

DD 38: Astronomie – Poster

Time: Wednesday 14:00–15:00

Location: ELP 6: Foyer

DD 38.1 Wed 14:00 ELP 6: Foyer

Insightful exact three-dimensional representation of curved spacetime — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

Astrophysics, general relativity and curved spacetime motivate students. However, so far, it was not possible to represent three-dimensional curved spacetime in an exact manner. But now, such an exact and **clarifying** representation is possible: From the usual algebraic description using a metric tensor, changes of lengths and of volume are derived. These are represented with help of transparent plastic material in a three-dimensional and exact manner.

This representation is **realistic**, as the above changes of lengths can be measured. It is **valuable**, as students can derive the cosmological constant Λ , though Einstein was unable to derive Λ from his ingenious general relativity. Perlmutter (1998) measured that value of Λ .

Similarly, deriving & using the dynamics of the above volumes, students can unify relativity, gravity and quanta.

Our results are in precise accordance with observation and fully derived from physical principles [1,2]. Experiences from teaching in research clubs and general study courses at a university are presented.

[1] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster.

[2] More info: <https://www.researchgate.net/profile/Hans-Otto-Carmesin>

DD 38.2 Wed 14:00 ELP 6: Foyer

Students Learn to Derive Universal Properties of Gravitons — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

Gravitation is omnipresent. However, it has been criticized since Newton (1686) that the **propagation** of the gravitational interaction has not yet been explained. But this propagation can now be derived by students in an elegant & exact manner: Based on the usual algebraic structure of general relativity, the dynamics of volume are analyzed & derived. These dynamics are **realistic**, as they can be measured. They are **meaningful**, as they imply universal properties of the dynamics of volume and gravity at various interconnected levels, at the level of: quanta [1], curvature of spacetime, tensors and spins, fields and potentials, the density of dark energy, the expansion of space since the Big Bang, the object that transmits gravity - the graviton.

The graviton is **insightful**, as it interconnects the above fields of knowledge about gravity, and tests are provided. Thereby, all results are in precise accordance with observation and fully derived from physical principles [2,3]. Experiences from teaching in research clubs and general study courses at a university are presented.

[1] Carmesin, H.-O. (2023): Students Exactly Derive Quantization and its Universality. PhyDid B, pp. 39-44. [2] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster. [3] More info: <https://www.researchgate.net/profile/Hans-Otto-Carmesin>

DD 38.3 Wed 14:00 ELP 6: Foyer

Students Learn to Derive the Energy Density of Volume — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

Volume is essential in everyday live - it basically describes the amount of space. However, Einstein (1917) proposed a *cosmological constant* Λ , which seems to assign an energy density to space, the *dark energy*. In fact, Perlmutter (1998) discovered the acceleration of the expansion of the universe, and this acceleration provides a value of Λ , though Einstein was unable to predict the value of Λ with his ingenious theory of general relativity. But here, we show how students can derive the energy density u_{vol} of volume and the theoretical value of the cosmological constant Λ_{theo} in an elegant and exact manner: Based on the usual algebraic structure of general relativity, the dynamics of volume are analyzed & derived. These dynamics are **realistic**, as they can be measured. They are **meaningful**, as they imply the process of formation of volume as well as the density of volume. Thereby, the derived values of u_{vol} and Λ_{theo} are in precise accordance with observation and fully derived from physical principles [1-3]. Experiences from teaching in re-

search clubs and general study courses at a university are presented. [1] Carmesin, H.-O. (2021): Quanta of Spacetime Explain Observations, Dark Energy, Graviton and Nonlocality. Berlin: Verlag Dr. Köster. [2] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster. [3] More info: <https://www.researchgate.net/profile/Hans-Otto-Carmesin>

DD 38.4 Wed 14:00 ELP 6: Foyer

Students Analyze the Impact of the H_0 Tension of the World-view — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

The modern worldview is based on the expansion of space (Einstein 1917, Hubble 1929). Friedman (1922) & Lemaitre (1927) used Einstein's general relativity to derive a time evolution of that expansion. They used the Hubble constant H_0 , a key parameter for the rate of expansion. But Riess (2022) observed at the 5σ confidence level that H_0 is not constant: This problem is named H_0 tension. What impact does it have on the worldview? We show how students can derive the source of the H_0 tension: Based on the usual algebraic structure of Einstein's ingenious general relativity, the dynamics of volume are analyzed & derived. These dynamics are used to analyze the H_0 tension: The increase of heterogeneity in the universe causes an increase of $H_0(t)$ with time. $H_0(t)$ is derived and implies that the age of the universe is 500 000 000 years smaller than expected before. Our results are precise accordance with observation and fully derived from physical principles [1-3]. Experiences from teaching in research clubs and general study courses at a university are presented. [1] Carmesin, H.-O. (2021): Quanta of Spacetime Explain Observations, Dark Energy, Graviton and Nonlocality. Berlin: Verlag Dr. Köster. [2] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster. [3] More info: <https://www.researchgate.net/profile/Hans-Otto-Carmesin>

DD 38.5 Wed 14:00 ELP 6: Foyer

Students Learn to Derive the Universal Elementary Charge — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

Electricity is omnipresent. However, its key quantity the elementary charge - has not been explained before 2021 [1]. We show how students can derive it: Based on the usual algebraic structure of Einstein's ingenious general relativity, the dynamics of volume and of its excitation states, quanta of spacetime, QST, are analyzed & derived [2]. An elementary particle mass forms from volume. That process is analyzed via the QST: A triple of QST forms such a mass at lowest energy. Each QST has a ω_i . These cause six forced oscillations. These form the electric field. The triple forms the electric charge, in precise accordance with observation: relative deviation 10^{-8} . Our results are precise accordance with observation and fully derived from physical principles [1-4]. Further results are outlined, e. g. about the electroweak interaction. Experiences from teaching in research clubs and general study courses at a university are presented. [1] Carmesin, H.-O. (2021): The Elementary Charge Explained by Quantum Gravity. Berlin: Verlag Dr. Köster. [2] Carmesin, H.-O. (2021): Cosmological and Elementary Particles Explained by Quantum Gravity. Berlin: Verlag Dr. Köster. [3] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster. [4] More info: <https://www.researchgate.net/profile/Hans-Otto-Carmesin>

DD 38.6 Wed 14:00 ELP 6: Foyer

Students Learn to Solve the Cosmological Constant Problem — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

Electricity and volumes are omnipresent. However, the theory of quantum electrodynamics predicts an energy density of the electromagnetic field u_{QED} that is a factor of 10^{122} larger than the observed energy density of volume u_{vol} , this is the cosmological constant problem, CCP. u_{vol} is essentially the observed dark energy. We show how students can solve it in an exact and elegant manner: Based on the usual algebraic structure of Einstein's ingenious general relativity, the dynamics of volume are analyzed & derived. With it, the energy density u_{vol} is derived and identified as a kinetic energy density. The potential energy

density of $u_{\text{vol,pot}}$ compensates u_{vol} and implies energy conservation during the expansion of space. Moreover, the volume dynamics show that u_{QED} is compensated by its potential energy density $u_{\text{QED,pot}}$, this solves the CCP. Moreover, the Casimir force is derived.

Our results are in precise accordance with observation and fully derived from physical principles [1,2]. Experiences from teaching in research clubs and general study courses at a university are presented.

[1] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster.

[2] More info: <https://www.researchgate.net/profile/Hans-Otto-Carmesin>

DD 38.7 Wed 14:00 ELP 6: Foyer

Students Learn to Derive Nonlocality form Fundamental Physics — ●HANS-OTTO CARMESIN — Athenaeum, Stade — Studienseminar Stade — Universität Bremen, Fachbereich 1

Quantum cryptography is an exciting new communication technology. It uses Einstein's (1948) Spukhafte Fernwirkung: Nonlocality. How does nonlocality work? We show how students can solve it in an exact and elegant manner: Based on the usual algebraic structure of Einstein's ingenious general relativity, the dynamics of volume are analyzed & derived. With it, the postulates of quantum physics are derived. Thereby, the physical meaning of the wave function is clarified. With it, two physical transformations of the states in Hilbert space are derived: the time evolution via the Schrödinger equation, and the swapping of solutions of that equation. It is shown that this swapping is not limited by the velocity of light and thus provides nonlocality.

Our results are precise accordance with observation and fully derived from physical principles [1,2]. Experiences from teaching in research clubs and general study courses at a university are presented.

[1] Carmesin, H.-O. (2023): Geometrical and Exact Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster.

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DD 38.8 Wed 14:00 ELP 6: Foyer

Lauf der Planeten: Die Rolle von Embodiment bei der Veränderung mentaler Modelle — ●MAXIMILIAN ALEXANDER LOCH^{1,3}, MALTE S. UBBEN² und EMMANUEL ROLLINDE³ — ¹Institut für Didaktik der Physik - Universität Münster, Münster, Deutschland — ²Institut für Fachdidaktik der Naturwissenschaften - Abteilung Phy-

sik und Physikdidaktik - Technische Universität Braunschweig, Braunschweig, Deutschland — ³Laboratoire de Didactique André Revuz CY Cergy Paris Université, Paris, Frankreich

Nach der Durchführung einer Pilotstudie, deren Ziel es war, herauszufinden, welche beispielhaften mentalen Modelle über das Sonnensystem bei Schülern existieren, haben wir die Studie auf eine Stichprobengröße von 100 Lernenden der Klassen 5 bis 13 mit 93 Prätests und 78 Posttests erweitert. Wir beobachteten, welche Auswirkungen der Einsatz von Embodied Learning im Rahmen des Erasmus+ Projektes "Aristarchus" haben könnte, das sich auf die Vermittlung astronomischer Grundlagen mit dem "Human Orrery" konzentriert. Dies geschah durch die Durchführung von Prä- und Posttests, deren Hauptbestandteil es war, das Sonnensystem vor und nach den im Rahmen des Aristarchus-Projekts durchgeführten Lernsequenzen zu zeichnen. Anhand der Ergebnisse haben wir induktiv eine Reihe von Items entwickelt, um die Zeichnungen zu klassifizieren, ihre Entwicklung zu analysieren und die zuvor vorgeschlagenen Klassifizierungen zu verfeinern. Während die Gestalt eines mentalen Modells leicht mit einer Zeichnung erfasst werden kann, kann das funktionale Verständnis nur teilweise dargestellt werden und wird Gegenstand zukünftiger Studien sein.

DD 38.9 Wed 14:00 ELP 6: Foyer

Analysis of Gravitational Instabilities in Stars Using a Model Sequence — ●LINA JARCK¹ and HANS-OTTO CARMESIN^{1,2,3} — ¹Athenaeum, Stade — ²Studienseminar Stade — ³Universität Bremen, Fachbereich 1

In a student research club, we investigate gravitational instabilities in stars. To do so, we develop a progressive sequence of models with increasing predictive power. Throughout our model sequence, we utilize the appropriate model for each specific inquiry. The models also provide opportunities for verification and comparison. First, we apply a model of Sun with variable density as a function of radius. As this function is widely known, we test our model. For further progression and validation of our method, we construct a model with variable density for White Dwarfs, where the Chandrasekhar limit confirms our results. Progressively, we develop a model with variable density for Neutron Stars and black holes. We represent the results within a specially created phase diagram. In this diagram, the states of stars are shown as a function of radius and mass. In the diagram, there are Neutron Stars, a transition-line to possible Quark-Gluon-Stars, and a transition-line to black holes.