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Moon's Paradox: Why the Moon Is Not a Planet Based on Desmos

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Abstract

In the Earth–Moon–Sun system, the Newtonian gravitational force exerted by the Sun on the Moon exceeds the force exerted by the Earth. A naive force-magnitude interpretation might therefore suggest that the Moon should be classified as a planet orbiting the Sun rather than as a satellite of the Earth. Newtonian mechanics resolves this situation through relative motion and stability analysis; however, the current approach introduces a primitive scalar criterion that determines binding dominance in multi-body systems. This paper presents Desmos theory as an axiomatic framework that embeds Newtonian gravity as a strict special case, connects consistently with General Relativity through a metric-based transformation, and admits a formal correspondence with energy quantization. Desmos is interpreted as a causal and explanatory layer that classifies structural binding prior to dynamics, geometry, or quantization.

Keywords: Desmos theory; binding dominance; Newtonian gravity; general relativity; energy; causality; Moon; satellites; cosmology; philosophy; mathematics

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1. Introduction

Gravitational systems frequently involve multiple competing influences rather than isolated two-body interactions. Desmos specifies a primitive scalar criterion that determines which interaction is causally dominant in multi-body systems. Structural classifications such as planet, satellite, binary companion, or Trojan object typically emerge only after detailed dynamical analysis.

The Earth–Moon–Sun system illustrates this limitation clearly: although the Sun exerts a larger Newtonian force on the Moon than the Earth does, the Moon remains an Earth satellite. Desmos theory addresses this conceptual gap by introducing a scalar binding-dominance functional that operates at the source level of causality.

2. Newtonian Gravity and Its Explanatory Domain

Newtonian gravity defines the pairwise force

$$\vec{F}_{ij}^{(N)} = G\frac{m_i m_j}{r_{ij}^2}\,\hat{r}_{ij},$$

and the equations of motion

$$m_i\vec{a}_i = \sum_{j\neq i}\vec{F}_{ij}^{(N)}.$$

This framework predicts trajectories and stability accurately. Desmos introduces a primitive scalar measure that ranks competing interactions in multi-body systems. Binding classifications therefore arise indirectly through post-dynamical reasoning.

3. Desmos Theory and the Interaction Functional

Desmos theory introduces a generalized interaction functional (Bond interaction)

$$\Delta_{ij} = k_B \frac{E_i E_j}{r_{ij}^n},$$

with the energy mapping

$$E_i = m_i \phi_i, \qquad \phi_i = \frac{GM_i}{r}.$$

The quantity Δ_{ij} is postulated as a primitive binding-dominance functional. It is not interpreted as a force or an energy, but as a scalar ordering measure that determines structural attachment independently of dynamical trajectories.

4. Newtonian Gravity as a Special Case of Desmos Theory

Newtonian gravity is recovered exactly as a special case of Desmos theory.
Imposing

$$n = 2, \qquad k_B \phi_i \phi_j = G,$$

yields

$$\Delta_{ij} = G \frac{m_i m_j}{r_{ij}^2} = F_{ij}^{(N)}.$$

Thus, Newtonian gravity is embedded as a strict limiting case of Desmos theory.

5. The Moon Case

Although

$$F_{\text{Moon--Sun}}^{(N)} > F_{\text{Earth--Moon}}^{(N)},$$

Desmos theory yields

$$\Delta_{\text{Earth--Moon}} \gg \Delta_{\text{Moon--Sun}},$$

classifying the Moon as Earth-bound at the interaction level. Newtonian mechanics remains correct but reaches this conclusion only indirectly.

6. Axiomatic Status of Binding Dominance

Axiom (Binding Dominance): In any gravitational system composed of more than two bodies, there exists a scalar interaction functional that orders pairwise bindings and determines structural attachment independently of dynamical trajectories.

Axiom (Desmos Functional):

$$\Delta_{ij} = k_B \frac{E_i E_j}{r_{ij}^n}, \qquad E_i = m_i \phi_i.$$

Newtonian gravity emerges as a corollary under the inverse-square limit.

7. Desmos as a Connection Theory: A Holistic View of Causality

Desmos theory can be interpreted as a connection framework linking Newtonian gravity, General Relativity, and energetic (including quantum) descriptions within a unified causal structure.

7.1. Desmos to General Relativity

In the weak-field limit, the spacetime metric satisfies

$$g_{00} \approx -\left(1 + \frac{2\Phi}{c^2}\right),$$

where Φ is the Newtonian gravitational potential. A relativistic potential proxy compatible with Desmos is defined as

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$$\phi_{\mathrm{GR}} = c^2\left(\frac{1}{\sqrt{-g_{00}}} - 1\right).$$

In the weak-field regime,

$$\phi_{\mathrm{GR}} \approx -\Phi = \frac{GM}{r},$$

recovering the Desmos potential input. Substitution yields a GR-consistent Desmos interaction:

$$\Delta_{ij}^{(\mathrm{GR})} = k_B \frac{(m_i\phi_{\mathrm{GR},i})(m_j\phi_{\mathrm{GR},j})}{r_{ij}^n}.$$

7.2. Energetic and Quantum Correspondence

Since Desmos is explicitly formulated in terms of energy, a formal correspondence with quantized energy may be introduced:

$$E_i^{(\mathrm{Desmos})} = m_i\phi_i \quad \Leftrightarrow \quad E_i^{(\mathrm{Q})} = n_i\hbar\omega_i,$$

which implies

$$m_i\phi_i = n_i\hbar\omega_i, \qquad n_i = \frac{m_i\phi_i}{\hbar\omega_i}.$$

Substitution into the Desmos functional yields

$$\Delta_{ij} = k_B\hbar^2 \frac{n_i n_j \omega_i \omega_j}{r_{ij}^n}.$$

This correspondence does not imply quantum dynamics of macroscopic motion; it indicates that energetic discreteness may influence structural binding.

Desmos therefore acts as a causal and explanatory layer preceding dynamics, geometry, and quantization.

8. Conclusions

The Moon is not a planet orbiting the Sun because its dominant interaction, in the Desmos sense, is with the Earth. Desmos theory embeds Newtonian gravity, connects consistently with General Relativity, and admits a formal energetic correspondence, thereby functioning as a holistic causality and explanation framework. Detailed relativistic and cosmological implications are left for future work.

Appendix A

Below are the proofs:

In Newtonian gravity, the pairwise force law is

$$\vec{F}_{ij}^{(N)} = G\frac{m_i m_j}{r_{ij}^2}\hat{r}_{ij}.$$

The acceleration of body i is given by the vector sum of forces:

$$m_i\vec{a}_i = \sum_{j\neq i}\vec{F}_{ij}^{(N)}.$$

Newtonian gravity therefore determines motion through an N-body dynamical problem. Furthermore,Desmos introduces a primitive scalar criterion of *binding dominance* for classification. Instead, notions such as “satellite” emerge from analysis of relative motion and stability (e.g., Hill stability).

Desmos theory introduces a generalized interaction form (Bond interaction):

$$\Delta_{ij} = k_B\frac{E_i E_j}{r_{ij}^n},$$

where the energy mapping is given by

$$E_i = m_i \phi_i.$$

Substituting $E_i = m_i \phi_i$ and $E_j = m_j \phi_j$, we obtain

$$\Delta_{ij} = k_B \, \phi_i \phi_j \, \frac{m_i m_j}{r_{ij}^n}.$$

The quantity Δ_{ij} functions as a scalar interaction measure, which can be used to rank binding dominance directly. Newtonian gravity is recovered exactly from the Desmos/Bond interaction under suitable parameter constraints.

Start from the Desmos/Bond interaction:

$$\Delta_{ij} = k_B \, \phi_i \phi_j \, \frac{m_i m_j}{r_{ij}^n}.$$

Impose the inverse-square exponent

$$n = 2$$

and calibrate the prefactor by requiring

$$k_B \, \phi_i \phi_j = G.$$

Then,

$$\Delta_{ij} = k_B \, \phi_i \phi_j \, \frac{m_i m_j}{r_{ij}^2} = G \frac{m_i m_j}{r_{ij}^2}.$$

Recognizing the right-hand side as the Newtonian force magnitude,

$$\Delta_{ij} = F_{ij}^{(N)}.$$

Thus, Newtonian gravity is a strict special case of Desmos theory under $n = 2$ and $k_B \phi_i \phi_j = G$.

theory defines binding dominance through the scalar ranking of Δ_{ij}. For the Earth–Moon and Moon–Sun pairs, Desmos theory yields the dominance condition

$$\Delta_{\text{Earth--Moon}} \gg \Delta_{\text{Moon--Sun}}.$$

This inequality expresses that the Earth–Moon binding interaction is stronger in the Desmos sense than the Moon–Sun interaction, even if the Newtonian force exerted by the Sun on the Moon is larger than that exerted by the Earth on the Moon.

Therefore, within Desmos theory, the Moon is fundamentally classified as Earth-bound (satellite) rather than Sun-bound as a planet.

This section is included to eliminate conceptual doubt. It is not used to reject Newtonian gravity, but to prove that the statement

$$\left|\vec{F}_{\text{Sun}\to\text{Moon}}\right| > \left|\vec{F}_{\text{Earth}\to\text{Moon}}\right| \quad \Rightarrow \quad \text{``Moon must orbit the Sun as a planet''}$$

is not a valid Newtonian implication.

Let R be the Earth–Sun distance and r the Earth–Moon distance with $r \ll R$. Newtonian solar acceleration at distance x from the Sun is

$$a_S(x) = \frac{GM_S}{x^2}.$$

The disruptive component for Earth-binding is the *difference* between solar acceleration on the Moon and on the Earth:

$$\Delta a_S = |a_S(R + r) - a_S(R)|.$$

Using a first-order Taylor approximation for $r \ll R$,

$$a_S(R + r) \approx a_S(R) + a_{S'}(R)\, r, \qquad a_{S'}(x) = \frac{d}{dx}\left(\frac{GM_S}{x^2}\right) = -\frac{2GM_S}{x^3}.$$

Thus,

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$$\Delta a_S \approx |a_{S'}(R)| r = \frac{2GM_S}{R^3} r.$$

Earth's gravitational acceleration on the Moon is

$$a_E = \frac{GM_E}{r^2}.$$

Earth-binding is stable when the binding acceleration exceeds the tidal disruption scale:

$$a_E \gg \Delta a_S.$$

Substituting,

$$\frac{GM_E}{r^2} \gg \frac{2GM_S}{R^3} r.$$

Cancel G and rearrange:

$$r^3 \ll \frac{M_E}{2M_S} R^3.$$

The criterion for Earth-binding involves the *differential* solar effect Δa_S, not the total solar force magnitude. Therefore, the fact that the Sun's Newtonian force on the Moon is larger than the Earth's does *not* imply that the Moon must be classified as a planet orbiting the Sun. The classification emerges from relative dynamics and stability, not from comparing raw force magnitudes.

Thus, for the parameter choice $s.d._0 = 1\ \mathrm{m}$ and $n = 2$, representative results are:

$$\Delta_{\text{Earth--Moon}} \approx 1.458 \times 10^{57}$$

and

$$\Delta_{\text{Moon--Sun}} \approx 1.066 \times 10^{54}.$$

Hence the dominance ratio in the Desmos sense is

$$\frac{\Delta_{\text{Earth--Moon}}}{\Delta_{\text{Moon--Sun}}} \approx \frac{1.458 \times 10^{57}}{1.066 \times 10^{54}} \approx 1.37 \times 10^3.$$

Thus, the Earth–Moon interaction is approximately three orders of magnitude stronger than Moon–Sun under the Desmos interaction functional.

Representative Newtonian force magnitudes are:

$$F_{\text{Earth--Moon}} = G\frac{M_E M_M}{r_{EM}^2} \approx 1.982 \times 10^{20}\ \mathrm{N},$$

and

$$F_{\text{Moon--Sun}} = G\frac{M_M M_S}{r_{MS}^2} \approx 4.363 \times 10^{20}\ \mathrm{N}.$$

Therefore, the Newtonian force ratio is

$$\frac{F_{\text{Moon--Sun}}}{F_{\text{Earth--Moon}}} \approx \frac{4.363 \times 10^{20}}{1.982 \times 10^{20}} \approx 2.20.$$

This shows that the Sun's Newtonian pull on the Moon is larger than Earth's by a factor of about $\mathbf{2.2}$, while the Desmos interaction functional ranks Earth–Moon as far more strongly bound than Moon–Sun. Within the context of the Moon's paradox, Desmos theory clarifies the causal hierarchy underlying gravitational phenomena by operating at a level prior to dynamics, geometry, and quantization. This establishes Desmos as a unifying causality and explanation theory with structural explanatory power across classical, realitivistic and quantum domains.

Appendix B

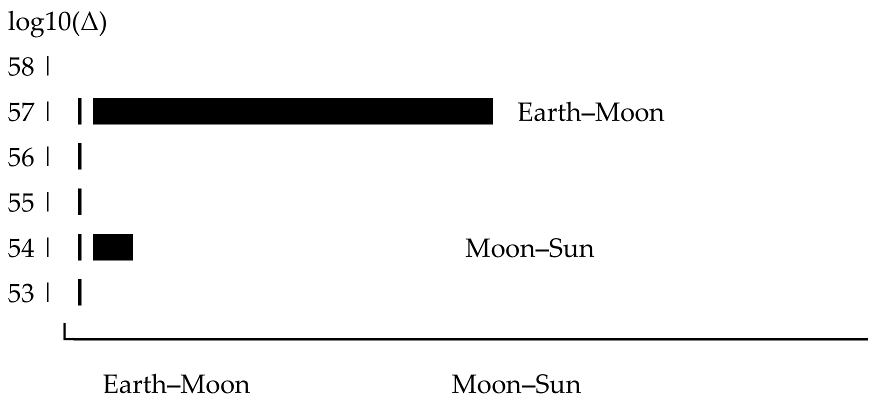
Table A1. Symbols, physical meaning, and SI units used throughout the paper.

Symbol	Physical meaning	SI unit
m_i, m_j	Mass of body i, j	kg

M_i, M_j	Source mass generating gravitational field	kg
r_{ij}	Distance between bodies i and j	m
r	Radial distance from source mass	m
G	Newtonian gravitational constant	m^3 kg^{-1} s^{-2}
c	Speed of light in vacuum	m s^{-1}
$\vec{F}_{ij}^{(N)}$	Newtonian gravitational force	N (kg m s^{-2})
$\vec{a}_i$	Acceleration of body i	m s^{-2}
Φ	Newtonian gravitational potential	m^2 s^{-2}
ϕ_i	Desmos potential proxy ($\phi_i = GM/r$)	m^2 s^{-2}
E_i	Desmos energy variable ($E_i = m_i\phi_i$)	J (kg m^2 s^{-2})
Δ_{ij}	Desmos binding-dominance functional	J^2 m^{-n}
k_B	Desmos interaction scaling constant	m^n J^{-2}
n	Desmos interaction exponent	dimensionless
g_{00}	Time–time metric component (GR)	dimensionless
$\phi_{\rm GR}$	Relativistic Desmos potential proxy	m^2 s^{-2}
$\hbar$	Reduced Planck constant	J s
ω_i	Angular frequency (quantum correspondence)	s^{-1}
n_i	Quantum occupation number (formal correspondence)	dimensionless
$\Delta_{ij}^{(\rm GR)}$	GR-consistent Desmos interaction	J^2 m^{-n}

Appendix C

(A) Desmos Interaction Functional Δ



Numerical placement:

log10(Δ_Earth–Moon) ≈ 57.16

log10(Δ_Moon–Sun) ≈ 54.03

Dominance:

$$\frac{\Delta_{EM}}{\Delta_{MS}} \approx 1.37 \times 10^3$$

(B). Newtonian Gravitational Force F

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Earth–Moon Moon–Sun

Numerical placement:

log10(F_Earth–Moon) ≈ 20.30

log10(F_Moon–Sun) ≈ 20.64

Ratio:

$$\frac{F_{MS}}{F_{EM}} \approx 2.20$$

References

Aguilera, M., Moosavi, S., & Shimazaki, H. (2020). A unifying framework for mean-field theories of asymmetric kinetic Ising systems. *Nature Communications*, 12. Retrieved from https://doi.org/10.1038/s41467-021-20890-5

Alazard, D., Sanfedino, F., & Kassarian, E. (2025). Non-linear dynamics of multibody systems: a system-based approach. *ArXiv*, abs/2505.03248. Retrieved from https://doi.org/10.48550/arxiv.2505.03248

Babichev, E., Izumi, K., Noui, K., Tanahashi, N., & Yamaguchi, M. (2024). Generalization of conformal-disformal transformations of the metric in scalar-tensor theories. *Physical Review D*. Retrieved from https://doi.org/10.1103/physrevd.110.064063

Bini, D., Damour, T., & Geralico, A. (2019). Novel Approach to Binary Dynamics: Application to the Fifth Post-Newtonian Level. *Physical Review Letters*, 123 23, 231104. Retrieved from https://doi.org/10.1103/physrevlett.123.231104

Bini, D., Damour, T., & Geralico, A. (2020). Sixth post-Newtonian local-in-time dynamics of binary systems. *Physical Review D*, 102, 24061. Retrieved from https://doi.org/10.1103/physrevd.102.024061

Blümlein, J., Maier, A., Marquard, P., & Schäfer, G. (2020a). Fourth post-Newtonian Hamiltonian dynamics of two-body systems from an effective field theory approach. *Nuclear Physics B*. Retrieved from https://doi.org/10.1016/j.nuclphysb.2020.115041

Blümlein, J., Maier, A., Marquard, P., & Schäfer, G. (2020b). The fifth-order post-Newtonian Hamiltonian dynamics of two-body systems from an effective field theory approach: Potential contributions. *Nuclear Physics B*, 965, 115352. Retrieved from https://doi.org/10.1016/j.nuclphysb.2022.115900

Bose, A., & Walters, P. (2021). A multisite decomposition of the tensor network path integrals. *The Journal of Chemical Physics*, 156 2, 24101. Retrieved from https://doi.org/10.1063/5.0073234

Cai, Z.-T., Li, H.-D., & Chen, W. (2024). Quantum-Classical Correspondence of Non-Hermitian Symmetry Breaking. *Physical Review Letters*, 134 24, 240201. Retrieved from https://doi.org/10.1103/vvrx-mljg

Challoumis, C. (2024). Panphysics Enopiisis. *Edelweiss Applied Science and Technology*, 8(6), 9356–9375. Retrieved from https://learning-gate.com/index.php/2576-8484/article/view/3999/1519

Chen, B., Sun, H., & Zheng, Y. (2024). Quantization of Carrollian conformal scalar theories. *Physical Review D*. Retrieved from https://doi.org/10.1103/physrevd.110.125010

Chen, Z.-Q., Ni, R.-H., Song, Y., Huang, L., Wang, J., & Casati, G. (2025). Correspondence Principle, Ergodicity, and Finite-Time Dynamics. *Physical Review Letters*, 134 13, 130402. Retrieved from https://doi.org/10.1103/physrevlett.134.130402

Cun, Y. (1988). A Theoretical Framework for Back-Propagation. Retrieved from https://consensus.app/papers/a-theoretical-framework-for-backpropagation-cun/a73d81505d9459b9851c580c9288ec9f/

D'Ambrosio, F., Heisenberg, L., & Kuhn, S. (2021). Revisiting cosmologies in teleparallelism. *Classical and Quantum Gravity*, 39. Retrieved from https://doi.org/10.1088/1361-6382/ac3f99

Das, S., Fridman, M., & Lambiase, G. (2025). Testing the quantum equivalence principle with gravitational waves. *Journal of High Energy Astrophysics*. Retrieved from https://doi.org/10.1016/j.jheap.2025.100413

Einstein, A. (1946). The Meaning of Relativity. Retrieved from https://doi.org/10.2307/2305460

Einstein, A. (2004). Einstein's 1912 manuscript on the special theory of relativity : a facsimile. Retrieved from https://consensus.app/papers/einsteins-1912-manuscript-on-the-special-theory-of-einstein/65d18c179b09570a94db7c37b14d39cc/

Einstein, A. (2005). Albert Einstein to Michele Besso. *Physics Today*, 58, 14. Retrieved from https://doi.org/10.1063/1.2012433

Einstein, A. (2007). On the Relativity Problem. *Boston Studies in the Philosophy of Science*, 250, 1528–1536. Retrieved from https://doi.org/10.1007/978-1-4020-4000-9_33

Einstein, A. (2015a). Relativity: The Special and the General Theory, 100th Anniversary Edition. Retrieved from https://consensus.app/papers/relativity-the-special-and-the-general-theory-100th-einstein/b27c2697bb9559cf98df9843d3bdcd00/

Einstein, A. (2015b). Relativity: The Special and the General Theory. Retrieved from https://doi.org/10.2307/j.ctv7h0s4k

Einstein, A, & Hawking, S. (1995). The Essential Einstein: His Greatest Works. Retrieved from https://consensus.app/papers/the-essential-einstein-his-greatest-works-einstein-hawking/47961fe0f91f548ba3742c11f0a7e70b/

Einstein, A, & Rosen, N. (1935). The Particle Problem in the General Theory of Relativity. *Physical Review*, 48, 73–77. Retrieved from https://doi.org/10.1103/physrev.48.73

Einstein, Albert. (1950). The Bianchi Identities in the Generalized Theory of Gravitation. *Canadian Journal of Mathematics*, 2, 120–128. Retrieved from https://doi.org/10.4153/cjm-1950-011-4

Fields, C., Friston, K., Glazebrook, J., & Levin, M. (2021). A free energy principle for generic quantum systems. *Progress in Biophysics and Molecular Biology*. Retrieved from https://doi.org/10.1016/j.pbiomolbio.2022.05.006

Gielen, S. (2021). Frozen formalism and canonical quantization in group field theory. *Physical Review D*. Retrieved from https://doi.org/10.1103/physrevd.104.106011

Hashimoto, K., Sugishita, S., Tanaka, A., & Tomiya, A. (2018). Deep learning and the AdS/CFT correspondence. *Physical Review D*. Retrieved from https://doi.org/10.1103/physrevd.98.046019

Heisenberg, L. (2018). A systematic approach to generalisations of General Relativity and their cosmological implications. *Physics Reports*. Retrieved from https://doi.org/10.1016/j.physrep.2018.11.006

Hess, P. (2020). Alternatives to Einstein's General Relativity Theory. *Progress in Particle and Nuclear Physics*, 114, 103809. Retrieved from https://doi.org/10.1016/j.ppnp.2020.103809

Järv, L., Kuusk, P., Saal, M., & Vilson, O. (2015). Transformation properties and general relativity regime in scalar–tensor theories. *Classical and Quantum Gravity*, 32. Retrieved from https://doi.org/10.1088/0264-9381/32/23/235013

Jarv, L., Runkla, M., Saal, M., & Vilson, O. (2018). Nonmetricity formulation of general relativity and its scalar-tensor extension. *Physical Review D*. Retrieved from https://doi.org/10.1103/physrevd.97.124025

Jiménez, J. B., Heisenberg, L., & Koivisto, T. (2019). The Geometrical Trinity of Gravity. *Universe*. Retrieved from https://doi.org/10.3390/universe5070173

Leigh, N., & Wegsman, S. (2018). Illustrating chaos: a schematic discretization of the general three-body problem in Newtonian gravity. *Monthly Notices of the Royal Astronomical Society*, 476, 336–343. Retrieved from https://doi.org/10.1093/mnras/sty192

Levi, M. (2018). Effective field theories of post-Newtonian gravity: a comprehensive review. *Reports on Progress in Physics*, 83. Retrieved from https://doi.org/10.1088/1361-6633/ab12bc

Li, X., Lyu, S.-X., Wang, Y., Xu, R., Zheng, X., & Yan, Y. (2024). Toward quantum simulation of non-Markovian open quantum dynamics: A universal and compact theory. *Physical Review A*. Retrieved from https://doi.org/10.1103/physreva.110.032620

Lin, S., Liu, H.-Y., Nguyen, D., Tran, N. T. T., Pham, H., Chang, S.-L., … Lin, M.-F. (2020). The theoretical frameworks. Retrieved from https://doi.org/10.1088/978-0-7503-3299-6ch2

McTague, J., & Foley, J. (2021). Non-Hermitian cavity quantum electrodynamics-configuration interaction singles approach for polaritonic structure with ab initio molecular Hamiltonians. *The Journal of Chemical Physics*, 156 15, 154103. Retrieved from https://doi.org/10.33774/chemrxiv-2021-0gpz8

doi:10.20944/preprints202512.1881.v1

Mocz, P., Lancaster, L., Fialkov, A., Becerra, F., Princeton, P.-H. C., Harvard, … Toulouse. (2018). Schrödinger-Poisson–Vlasov-Poisson correspondence. *Physical Review D*, 97, 83519. Retrieved from https://doi.org/10.1103/physrevd.97.083519

Murray, R., Orr, B., Al-Khateeb, S., & Agarwal, N. (2025). Constructing a multi-theoretical framework for mob modeling. *Soc. Netw. Anal. Min.*, 15, 33. Retrieved from https://doi.org/10.1007/s13278-025-01449-4

Naruko, A., Saito, R., Tanahashi, N., & Yamauchi, D. (2022). Ostrogradsky mode in scalar-tensor theories with higher-order derivative couplings to matter. *Progress of Theoretical and Experimental Physics*. Retrieved from https://doi.org/10.1093/ptep/ptad049

Nashed, G., & Bamba, K. (2025). Properties of compact objects in quadratic non-metricity gravity. *Annals of Physics*. Retrieved from https://doi.org/10.1016/j.aop.2025.170139

Ovalle, J. (2018). Decoupling gravitational sources in general relativity: The extended case. *Physics Letters B*. Retrieved from https://doi.org/10.1016/j.physletb.2018.11.029

Palariev, V., & Shtirbu, A. (2025). Theoretical framework of grape irrigation: a review. *Collected Works of Uman National University of Horticulture*. Retrieved from https://doi.org/10.32782/2415-8240-2025-106-1-304-329

Rehman, A., Naseer, T., & Dayanandan, B. (2025). Interpretation of complexity for spherically symmetric fluid composition within the context of modified gravity theory. *Nuclear Physics B*. Retrieved from https://doi.org/10.1016/j.nuclphysb.2025.116852

Sasmal, S., & Vendrell, O. (2020). Non-adiabatic quantum dynamics without potential energy surfaces based on second-quantized electrons: Application within the framework of the MCTDH method. *The Journal of Chemical Physics*, 153 15, 154110. Retrieved from https://doi.org/10.1063/5.0028116

Vacaru, S. (2025). Inconsistencies of Nonmetric Einstein–Dirac–Maxwell Theories and a Cure for Geometric Flows of f(Q) Black Ellipsoid, Toroid, and Wormhole Solutions. *Fortschritte Der Physik*, 73. Retrieved from https://doi.org/10.1002/prop.70003

Wang, S.-X., & Yan, Z. (2024). General theory for infernal points in non-Hermitian systems. *Physical Review B*. Retrieved from https://doi.org/10.1103/physrevb.110.l201104

Wiese, U.-J., & Einstein, A. (2021). Statistical Mechanics. *Manual for Theoretical Chemistry*. Retrieved from https://doi.org/10.1093/acprof:oso/9780199655526.003.0002

Yang, Y., Ren, X., Wang, Q., Lu, Z., Zhang, D., Cai, Y.-F., & Saridakis, E. (2024). Quintom cosmology and modified gravity after DESI 2024. *Science Bulletin*. Retrieved from https://doi.org/10.1016/j.scib.2024.07.029