^^] = Σn Yn. Xn.

Δt^^i, n=1 to n infinite, the Taylor series linear in multiplication inverse Δt^^i due to property eq. 1. 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.

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

With TU any transformation, TU[t^^] = 1 + Σn. Yn. (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 the 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, 1989). 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 already in (Hollestelle, 2020). Within the time interval only set there is exactly one generator, time interval Δt, due to the multiplication linearity theorem (Hollestelle, 2024).

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 multiplication 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^^.

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, the time interval multiplication ‘set rule’, and set generators

Theorem B3. from (Hollestelle, 2024). 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 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*|]].

The expression |operator*| indicates the operator quantity, D*||Δt[A1] is the time interval derivative of quantity A1, both occur in the time interval operator definition. The 2nd step is due to the time interval ‘set rule’ for the time interval derivative of multiplication for any time interval Δt1 and any scalar a, derived in (Hollestelle, 2024):

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

for any, in this case time interval, quantity a. Δt1. The one moment time ‘set rule’ provides usually the derivative definition for any one moment time quantity q1 and any scalar a:

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 for 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 'move 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 operator TU*I with 1-dim. current parameter t^^ and only one generator equal to 1/G. One can write the one moment time TU*I operator 'working to the right' on t^^ for simplicity with the generator written with 1/G, with eq. B16. Disregard usual commutators [G, G]||q = 'addition zero'||q, and write for the 1st derivatives d/dq*[t^^] = 1/α, scalar, and d/dq*[1/G] = β, equal to 'multiplication zero'||q for 1/G invariant, where higher orders cancel. Applied is the '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 is 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 not 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 any finite number c1. One can choose α = 'multiplication unit'||scalar, and q = α. t^^ = t^^, and 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. Apply the time interval 'set rule', while

ΔA1 = Δt^^ and scalar r = tlim^^/tl^^.

Theorem B5. 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 zero'||Δt within the time interval description. This was discussed in par. 1.2, and assumes calibration of object ruler type of measuring ΔPi and measuring wave propagation at surface ΔA.

Since the time interval set canonical property is valid, one can write, including only the 1st order derivatives, with time interval commutators [Δt, Δt]||Δt = Δt and [ΔG, ΔG]||Δt = ΔG, where [Δt1, Δt2]||Δt = M[A[TS[Δt1], Δt1i], Δt2] = M[I*||

Δt1 [Δt1], Δt2] = Δt2.

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]]

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.

*Operator TU*I*

From the 'set rule' applied to *operator* TU*I, one finds TU*I*[Δt^^] = A[d1. Δαi, D*||Δq[d1]] with in this case d1 = | TU*I*| the operator TU*I quantity, a scalar since TU*I equals the identity.

One can define ΔM with exp[M[Δt^^, ΔG]] = exp[ΔM], with a Taylor series. Multiplication of two time interval quantities M[Δt1, Δt2] is again a time interval quantity, equal to say Δt3, (Hollestelle, 2024), theorem 4. Not included in the original 'set rule' definition is time interval multiplication M[Δt1, Δt2], rather scalar multiplication, however it is assumed applicable.

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

exp[ΔM] = 1 + (Σ(k ≥ 1) 1/k!). M[ΔM. exp[ΔM]] = A[(m – 1). M[ΔM, exp[ΔM]]i, M[ΔM, exp[ΔM]] = (m – 1). Δt^^ Recall ΔM equals in this case ΔNC and Δt^^, the Δq dependent on the object ruler and Δt^^, not on Δt or equilibrium time development. Remains the following 1st order equations:

(m - 1). Δt^^ = A['addition unit'||Δq, ΔM]. exp[ΔM] (m – 1). Δt^^ = A['addition unit'||Δq, ΔM] = exp[ΔM]

(m – 1). Δq = A['addition unit'||Δq, ΔM] = exp[Δt^^] = A['addition unit'||Δq, exp['addition zero'||Δq]]

Trial solution is Δαi = Δα = 'multiplication unit'||Δq = Δq and it follows D*||Δq[Δq] = Δq and ΔG = Δq.

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

B17 TU*I*[Δt^^] = exp[ΔM] = (m – 1). Δt^^ = M[M['addition unit'||Δq, Δqi], Δt^^]] = 'addition unit'||Δq = Δt^^

The time interval transformation TU*I* is found to be equal to the time interval current parameter Δt^^ identity operator, TU*I*[Δt^^] = Δt^^. This is consistent with correspondence with one moment time current parameter results eq. B16, i. e. Δt^^ ~ t^^, and TU*I*[t^^] = t^^. Recall the canonical property for the time interval only set is valid.

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], applying eq. 1. 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.

<u>Comment B</u>12. 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 propagation collapse' within Δt, where the order of any wave function collapse can be interchanged.

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

The choice for TU leaves mdTU*[dt] invariant, since the specific Lorentz transformations TS, which are coordinate transformations for domain dw and dt, preserve surface measure at the propagation 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. 18 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. outer-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 description with Δw and Δwi, 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, for dt, multiplication follows par. B12(A3) with alternative 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 follows outer 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, mPi = mQi and mdTU*I*[dQi] = mdTU*I*[dPi]. It follows series parameter Z for current parameter w can be solved from the remaining parameters, and where A1 = 1/r1 = w(r1)/w, and A2 = 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 r2 = 1/(1 + ε(r2)).One can derive from the requirements one moment time eq. B22, where r1 and r2 both should approximate r, and w(r1), w(r2), and A1(r1) and A2(r2) similar, to evaluate solutions.

B22 w(r1). (ε(r2) + A1(r1). (1 – ε(r2))) - A2(r2). (1 – w(r1)) = 0. t0

The parameters A1(r1) and A2(r2) are dependent on each other to avoid the singularity of TU at w = w0 and t^^ = t0^^. They can be adjusted independently with r1 and r2, however make sense only when related through r1 = r2 = r.

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 ε(r) equivalent to parameter ε(r). Eq. B23 describes the mentioned requirements, and reduces the number of degrees of freedom with one.

For the time interval description there is to all orders of Δw(r1), due to eq. 1, TU*I*[Δw(r1)] = M[Δt, (Σn Yn). 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. The ΔGw is the time interval generator for the current parameter Δw set, similar to generator ΔG for the current parameter Δt^^ set defined in par. B12(A4), within the time interval description, 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). M[Δt, Δt]] = Δt

To retrieve a solution different from the trivial one, one can start with independent A1(r1) and A2(r2). One gathers the quadratic terms in A1 and A2, 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 from the time interval set. 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 degrees of freedom do not change for surface parts Pi, 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, meaning wave propagation surface A, due to time development, does not change and develop away from the star source, valid for all Δt, where mΔt = 'multiplication unit'||Δt 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^^ 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, 1989), 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. Solutions P(N)u with more than two surface parts

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

Comment B16. Solutions with $N > 2$ can be related to the multiple n star-source emission cloud collective from par. 3. To find an example surface P(N)u, apply parameter Z = N = n, with n the number of star sources, and N the number of surface parts, leaving out Z equal to infinity where singularity w0 remains unsolved.

Trivially the P(N = Z)i defined with dw(Z) and dt are disjoint when open, considering parameter w = w(N), for finite Z, they re-place and adjust space according with N = Z to N = Z + 1.

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

A simple 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 with scaling parameter s = mΔq = s. mΔt, however in par. 6. it is derived s = 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 propagation 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. Scaling parameter s = 1, according to mΔq = s. mΔt, not is meant 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 emission cloud. Another relation can be found from the wave propagation velocity, *c*(Δt) = M[Δq, Δti]. 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 emission cloud 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. the open and non zero and 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, 2024). 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 or 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 structure constants 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.

 doi:10.20944/preprints202509.0057.v1

The 1-pair of time interval only 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 |ΔEg – ΔEs| = |

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: there is applied only one: 1-pair one moment time parameters t and only one: relevant event time interval Δt, to derive the 'set rule' eqs. for the time interval only derivatives to t and Δt respectively, (Hollestelle, 2024). These eqs. make sense with a non-zero factor Rest, for non- trivial commutation relations.

D*|t [a. Δt1] = A [a. D*|t [Δt1], Rest(a)|t] Rest(a)|t = M [D*|t [a], Δt]

D*||Δt [a. Δt1] = A [a. D*||Δt [Δt1], Rest(a)||Δt] Rest(a)||Δt = M [D*||Δt [a], Δt]

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, returning 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 and the specific time interval derivative expression, D*||t[A2] = -1. A2. 1/t, for a decreasing positive one moment time quantity A2, where Es changes to Eg, derived in (Hollestelle, 2020), and the second line with time interval qantity [a. Δt1] = M[ΔEs, Δt*] of eq. C5. TS*[ΔEs(Δt)] = ΔEs(Δt*) results in the first line of C5.

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'.

Energy ΔEg should be acquired, space like Δq dependent, where ΔEs is Δt and Δq dependent. TS*[ΔdU(Δq)] = ΔdU(Δq') results in the second line of C5.

C5 TS*[ΔEs] = ΔEs* = -1. A[ΔEs, D||Δt*[ΔEs]]

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

References

Arnold, V. I. (1974), Mathematical Methods of Classical Mechanics, (English translation, 1989, Vogtmann K. and A. Weinstein), Springer Verlag N.Y.

Beller, M. (1999), Quantum dialogue, The making of a revolution, Univ. Chicago Press.

Cohen, E. R., and P. Giacomo (1987), SUNAMCO 87-1, revision 1987, I.U.P.A.P.-25.

Curie, P. (1894), Sur la symétrie dans les phénomènes physiques, symétrie d'un champ électrique et d'un champ magnétique, J. de Phys. (Theor. Appl.), 3(1), (original in French), Hal archives-ouvertes 10.1051.

Einstein, A. (1905), in: The Principle of Relativity, Lorentz, H., Einstein, A., Minkovski, H. and H. Weyl, (English translation 1923, Methuen and Company; reprint, Perrett, W. and G. Jeffery 1952, Dover Publishers), includes (a) On the Electrodynamics of Moving Bodies, (b) The Foundation of the General Theory of Relativity.

 doi:10.20944/preprints202509.0057.v1

Fetter, A. L., and J. D. Walecka (1971), Quantum theory of many-particle systems, McGraw-Hill.

French, S., and D. Krause, (2006), Identity in Physics, A Historical, Philosophical and Formal Analysis, Oxford UP Goldstein, H. (1950), Classical Mechanics, Addison-Wesley.

Hocking, J. G., and G. S. Young, (1961), Topology, Addison-Wesley.

Jauch, J. M., and F. Rohrlich, (1955), The Theory of Photons and Electrons, second ed. 1980, Springer Verlag.

Van Kampen, N. G. (1988), Ten theorems about quantum mechanical measurements, Physica A 153, North Holland Physics, "All this is a consequence of the Schrodinger equation for the total system, *which consists of the object system, in this case the electron, together with the apparatus.*", Thermodynamic equilibrium however is a macroscopic feature. "*Those are macrostates which the system, when left alone, will reach sooner or later.*" A macrostate for which it follows "*entropy does not change in overall universe.*"

Merzbacher, E. (1961), Quantum Mechanics, second ed. 1970, J. Wiley & Sons.

Millikan, R. A. (1916), A direct photoelectric determination of Planck's " *h*.", Physical Review VII 2nd series march (73) Murawski, R., and Th. Bedürftig, (2004), Alte und neue Ansichten über die Zahlen – aus der Geschichte des Zahlbegriffs, Mathematische Semesterberichte 51, Springer, (English translation 2010 by the authors, From the history of the concept of number, Poznań Studies 98, Rodopi).

Noether, E. (1918), Invariant Variation Problems, Transport Theory and Statistical Physics, 1(3), (English translation 1971, M. A. Tavel, arxiv:physics/0503066v3).

Newton, I. (1686), The Mathematical Principles of Natural Philosophy, (English translation 1729, A. Motte, Benjamin Motte Editors), Book I, includes (a) the axioms or laws of motion, (b) the principles of derivatives by infinitesimal limit, (c) the definition of the quantity of matter related to acceleration, proportional to mass known by its weight.

Omnès, R. (1994), The interpretation of quantum mechanics, Princeton series in physics, Princeton UP.

Roos, W. J. (1978), Grondslagen van de quantummechanica, foundations of quantum physics, available in Dutch only, graduate course, Utrecht Univ.

Sakurai, J. J. (1967), Advanced Quantum Mechanics, seventh ed., 1978, Addison Wesley.

De Theije, P., e. a. (1995), The shapes of galaxy clusters, Mon. Not. R. Astron. Soc. 273, 30-46.

Veltman, M. (1974), Representations of Groups and Applications to Elementary Particle Physics, graduate course, Utrecht Univ.

De Wit, B., and J. Smith, (1986), Field Theory in Particle Physics, Vol. I, North Holland Physics.

References author

Hollestelle, H. (2017), Thermodynamics of a set of closed curved surfaces and Noether's theorem, Int. Jrnl. of Science & Tech. 5(1).

Hollestelle, H. (2017b), A new virial equilibrium for galaxy clusters forming finite alignments, Int. Jrnl. of Science & Tech. 5(10).

Hollestelle, H. (2018), Gravitation, Immediate action at a distance or 'close up' events?, Int. Jrnl. of Science & Tech. 6(12).

Hollestelle, H. (2020), Time, Equilibrium, and General Relativity, Int. Jrnl. of Science & Tech. 8(5).

Hollestelle, H. (2021), Some Results for a Time Interval Approach to Field Theory and Gravitation, preprints202106.0684.v3.

Hollestelle, H. (2022), Some comments on a time interval only description, preprints202209.0151.v1.

Hollestelle, H. (2024), The Time Interval Only Set, part 1, preprints202209.0151.v5.