Astrobiological Aspects of Global Scaling

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In this paper we apply chain systems of harmonic quantum oscillators as a fractal model of matter to the analysis of astrophysical and biological metric data. Astrobiological aspects of global scaling are discussed.

Introduction

Already in [1] we have shown that scale invariance is a fundamental characteristic of chain systems of harmonic oscillators. In [2] we applied this model on chain systems of harmonic quantum oscillators and could show that particle rest masses coincide with the eigenstates of the system. This is valid not only for hadrons, but for mesons and leptons as well. On this background we proposed scaling as model of mass emergency [3] and introduced our fractal model of matter as a chain system of oscillating protons and electrons. Andreas Ries [4] demonstrated that this model allows for the prediction of the most abundant isotope of a given chemical element.

Our fractal model of matter as a chain system of oscillating protons and electrons provides also a good description of the mass distribution of large celestial bodies in the Solar System [5]. Physical properties of celestial bodies such as mass, size, rotation and orbital period can be understood as macroscopic quantized eigenstates in chain systems of oscillating protons and electrons [6]. This allows to see a connection between the stability of the Solar system and the stability of electron and proton and consider scale invariance as a forming factor of the Solar system.

In [7] we have calculated the model masses of unknown planets in the Solar system which correspond well with the hypothesis of Batygin and Brown [8] about a new gas giant called "planet 9" and with the hypothesis of Volk and Malhotra [9] about an unknown Mars-to-Earth mass "planet 10" beyond Pluto.

In [6] we have proposed a new interpretation of the cosmic microwave background as a stable eigenstate in a chain system of oscillating protons. Therefore, our model may be of cosmological significance as well.

In [10] we applied our model to the domain of biophysics and have demonstrated that the frequency ranges of electrical brain activity and of other cyclical biological processes correspond with eigenstates in chain systems of oscillating protons and electrons. This would indicate that biological cycles may have a subatomic origin.

Scale invariance as a property of the metric characteristics of biological organisms is well studied [11, 12] and it is not an exclusive characteristic of adult physiology. Furthermore, many metric characteristics of human physiology, for example, the frequency ranges of electrical brain activity [13, 14], are common to most mammalian species.

In this paper we demonstrate how the scale invariance of our fractal model of matter as a chain system of oscillating protons and electrons allows us to see a connection between the metric characteristics of biological organisms and those of the celestial bodies. This connection could be of astrobiological significance.

Methods

In [1] we have shown that the set of natural frequencies of a chain system of similar harmonic oscillators coincides with a set of finite continued fractions $\mathcal{F}$, which are natural logarithms:

$$\ln(\omega_{jk}/\omega_{00}) = n_{j0} + \cfrac{z}{n_{j1} + \cfrac{z}{n_{j2} + \ddots + \cfrac{z}{n_{jk}}}} = \tag{1}$$

$$= [z, n_{j0}; n_{j1}, n_{j2}, \ldots, n_{jk}] = \mathcal{F},$$

where ω_{jk} is the set of angular frequencies and ω_{00} is the fundamental frequency of the set. The denominators are integer: $n_{j0}, n_{j1}, n_{j2}, \ldots, n_{jk} \in \mathrm{Z}$, the cardinality $j \in \mathrm{N}$ of the set and the number $k \in \mathrm{N}$ of layers are finite. In the canonical form, the numerator z equals 1.

For finite continued fractions $\mathcal{F}$ (1), ranges of high distribution density (nodes) arise near reciprocal integers 1, 1/2, 1/3, 1/4, ... which are the attractor points of the distribution.

Any finite continued fraction represents a rational number [15]. Therefore, all natural frequencies ω_{jk} in (1) are irrational, because for rational exponents the natural exponential function is transcendental [16]. It is probable that this circumstance provides for high stability of an oscillating chain system because it prevents resonance interaction between the elements of the system [17]. Already in 1987 we have applied continued fractions of the type $\mathcal{F}$ (1) as criterion of stability in engineering [18, 19].

In the case of harmonic quantum oscillators, the continued fractions $\mathcal{F}$ (1) not only define fractal sets of natural angular frequencies ω_{jk} , oscillation periods $\tau_{jk} = 1/\omega_{jk}$ and wavelengths $\lambda_{jk} = c/\omega_{jk}$ of the chain system, but also fractal sets of energies $\mathrm{E}_{jk} = \hbar \cdot \omega_{jk}$ and masses $\mathrm{m}_{jk} = \mathrm{E}_{jk}/c^2$ which correspond with the eigenstates of the system. For this reason, we call the continued fraction $\mathcal{F}$ (1) the "fundamental

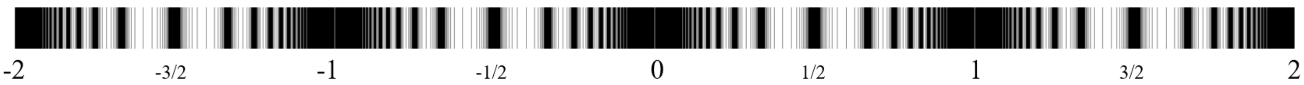

Fig. 1: The canonical projection of $\mathcal{F}$ (natural logarithmic representation).

fractal" of eigenstates in chain systems of harmonic quantum oscillators.

Normal matter is formed by nucleons and electrons because they are exceptionally stable. Furthermore, protons and neutrons have similar rest masses (the difference being only 0.14 percent). This allows us to interpret the proton and the neutron as similar quantum oscillators with regard to their rest masses. Therefore, in [3, 6] we have introduced a fractal model of matter as a chain system of oscillating protons and electrons.

Table 1 shows the basic set of electron and proton units that can be considered as a fundamental metrology (c is the speed of light in vacuum, $\hbar$ is the reduced Planck constant).

We hypothesize that scale invariance based on the fundamental fractal $\mathcal{F}$ (1), calibrated on the metric properties of the proton and electron, is a universal characteristic of organized matter. This hypothesis we have called 'global scaling' [6].

Results

Let's start with the metric characteristics large celestial bodies. The current amount of the Solar mass supports our hypothesis of global scaling, because it corresponds to a main attractor node of the $\mathcal{F}$ (1) calibrated on the electron. In fact, the natural logarithm of the Sun-to-electron mass ratio is close to an integer number:

$$\ln\left(\frac{\mathrm{M_{Sun}}}{\mathrm{m_{electron}}}\right) = \ln\left(\frac{1.9884 \cdot 10^{30}\ \mathrm{kg}}{9.10938356 \cdot 10^{-31}\ \mathrm{kg}}\right) = 138.936$$

The electron rest mass is $\mathrm{m}_e = 9.10938356 \cdot 10^{-31}$ kg [20].

In the canonical form of the fundamental fractal $\mathcal{F}$ (1), shorter continued fractions correspond with more stable eigenstates of a chain system of harmonic oscillators. Therefore, integer logarithms represent the most stable eigenstates (main attractor nodes).

In the framework of our model of matter, the correspondence of the Sun-to-electron mass ratio with a main attractor node of the fundamental fractal $\mathcal{F}$ (1) is a criterion of high stability of the chain system of quantum oscillators that appears as the star we call 'Sun'. Therefore, the current body mass of the Sun is not casual, but an essential aspect of its stability.

Also the correspondence of the current radius of the Sun with a main attractor node (integer logarithm) now we can understand as criterion of its stability:

$$\ln\left(\frac{\mathrm{R_{Sun}}}{\lambda_{\mathrm{electron}}}\right) = \ln\left(\frac{6.96407 \cdot 10^{8}\ \mathrm{m}}{3.8615926764 \cdot 10^{-13}\ \mathrm{m}}\right) = 48.945$$

The angular Compton wavelength of the electron is $\lambda_e = 3.8615926764 \cdot 10^{-13}$ m [20].

The natural logarithm of the proton-to-electron mass ratio is approximately 7.5 and consequently, the fundamental fractal $\mathcal{F}$ calibrated on the proton will be shifted by 7.5 logarithmic units relative to the $\mathcal{F}$ calibrated on the electron:

$$\ln\left(\frac{1.672621898 \cdot 10^{-27}\ \mathrm{kg}}{9.10938356 \cdot 10^{-31}\ \mathrm{kg}}\right) \approx 7.5$$

Consequently, integer logarithms of the proton $\mathcal{F}$ correspond to half logarithms of the electron $\mathcal{F}$ and vice versa. Therefore, all the most stable eigenstates are connected through division of the integer logarithms by 2.

As we have seen above, the Solar mass coincides with the main attractor and stability node $[139; \infty]$ of the $\mathcal{F}$ calibrated on the electron. Dividing the logarithm $139/2 = 69.5$ we receive the logarithm of the node $[69; 2]$ that is the main node $[62; \infty]$ of the $\mathcal{F}$ calibrated on the proton, because $69.5 - 7.5 = 62$.

This main node corresponds to the mass: $\mathrm{m}_p \cdot \exp(62) = 1.4$ Kg, where $\mathrm{m}_p = 1.672621 \cdot 10^{-27}$ kg is the proton rest mass [20]. Probably, the mass range around 1.4 kg isn't noticeable in astrophysics, but in biophysics it is. This mass range is typical for the adult human brain [21] represented by 7 billion samples (current terrestrial population of homo sapiens).

At the same time, the Solar mass is near the node $[131; 2]$ of the $\mathcal{F}$ calibrated on the proton, because $139 - 7.5 = 131.5$. Dividing the logarithm $131.5/2 = 65.75$ we receive a logarithm that corresponds to the significant subnode $[66; -4]$ in the range of the world statistical average adult human body mass: $\mathrm{m}_p \cdot \exp(65.75) = 60$ kg [20].

Table 1: The basic set of physical properties of the electron and proton. Data taken from Particle Data Group [20]. Frequencies, oscillation periods and the proton wavelength are calculated.

property	electron	proton
rest mass m	$9.10938356(11) \cdot 10^{-31}$ kg	$1.672621898(21) \cdot 10^{-27}$ kg
energy $\mathrm{E} = \mathrm{mc}^2$	0.5109989461(31) MeV	938.2720813(58) MeV
angular frequency $\omega = \mathrm{E}/\hbar$	$7.76344071 \cdot 10^{20}$ Hz	$1.42548624 \cdot 10^{24}$ Hz
oscillation period $\tau = 1/\omega$	$1.28808867 \cdot 10^{-21}$ s	$7.01515 \cdot 10^{-25}$ s
wavelength $\lambda = c/\omega$	$3.8615926764(18) \cdot 10^{-13}$ m	$2.1030891 \cdot 10^{-16}$ m

Jupiter's body mass coincides with the main attractor node [132; ∞] of the electron-calibrated $\mathcal{F}$ (1):

$$\ln\left(\frac{\mathrm{M_{Jupiter}}}{\mathrm{m_{electron}}}\right) = \ln\left(\frac{1.8986 \cdot 10^{27}\ \mathrm{kg}}{9.10938356 \cdot 10^{-31}\ \mathrm{kg}}\right) = 131.98$$

Dividing the logarithm $132/2 = 66$ we receive the logarithm of the main node [66; ∞] that corresponds to the mass: $\mathrm{m}_e \cdot \exp(66) = 42$ g. This mass range coincides with the average mass of the human spinal cord [23].

At the same time, Jupiter's body mass is near the node [124; 5] of the proton-calibrated $\mathcal{F}$ (1):

$$\ln\left(\frac{\mathrm{M_{Jupiter}}}{\mathrm{m_{proton}}}\right) = \ln\left(\frac{1.8986 \cdot 10^{27}\ \mathrm{kg}}{1.672621 \cdot 10^{-27}\ \mathrm{kg}}\right) = 124.47$$

The half value of this logarithm $124.47/2 = 62.24$ corresponds to the mass: $\mathrm{m}_p \cdot \exp(62.24) = 1.78$ kg that is the range of the adult human liver [21]. It is remarkable that the most massive planet of the Solar System corresponds with the most massive organ of the human organism – the liver.

Saturn's body mass is near the subnode [123; 4] of the proton-calibrated $\mathcal{F}$ (1):

$$\ln\left(\frac{\mathrm{M_{Saturn}}}{\mathrm{m_{proton}}}\right) = \ln\left(\frac{5.6836 \cdot 10^{23}\ \mathrm{kg}}{1.672621 \cdot 10^{-27}\ \mathrm{kg}}\right) = 123.26$$

The half value of this logarithm $123.26/2 = 61.63$ corresponds to the mass: $\mathrm{m}_p \cdot \exp(61.63) = 0.975$ kg that is the range of the adult human lungs [21]. It is remarkable that the second massive planet of the Solar System corresponds with the second massive organ of the human organism – the lungs.

The radius of Saturn is near the main node [54; ∞] of the $\mathcal{F}$ calibrated on the proton:

$$\ln\left(\frac{\mathrm{R_{Saturn}}}{\lambda_{\mathrm{proton}}}\right) = \ln\left(\frac{6.0268 \cdot 10^{7}\ \mathrm{m}}{2.1030891 \cdot 10^{-16}\ \mathrm{m}}\right) = 54.01$$

Dividing the logarithm $54/2 = 27$ we receive the logarithm of the main node [27; ∞] that corresponds to the wavelength $\lambda_p \cdot \exp(27) = 0.11$ mm that coincides with the size of the human fertile oocyte (zygote) [24].

As shown above, the Solar radius coincides with the main node [49; ∞] of the $\mathcal{F}$ calibrated on the electron. Dividing the logarithm $49/2 = 24.5$ we receive the logarithm of the node [24; 2] that is the main node [32; ∞] of the $\mathcal{F}$ calibrated on the proton, because $24.5 + 7.5 = 32$. This logarithm corresponds to the wavelength $\lambda_e \cdot \exp(24.5) = 16.6$ mm that coincides with the object focal length of the human eye [25] that is also the length of the newborn eyeball.

At the same time, the Solar radius is near the node [56; 2] of the $\mathcal{F}$ calibrated on the proton:

$$\ln\left(\frac{\mathrm{R_{Sun}}}{\lambda_{\mathrm{proton}}}\right) = \ln\left(\frac{6.96407 \cdot 10^{8}\ \mathrm{m}}{2.103089 \cdot 10^{-16}\ \mathrm{m}}\right) = 56.46$$

The angular Compton wavelength of the proton is $\lambda_p = 2.103089 \cdot 10^{-16}$ m [20].

Dividing the logarithm $56.5/2 = 28.25$ we receive the logarithm of the significant subnode [28; 4] that corresponds to the wavelength $\lambda_p \cdot \exp(28.25) = 0.39$ mm that coincides with the second focal length [26] behind the retina of the human eye.

Already in 1981 Leonid Chislenko [27] did demonstrate that ranges of body masses and sizes preferred by the most quantity of biological species show an equidistant distribution on a logarithmic scale with a scaling factor close to 3. Probably, this is a consequence of global scaling, if we consider that the scaling factor $e = 2.718\ldots$ connects the main attractor nodes of stability in the fundamental fractal $\mathcal{F}$.

Conclusion

Applying our fractal model of matter as chain system of oscillating protons and electrons to the analysis of astrophysical and biophysical metric data we can assume that the metric characteristics of biological organisms and those of the Solar system have a common subatomic origin. However, there is a huge field of research where various discoveries are still to be expected.

Acknowledgements

The author is grateful to Viktor Panchelyuga and Leili Khosravi for valuable discussions.

Submitted on November 5, 2017

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