Earth's biodiversity compensates the Universal's gravitational response of mass creation

1. The Universe as web of events (Whitehead)

According to Whitehead (2007) nature is disclosed to the mind as a web of events. Any event is characterized by factors, containing extrinsic and intrinsic characters. Only extrinsic characters make room for observable events. Extension and duration are the a priori conditions to observability, both are implied by mass. The latter , however, is not the substrate of linear momentum, energy, inertial momentum, but mass is a dynamic hidden factor of any event connected to another hidden factor, namely gravitation. An event with minimum duration is called an event-particle. The event-particle e is the result of converging extrinsic properties connected to surrounding events of the ensemble $\mathscr{E}$. Within the ensemble $\mathscr{E}$, particle-events require a “Moment” as the duration of minimum extension representing all nature at an instant “now” as well as a spatial “Station” at a location “here” (Whitehead, 2007). According to Whitehead, mass emerges as a factor of an event whose interior character appears as gravitation and whose exterior character appears as movement characterized by energy and momentum (Whitehead, 2007). Therefore, mass as a quantifiable characteristic of events is not observable since it is an intrinsic characteristic. By contrast, luminosity as it appears in the Tully Fisher (1977) relation is an observable extrinsic characteristic, just as Cosmic microwave background radiation (CMBR) (Whitehead, 2007).

As Verstraeten&Verstraeten (2025) remarked the space of discernible observable bits is discontinuous, it can be extended to a continuous space, provided the terms with respect to the bandwidth limit of the Shannon sample theory are accepted (Shannon & Weaver, 1963). Moreover, accepting the UV-cutoff, Kempf (2010) claims an extension of a discontinuous space to a continuous Riemann manifold and even to the Lorentz manifold.

The set $\mathscr{E}$ of experimental countable outcomes forms a topological space Verstraeten&Verstraeten 2022). This implies the definition of a Borel algebraic set on Whitehead’s set of particle events. If a collection $\mathscr{M}$ of duration subsets of the set $\mathscr{E}$ of event-particles including $\mathscr{E}$ is containing (i) all countable unions of subsets of $\mathscr{E}$, and (ii) all countable subsets of intersections of subsets of $\mathscr{E}$, and (iii) all subsets of event-particles included in the countable union of subsets, then ($\mathscr{M}$, $\mathscr{E}$) is a Borel Space. In order to be distinguishable, the ensemble of event-particles must be endowed by a Hausdorff topology so that any extrinsic character (e.g., velocity, position, time, luminosity) can be mapped by a homeomorphism on $\mathscr{F}$. Furthermore, a measurement protocol produces a countable ensemble of experimental data $\mathscr{E}$ as separable final results of a cyclic process starting from and ending within the experimental setting. In addition, there is always a transfer of energy Q and, consequently, a Kelvin-Planck thermodynamic theory is involved. The limiting points of the converging series ei of $\mathscr{E}$ are mapped on a data base within $\mathscr{F}$. As it contains all limiting points, this database of observable events is a compact set. Within any time-like cone containing the ensemble of events $\mathscr{E}$, the experimental setting detects a physical phenomenon $\mathscr{M}$ (i.e. luminosity) and collects irreversibly the data in an ensemble $\mathscr{E}$. In consequence, a finite regular Borel measure B is defined on the set $\mathscr{E}$ of event-particles in order to connect the event particles irreversibly to the compact data $\mathscr{F}$. $\mathscr{F}$ presuppose the intervention of the existence of a Kelvin-Planck thermodynamic theory which is a necessary and sufficient condition for the Clausius-Duhem inequality representing the second law of thermodynamics (Truesdell, 1983). The proof is based on the separation theorem of Hahn-Banach that admit a hyperplane within a Hausdorff ensemble, including one closed ensemble $\mathscr{E}$ and one compact

$\mathscr{F}$ so that there exist canonical adjoint functionals T and S, called thermodynamic temperature and entropy so that dQ/T dS on the compact set $\mathscr{F}$

2. Erik Verlinde ' s concept of gravitation

Verstraeten&Verstraeten (2022,2024,2025) incorporated Whitehead's concepts of space, time and mass in Verlinde's alternative conception of gravitation as memory effect of competitions of long and short range entanglement entropy out of the de Sitter space.

According to Verlinde (2017), mass is a hidden variable that changes the entanglement of quantum information considered as the cause of emergence of spacetime and gravity. He makes room for the central role of the Bekenstein-Hawking Entropy (2) and the Hawking Temperature (3), both corollaries of the thermodynamics of black holes. Verlinde, however, extends the former claims to the de Sitter spacetime characterized by a positive cosmological constant and by no boundary at spatial infinity. He restricts the entanglement of dynamic information qubits on one site of the horizon with internal entanglements as well. The entanglement entropy is the entropy of the non-observable (Casini and Huerta 2009). Consequently, this entropy is out of the range of Whitehead´s spacetime of observable events. Within the de Sitter space, however, some degrees of freedom are thermalized. A nonlocally stored thermodynamic entropy $S_t(V)$ emerges and competes with the entanglement entropy. Where is this non-localized thermalized entropy is coming from. Verlinde did not mention the origin of the thermalized excitation of the entanglement of qubits, but it cannot be ruled out that this concerns the Hawking radiation.Indeed, the information stored in a black hole is finite and lost by radiation energy. The latter is thermalized (Hawking, 2016).

The result is the emergence of baryons and the creation of mass M. This means that the so-called Coulomb branch mass branches-off from Higg's branch as a stress-strain response of the pre-baryonic Universe (Verlinde 2017 14-15). In Whitehead's conception of observability, the creation of the Coulomb branch out of Higg's branch is presented as an instant of time. However, since the latter is the ideal real of all nature without any temporal extension, the branch-off is unobservable (Whitehead 2007 61). Moreover, de Sitter space contains exactly the limits of storage capacity by its cosmological horizon. In consequence, thermal volume entropy turns the spacetime into a reactive elastic medium and gravitation. It is fed by the created positive dark energy which emerges from the elastic reaction of the de Sitter space within the cosmological horizon, while the horizon stabilises (Verlinde 2017 16-19). Gravitation is a spacetime reaction to this competition after the production of mass-carrying baryons. Furthered, entropy of the de Sitter space S_M is decreasing and the reason is that thermal entropy contributes to the de Sitter entanglement entropy. The reactive action of gravitation to the baryon mass escape, minimizes the memory effects on external perturbations in condensed matter. Verlinde identifies the latter as the emergence of apparent positive dark energy. The pressure-less fluid disclosures the emergent nature of gravitation as intrinsic elastic response of spacetime.

Finally, it results in the classic Lame equality:

$$\mu \geq 0, \lambda + 2.\mu \geq 0 \text{ where } \sigma_{ij} = \lambda.\varepsilon_{kk}.\delta_{ij} + 2.\mu.\varepsilon_{ij} \quad (1)$$

Here σ is the stress and ε is the strain, δ is the Kronecker delta, the indices i and j vary between 1 and 4, corresponding to the time and space coordinates, and k indicates the diagonal terms of the matrix. μ and λ are the Lamé parameters

Since Verlinde does not put a substratum status on mass, and since he does not equate curvature of space with gravitation action, he reformulates gravitation rather as Whitehead´s concept of nature. Particularly, the cornerstone role of factor mass for observability of events gives support to the emergence of space and time after the escape of baryonic mass and the reactive force of gravitation, followed by the settling down of energy and momentum in a web of space- and time-like events.

Moreover, Verlinde's experimental support for his conception of gravitation sounds analogous to Whitehead's claims about what Nature is disclosing to the Mind. Indeed, Verlinde links his results about visible baryonic matter density to the missing dark matter by means of the Tully-Fisher scaling relation that explains the border flattering of galaxies (Verlinde 2017 38-39). In Verlinde's conception, the baryonic Tully-Fisher scaling relation (1977) connects visible baryonic matter Σ_b density to positive apparent matter Σ_D:

$$\Sigma_D\, r = \frac{a_0}{8\pi G} \cdot \frac{\Sigma_b(r)}{(d|1)} \frac{\Sigma_b(r)}{(d|1)} \quad (2)$$

Gravitation and Mass correspond to the expanding or shrinking spacetime but not the motion of the hypothetical substratum mass is measured, but the spacetime variation by varying luminosity.

3. Earth's production of entropy

Gravitation is a spacetime reaction to this competition after the production of mass-carrying baryons. Furthered, entropy of the de Sitter space S_M is decreasing and the reason is that thermal entropy contributes to the de Sitter entanglement entropy. Formally:

$$S_M < A(r) + \frac{A(r)}{4} h\, kruis \quad (3)$$

The right-hand side is the entropy of a black hole inside the region bounded by surface A (Verlinde 2017 5). This means that we can consider the branch off from the Higg's space to the Coulomb space represents a low entropy state of the de Sitter space as already mentioned by Reichenbach (1956) and Grunbaum (1973), though both formulized in the scope of an entropy lawlike reduction of the Arrow of Time.

However, gravitation as memory effect of baryon production in terms of strain ε and stress σ implies that the entropy production of any celestial body and particularly our of our own Planet increases and decreases, depending on the dominating strain or stress. As an elastic medium decreases its entropy by stress and increases its entropy by strain, so does our Planet. This means that Earth's entropy production varies not only by input and output of energy flow but also by the gravitational memory effect of the de Sitter space. Moreover, Earth's entropy production is also decreasing by living organism (*see* Penrose) that enlarge the trend of decreasing entropy if stress overrules strain. Indeed, Nobel Prize winner Roger Penrose claimed the proposition that biotic life on Earth reduces Earth's entropy production and consequently Earth's Thermodynamic Free Energy, i.e. the substantial parameter of Earth's meta-stable thermodynamic state. However, we emphasize that Penrose´ s claims don´t have to be considered as Lovelock's Gaian hypothesis considering our Planet as a self-consistent teleological organism (1979,1988). On the contrary, Penrose´s claims are perfectly understood in the scope of the mechanical cosmological model in which gravitation, inertial phenomena and thermodynamic entropy production are just reactions against creating space and time out of information qubits of the early Universe (Verlinde, 2017, Verstraeten 2022, 2025).

4. Surface temperature, Entropy production by Earth as Black body

The basic idea is that ecosystems evolve, subject to external constraints (e.g., element availability, energy source, etc.), towards stationary states that maximize the flow of energy through the ecosystem per unit time, which is power (MPP, Hall and McWhirter, 2023). There is a related idea that was popularized most recently in a series of papers by Kleidon 2010 that is termed the Maximum Entropy Production Principle (MEP). The MEP hypothesis basically states that the ecosystem will evolve towards a state where it generates the most entropy per unit time from an external energy flow**.**

Considering the Earth as a black body the radiated energy power is given by the Stefan – Boltzmann Law :

▪P(power) = A (surface) . σ . T4 with σ = 5.670374419 10-8 W/m2K4

From the temperature decay from the Solar Radiation T = 5778K to Earth's average temperature T=255K, we conclude that the main radiation wave length λ increase and in consequence the respective wave frequency ν decrease. So, more photons are emitted than absorbed by Earth and Enthalpy is produced.

: H= U + p.V where dH = TdS + Vdp (S: Entropy)

We assume constant pressure during received signals from examined and so Earth's entropy production can be calculated on the basis op the measured surface temperature

We add also include the latent heat component due to the precipitation term of June:

2256 x1000 joule/kg xliter precipitation/m2 30.24.3600

So: dS= dQ/T (dQ emitted Heat by Earth, T the averaged June land surface temperature of severalr examined areas from 2003 till 2022).

Furthermore

▪ΔS/Δt = (St2 – St1)/Δt

▪ΔS/Δt = A .σ.(T2004 – T2003) and so on till 2022

(Time lapse over one year-entropy shift calculated over two

successive measured land surface temperatures of June)

5. Hubbel's Unified Theory of biodiversity (Hubbel, 2001)

Hubbel´s "The Unified Neutral Theory of Biodiversity and Biogeography" is based on the Island Biography of MacArthur and Wilson (1967). Instead of the Niche approach for determining species abundance Hubbel' Unified Theory is a dispersion approach based on offspring, immigration and emigration around neutral postulate. The former approach assumes species mutually competitive but coexistent in interactive equilibrium. The dispersed assembly perspective, however, starts from non-equilibrium with ecological equivalence for each individual concerning giving birth, dying, migrating and speciation. There is a zero sum ecological stochastic drift with random migration , random speciation and random fluctuations in population by birth and dead. The ecological community is trophical similar and the species are competing for the same or similar resources.

This is an entropy-like approach because the mean result of the species distribution is formalized by a lognormal distribution which implies the statistical Shannon entropy with the standard deviation as a substantial parameter. We derived the entropy density production of 16 ecosystems by measuring the ground temperature from space, calculating the radiated heat energy by the Stephan-Boltzmann law and linking the result to the respective Shannon entropy of the ecosystem. The standard deviation of the species abundance distribution decreases with increase with entropy production increase and increases with entropy production decrease

Shannon Entropy : $1/2 + 1/2 \ln(2\pi\sigma) + \mu$

(μ: average, σ: standard deviation)

Thermodynamic Entropy = - kb x Shannon Entropy (kb is theBoltzmann constant)

$\Delta S/\Delta t = (St2 – St2)/ \Delta t = - kb \ln(\sigma 2/\sigma 1)$

$\Delta S/\Delta t < 0$ means $\sigma 2 > \sigma 1$ or increase in biodiversity

$\Delta S/\Delta t > 0$ means $\sigma 2 < \sigma 1$ or decrease in biodiversity

6. Arhenius species area power

N = c A^z, N total number of species, A surface area, with population density rho)

$0,15 < z < 0,4$; $c = \rho^z$ $N = (\rho A)^z$

$$N = \left(\frac{\Theta}{2\upsilon A}\right)^z \quad ; \quad N = \left(\frac{\theta}{2\left(1-exp-\frac{\Delta S}{kb}\right)A}\right)^z$$ (diversity number theta)

$\ln N = z \ln \theta – z \ln 2A - z \ln (1 – \exp – \Delta S/k\,b)$

after normalizing of initial time , proceding time , surface and and entropy shift

And for $\Delta S \ggg kb$

$\ln N = 1 - z\, \Delta S / k\, b$ if $\Delta S > 0$ number of species is declining

if $\Delta S < 0$ number of species is increasing

7. Measuring surface temperature by remote sensing and calculating respective entropy of some ecosystems

We derive Earth´s entropy production from the Stefan-Boltzmann law. Monthly land surface temperature (LST) are obtained from remotely sensed MODIS and SENTINEL data over the period 2003-2020 and monthly latent heat data from the FLUXCOM-X global fluxes collection for a one by one kilometer pixels. (1)MODIS LST_cci : Land surface temperature from MODIS for 002-2022 (Ghent, Veal, Perry, 2022). 2) See also: ESA Land Surface Temperature Climate Change Initiative (LST_cci): Land surface temperature from MODIS (Moderate resolution Infra-red Spectroradiometer) on Aqua, level 3 collated (L3C) global product (2002-2018), version 3.003) Exploring the use of remotely-sensed Earth's entropy production to reveal the ecological fitness of forests (EGU 2023. section 9B1,3599)

We analyse 11 ecosystems worldwide (mean of 3 x 3 pixels). Eight of them are National Parks where minimal anthropogenic stress can be assumed. Three control areas subjected to human economic activity nearby National Parks are added for comparison. A decline in entropy production down to -3.7% per decade is observed in areas around the equator (Foz do Iguaco in Brazil, the Ngorongoro in Tanzania, and Gal Oya in Sri Lanka). The entropy production over the Mediterranean area (Spain) and northern Europe (Finland) is stable, while the entropy production is increasing dramatically up to +2.4% per decade over the Western European National Parks (the Netherlands, Flanders). These areas are characterized by a very high anthropogenic environmental pressure. Differences in the trends of entropy production are observed when mean values are computed from 3 x 3 pixels or from 9 x 9 pixels. Generally, the more the pixels, the smoother, the smaller the absolute trend values. For the Landes in France, the trend switches from a small negative value on the larger scale to a more substantial positive value at the smaller scale. Generally, wetter ecosystems tend to lower the Earth´s entropy production thereby increasing the biodiversity of vegetation.

8. Results

sentinel_LST_FLUXCOM_ET_9locations_3x3.›

References

Hall, C.A.S.; McWhirter, T. Maximum power in evolution, ecology and economics. Phil. Trans. R. Soc. A 2023, 381, 20220290. [CrossRef]

Kleidon, A. A basic introduction to the thermodynamics of the Earth system far from equilibrium and maximum entropy production. Phil. Trans. R. Soc. B 2010, 365, 1303–1315. [CrossRef] [PubMed]

Casini, Horatio and Huerta, Marin (2009) Entanglement Entropy in free Quantum Field Theory. J. Phys. A4 2504007, https://doi.org/10.1088/1751-8113/42/50/504007.

Hawking, Stephen W (1974) Black hole explosions. Nature, 248, (5443); 30-31.

Hawking, Stephen W., Hertog, Thomas (2006) Populating the Landscape. A Top-Down Approach. Physical review D 73: 123527.

Hawking, Stephen W. (2016) The Origin of the Universe. Proceedings of the Plenary Session 25-29 November 2016, reds. W. Arbers, J. von Braun, M. Sanchez Sorondo. City of Vatican, 2020. Acta 24. Kauffman, Stuart A. (2022) Quantum Gravity If Non-Locality is Fundamental. Entropy, 24(4), 554.

Kauffman, Stuart A. (2023) Notes on Quantum Gravity, Dark Matter and Dark Energy. In The Third Minkowski Conference on the Foundations of Spacetime Physics. September 11-14 2023, Albena.

Kempf, Achim (2010) Spacetime could be simultaneously continuous and discrete, in the same way that information can be. New Journal of Physics 12, 115001.

Kukla, André (2000) Social constructivism and the philosophy of science, Routledge, London and New York.

Lemaitre, Georges (1931) The Beginning of the World from the Point of View of Quantum Theory. Nature, 127 (3210), 706, https://doi.org/10.1038/127706b0.

Luty, Damian (2023) Spacetime realism against supersubstantivalism. In Third Hermann Minkowski Meeting on the Foundations of Spacetime Physics 10.09.2023 – 14.09.2023 Albena, Bulgaria. Misner, Charles W, Thorne, Kip S, and Wheeler, John A. (1973) Gravitation. San Francisco: Freemand and Company.

Noether, Emmy (1971) Invariant variation problems. Transport Theory and Statistical Physics, 1(3), 186-207.(M. A. Tavel's English translation of "Invariante Variationsprobleme," Nachr. d. Köonig. Gesellsch. d. Wiss. zu Göttingen, Math-phys.1918 Klasse, 235-257. https://doi.org/10.1080/00411457108231446

Penrose, Roger (2010) Cycles of Time: An Extraordinary New View of the Universe. London: Bodley Head.

Penzias, Arno A., Wilson, Robert W. (1965) A Measurement of Excess Antenna Temperature At 4080 Mc/s*. Astrophysical Journal Letters. 142, 419-421.

Popper, Karl R. (1956a) The arrow of time. Nature, 177, 538. Popper, Karl R. (1956b) Irreversibility and Mechanics. Nature, 178, 382. Popper, Karl R. (1957) Irreversible Processes in Physical Theory. Nature 2, 179, 1297. Part I. Philosophy of the Cosmos 66 Philosophy and Cosmology, Volume 34, 2025

Shannon, Claude E. and Weaver Warren (1963) The Mathematical Theory of Communication. Champaign, IL: University of Illinois Press. Tully, R. Brent and Fisher, J.Richard (1977) A New

Method of Determining Distances to Galaxies. Astronomy and Astrophysics, 54, 661-673. Udwadia, Firdaus E., and Kalaba, Robert E. (2002) On the Foundations of Analytical Dynamics. Int. Journal Nonlinear Mechanics, 37(6), 1079- 090. Verlinde, Erik P. (2017) Emergent Gravity and the dark Universe. SciPost Phys. 2, 016, http:// arxiv.org/abs/1611.02269v2.

Verstraeten, Guido J.M. and Verstraeten, Willem W. (2022) Accessing a Big Bounce Universe with Concealed Mass and Gravitation. Philosophy and Cosmology, 28, 2022, 32-40. Verstraeten,

Guido J.M. and Verstraeten, Willem W. (2024) Concealed Mass and Gravitation within Whitehead's conception of observability in space and time suggest a Big Bounce Universe, In Eric Ling and Annachiara Piubello (Eds), Spacetime 1908-2023. Selected peer-reviewed papers presented at the Third Hermann Minkowski Meeting on the Foundations of Spacetime Physics, pp. 63-72, 11-14 September 2023, Albena, Bulgaria (Minkowski Institute Press, Montreal 2024).

Vidal, Guifré (2007) Entanglement renormalization. Phys. Rev. Lett., 99, 220405.

Whitehead, Alfred, N. (2007) The Concept of Nature. New York: Cosimo Classics. Yahalom, Asher (2021) Tully–Fisher relations and retardation theory for galaxies. International Journal of Modern Physics D Vol. 30, No. 14, 2142008-1-8.

Yahalom, Asher (2023) Hermann Minkowski's Spacetime and the "Dark Matter Problem¨. In Eric Ling and Annachiara Piubello (Eds), Spacetime 1908-2023. Selected peerreviewed papers presented at the Third Hermann Minkowski Meeting on the Foundations of Spacetime Physics, pp. 63-72, 11-14 September 2023, Albena, Bulgaria (Minkowski Institute Press, Montreal 2024).