

# Solar System. Angular Momentum. Dark Matter Reactors

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## Abstract

The developed Hypersphere World-Universe Model (WUM) is consistent with all Concepts of the World [1]. In WUM, we postulate the principal role of Angular Momentum and Dark Matter in Cosmological theories of the World. The most widely accepted model of Solar System formation, known as the Nebular hypothesis, does not solve the **Angular Momentum problem** – why is the orbital momentum of Jupiter larger than rotational momentum of the Sun? WUM is the only cosmological model in existence that is consistent with this Fundamental Law. The Nebular hypothesis does not solve **Internal Heating and Diversity** problems for all Planets and Moons in Solar system – why the actual mean surface temperature of them is higher than their effective temperature calculated based on the Sun’s heat for them and how could each one be so different if all of them came from the same nebula? The proposed concept of Dark Matter Reactors in Cores of all gravitationally-rounded Macroobjects successfully resolves these problems.

## 1. Introduction. Short History of Solar System Formation

The most widely accepted model of Solar system formation, known as the Nebular hypothesis, was first proposed in 1734 by E. Swedenborg [2], [3] and later elaborated and expanded upon by I. Kant in 1755 in his “Universal Natural History and Theory of the Heavens” [4].

**Nebular Hypothesis** maintains that 4.6 billion years ago, the Solar System (SS) formed from the gravitational collapse of a giant molecular cloud, which was light years across. Most of the mass collected in the Centre, forming the Sun; the rest of the mass flattened into a protoplanetary disc, out of which the planets and other objects in SS formed.

The Nebular hypothesis is not without its critics. In his “The Wonders of Nature”, V. Ferrell outlined the following counter-arguments [5]:

- *It contradicts the obvious physical principle that gas in outer space never coagulates; it always spreads outward;*
- *Each planet and moon in Solar system has unique structures and properties. How could each one be different if all of them came from the same nebula;*
- *A full 98 percent of all the angular momentum in the Solar system is concentrated in the planets, yet a staggering 99.8 percent of all the mass in our Solar system is in our Sun;*
- *Jupiter itself has 60 percent of the planetary angular motion. Evolutionary theory cannot account for this. This strange distribution was the primary cause of the downfall of the Nebular hypothesis;*
- *There is no possible means by which the angular momentum from the Sun could be transferred to the planets. Yet this is what would have to be done if any of the evolutionary theories of Solar system origin are to be accepted.*

**Lunar Origin Fission Hypothesis** was proposed by G. Darwin in 1879 to explain the origin of the Moon by rapidly spinning Earth, on which equatorial gravitative attraction was nearly overcome by centrifugal force [6]. D. U. Wise made a detailed analysis of this hypothesis in 1966 and concluded that “*it might seem prudent to include some modified form of rotational fission among our working hypothesis*” [7].

**Solar Fission Theory** was proposed by L. Jacot in 1951 who stated that [8]:

- *The planets were expelled from the Sun one by one from the equatorial bulge caused by rotation;*
- *One of these planets shattered to form the asteroid belt;*
- *The moons and rings of planets were formed from the similar expulsion of material from their parent planets.*

T. Van Flandern further extended this theory in 1993 [9]. He proposed that planets were expelled from the Sun in pairs at different times. Six original planets exploded to form the rest of the modern planets. It solves several problems the standard model does not:

- *If planets fission from the Sun due to overspin while the proto-Sun is still accreting, this more easily explains how 98% of the Solar system's angular momentum ended up in the planets;*
- *It solves the mystery of the dominance of prograde rotation for these original planets since they would have shared in the Sun's prograde rotation at the outset;*
- *It also explains coplanar and circular orbits;*
- *It is the only model that explains the twinning of planets (and moons) and difference of planet pairs because after each planet pair is formed in this way, it will be some time before the Sun and extended cloud reach another overspin condition.*

The outstanding issues of the Solar fission are:

- *It is usually objected that tidal friction between a proto-planet and a gaseous parent, such as the proto-Sun, ought to be negligible because the gaseous parent can reshape itself so that any tidal bulge has no lag or lead, and therefore transfers no angular momentum to the proto-planet;*
- *There would exist no energy source to allow for planetary explosions.*

Neither L. Jacot nor T. Van Flandern proposed an origin for the Sun itself. It seems that they followed the standard Nebular hypothesis of the formation of the Sun. In our Model, we concentrated on furthering the Solar fission theory [10].

### 3. Angular Momentum Problem

Angular Momentum Problem is one of the most critical problem in Standard Cosmology that must be solved. Standard Cosmology does not explain how Galaxies and Extrasolar systems obtained their enormous orbital angular momenta. Any theory of evolution of the Universe that is not consistent with the Law of Conservation of Angular Momentum should be promptly ruled out. To the best of our knowledge, WUM is the only cosmological model in existence that is consistent with this Fundamental Law.

The outstanding issues of SS are:

- The rotational momentum of the Sun is smaller than Jupiter's, Saturn's, Uranus's, and Neptune's orbital momentum. Evolutionary theory cannot account for this. This strange distribution was the primary cause of the downfall of the Nebular hypothesis;
- There is no possible means by which the angular momentum from the Sun could be transferred to the planets.

There is another problem in the Standard Cosmology – **Orbital Angular Momentum problem** [11]:

- SS has an orbital momentum  $L_{orb}^{SS}$  calculated based on the distance of 26.4 kly from the galactic Centre

and orbital speed of about 220 km/s :  $L_{orb}^{SS} = 1.1 \times 10^{56} J s$ , which far exceeds the rotational angular momentum:  $L_{rot}^{SS} = 3.2 \times 10^{43} J s$ ;

- Milky Way (MW) galaxy is gravitationally bounded with the Local Supercluster and has an orbital angular momentum  $L_{orb}^{MW}$  calculated based on the distance of 65 million light-years from Local Supercluster and orbital speed of about 400 km/s [13]:  $L_{orb}^{MW} = 2.5 \times 10^{71} J s$ , which far exceeds the rotational angular momentum of MW [14]:  $L_{rot}^{MW} \approx 1 \times 10^{67} J s$ ;
- How did MW and SS obtain their substantial orbital angular momenta?

In frames of WUM, we calculated rotational and orbital angular momentum of all gravitationally-rounded Macroobjects in SS, from Mimas, a small moon of Saturn ( $R_M = 198 km$ ,  $M_M = 3.75 \times 10^{19} kg$ ) to the Sun itself ( $R_S = 7 \times 10^5 km$ ,  $M_S = 2 \times 10^{30} kg$ ) and found that orbital momenta of most satellites are indeed substantially smaller than the rotational momenta of their prime objects, with three exceptions [11]:

- The Sun accounts for about 0.3% of the total rotational angular momentum of SS while about 60% is attributed to Jupiter;
- The rotational momentum of the Earth is substantially smaller than Moon's orbital momentum;
- The rotational momentum of Pluto is considerably smaller than Charon's orbital momentum.

In our opinion, there is the only one mechanism that can provide angular momenta to Macroobjects – **Rotational Fission** of overspinning (surface speed at equator exceeding escape velocity) Prime Objects. From the point of view of Fission model, the Prime Object is transferring some of its rotational angular momentum to orbital and rotational momenta of satellites. It follows that the **rotational momentum of the prime object should exceed the orbital momentum of its satellite**.

In frames of WUM, Prime Objects are Dark Matter (DM) Cores of Superclusters, which must accumulate tremendous rotational angular momenta before the Birth of the Luminous World. It means that it must be some long enough time in the history of the World, which we named “Dark Epoch” [12]. To be consistent with the Law of Conservation of Angular Momentum we developed a New Cosmology of the World:

- WUM introduces Dark Epoch (spanning from the Beginning of the World for 0.45 billion years) when only DM Macroobjects (MOs) existed, and Luminous Epoch (ever since for 13.77 billion years) when Luminous MOs emerged due to the Rotational Fission of Overspinning DM Superclusters' Cores and self-annihilation of Dark Matter Particles (DMPs);
- Proposed Weak Interaction between DMPs provides the integrity of DM Cores, which are 3D fluid balls with a high viscosity and act as solid-state objects;
- The main objects of the World are overspinning DM Cores of Superclusters, which accumulated tremendous rotational angular momenta during Dark Epoch and transferred it to DM Cores of Galaxies during their Rotational Fission. The experimental observations of galaxies in the universe showed that most of them are disk galaxies: about 60% are ellipticals and about 20% are spirals [13]. These results speak in favor of the developed Rotational Fission mechanism;
- Size, mass, density, composition,  $L_{orb}$  and  $L_{rot}$  of satellite cores depend on local density fluctuations at the edge of the overspinning prime DM cores and cohesion of the outer shell. Consequently, the diversity of satellite cores has a clear explanation;
- Dark Matter Core of MW was born 13.77 billion years ago as the result of the Rotational Fission of the Local Supercluster DM Core;
- DM Cores of Extrasolar systems, planets and moons were born as the result of the repeating Rotational Fissions of MW DM Core in different times (4.57 billion years ago for SS);

- Macrostructures of the World form from the top (superclusters) down to galaxies, extrasolar systems, planets, and moons.

Based on the developed New Cosmology, we performed a detailed analysis of the angular momenta of all gravitationally-rounded Macroobjects in SS and found that [11]:

- The overspinning DM Core of MW could produce DM core of the Sun with the substantial orbital angular momenta of SS;
- The overspinning DM Core of the Sun could produce DM cores of all planets, which could produce DM cores of all moons, including the Moon of the Earth;
- The Pluto – Charon pair is definitely a binary system. Charon was not generated by Pluto’s DM core; instead, they are two Macroobjects that happened to be bounded together by gravity.

## 4. Sun

**Internal Structure.** According to the standard Solar model, the Sun has:

- Core that extends from the center to about 20–25% of the solar radius, contains 34% of the Sun's mass with density  $\rho_{max} = 1.5 \times 10^5 \text{ kg/m}^3$  and  $\rho_{min} = 2 \times 10^4 \text{ kg/m}^3$ . It produces all of Sun’s energy;
- Radiative zone from the Core to about 70% of the solar radius with density  $\rho_{max} = 2 \times 10^4 \text{ kg/m}^3$  and  $\rho_{min} = 2 \times 10^2 \text{ kg/m}^3$  in which convection does not occur and energy transfer occurs by means of radiation;
- Core and Radiative zone contain practically all Sun’s mass [14]. In our view, they are parts of DM Core of the Sun.

The large power output of the Sun is mainly due to the huge size and density of its Core (compared to the Earth), with only a fairly small amount of power being generated per cubic meter. Theoretical models of the Sun's interior indicate a maximum power density of approximately  $276.5 \text{ W/m}^3$  at the center of the Core [15] (see **Table 1**), which is about the same power density inside a compost pile [16] and closer approximates reptile metabolism than a thermonuclear bomb.

**Solar Core Rotation.** E. Fossat, *et al.* found that Solar Core rotates  $3.8 \pm 0.1$  faster than the surrounding envelope [17]. The fact that the Solar Core rotates faster than surrounding envelope, despite high viscosity of the internal medium, is intriguing. WUM explains this phenomenon through the absorption of DMPs by Solar Core over time  $\tau$ . DMPs supply not only additional mass ( $\propto \tau^{3/2}$ ), but also additional angular momentum ( $\propto \tau^2$ ). DM Core irradiates products of DMPs self-annihilation, which carry away excessive angular momentum. The Solar Wind is the result of this mechanism [12].

**Evolution of the Sun.** By 1950s, stellar astrophysicists had worked out the physical principles governing the structure and evolution of stars [18]. According to these principles, the Sun’s luminosity had to change over time, with the young Sun being about 30% less luminous than today [19], [20], [21], [22]. The long-term evolution of the bolometric solar luminosity  $L(\tau)$  as a function of cosmological time  $\tau$  can be approximated by a simple linear law:  $L(\tau) \propto \tau$  [18].

One of the consequences of WUM holds that all stars were fainter in the past. As their cores absorb new DMPs, size of MO cores  $R_{MO}$  and their luminosity  $L_{MO}$  are increasing in time:  $R_{MO} \propto \tau^{1/2}$  and  $L_{MO} \propto R_{MO}^2 \propto \tau$ , respectively. Taking the age of the World:  $A_W \cong 14.2 \text{ Byr}$  and the age of SS:  $A_{SS} \cong 4.6 \text{ Byr}$ , it is easy to find that the young Suns’ output was 67% of what it is today. Literature commonly refers to the value of 70% [21]. This result supports the developed model of the structure and evolution of the Sun [18].

**Table 1.** Computer Model of the Sun at 4.5 Billion Years. Adapted from [15].

Radius, Rel. to $R_{\odot}$	Radius $\times 10^9 m$	Temperature $\times 10^6 K$	Luminosity, %	Fusion Rate, $W/kg$	Fusion Power Density, $W/m^3$
0	0.00	15.7	0	0.0175	276.5
0.09	0.06	13.8	33	0.010	103.0
0.12	0.08	12.8	55	.0068	56.4
0.14	0.10	11.3	79	.0033	19.5
0.19	0.13	10.1	91	.0016	6.9
0.22	0.15	9.0	97	0.0007	2.2
0.24	0.17	8.1	99	0.0003	0.67
0.29	0.20	7.1	100	0.00006	.09
0.46	0.32	3.9	100	0	0
0.69	0.48	1.73	100	0	0
0.89	0.62	0.66	100	0	0

**Solar Flare** is a sudden flash of increased brightness on the Sun, usually observed near its surface and in close proximity to a sunspot group. Powerful flares are often, but not always, accompanied by a coronal mass ejection. The maximum total energy of a bolometric fluence that was observed in 2012 is:  $6 \times 10^{25} J$  [23]. During the impulsive stage of Solar flares, radio waves, hard x-rays, and gamma rays with energy above 100 GeV are emitted (one photon had an energy as high as 467.7 GeV) [24].

**Coronal Mass Ejection** is a significant release of plasma from the solar corona. They often follow solar flares and are normally present during a solar prominence eruption. Coronal mass ejections are often associated with other forms of solar activity, but a broadly accepted theoretical understanding of these relationships has not been established. Coronal Mass Ejections most often originate from active regions on the Sun's surface, such as groupings of sunspots associated with frequent flares.

In **WUM**, Solar Flares and Coronal Mass Ejections are the result of the activity of DM Core of the Sun. They can be explained by the Sun's DM Core eruptions of DMPs and their subsequent self-annihilation. As the result, radio waves and gamma rays are observed together with mass ejections of ordinary particles originated by the self-annihilation of DMPs. It is worth noting that the self-annihilation of DMPs depends on the density squared. It is in good agreement with Fusion Power Density distribution inside of the Sun considering drop of density from  $1.5 \times 10^5 kg/m^3$  at the Centre to  $2 \times 10^2 kg/m^3$  at the edge of DM core.

## 5. Earth

**Internal Structure.** Information about the Earth's structure mostly comes from the analysis of seismic waves. According to the standard model, the Earth has the following layers: an outer silicate solid Crust, solid Mantle, a liquid Outer core, and a solid Inner core. The Inner core is believed to be composed of an iron–nickel alloy with some other elements. The temperature at the Inner core's surface is estimated to be approximately 5,700 K. The liquid Outer core surrounds the Inner core and is believed to be composed of iron mixed with nickel and trace amounts of lighter elements.

Although seismic waves propagate through the core as if it was solid, the measurements cannot distinguish between a perfectly solid material from an extremely viscous one. Some scientists have therefore considered whether there may be **slow convection in the Inner Core as is believed to exist in the Mantle**. That could be an explanation for the anisotropy detected in seismic studies. In 2009, B. Buffett estimated the viscosity of the Inner core at  $10^{18} \text{ kg m}^{-1} \text{ s}^{-1}$  [25].

In our view, the Inner core, Outer core, and Lower mantle are the parts of the Earth's liquid DM core, which have different viscosities from extremely high values for the Inner core going down to a 660-km boundary between the Lower mantle and Upper mantle with Crust (see below). The main characteristics of the Earth's layers are presented in **Table 2**.

**Table 2.** Density and Mass of Earth's Layers. Adapted from [26].

Depth, km	Component Layer	Outer Radius, Rel. to Earth Radius	Density, $kg/m^3 \times 10^3$	Mass, kg $\times 10^{22}$	Mass, Rel. to Earth Mass
0	Atmosphere		0.0012	0.0005	0.0000008
0 - 11	Oceans	1	1.02 - 1.05	0.14	0.0002
0 - 35	Crust	1	2.2 - 2.9	4	0.007
35 - 660	Upper Mantle	0.99	3.4 - 4.4	112	0.19
660 - 2900	Lower Mantle	0.9	3.4 - 5.6	265	0.44
2900 - 5100	Outer Core	0.55	9.9 - 12.2	183	0.31
5100 - 6400	Inner Core	0.2	12.8 - 13.1	12	0.02

Let us take a look at the structure of the Earth:

- An Inner core and an Outer core that extend from the Centre to about 55% of the Earth radius with density  $\rho_{max} = 1.3 \times 10^4 \text{ kg/m}^3$  and  $\rho_{min} = 9.9 \times 10^3 \text{ kg/m}^3$  ;
- Lower mantle, spanning from the Outer core to about 90% of the Earth radius (below 660 km) with density  $\rho_{max} = 5.6 \times 10^3 \text{ kg/m}^3$  and  $\rho_{min} = 3.4 \times 10^3 \text{ kg/m}^3$  ;
- Upper mantle, spanning from the Lower mantle to about 99% of the Earth radius (below 35 km) with density  $\rho_{max} = 4.4 \times 10^3 \text{ kg/m}^3$  and  $\rho_{min} = 3.4 \times 10^3 \text{ kg/m}^3$  ;
- Inner core, Outer core, and Lower mantle contain most of the Earth's mass [27].

Very little is known about the Lower mantle apart from that there is a seismicity cutoff-660 (660-km discontinuity):  $\rho_{min} = 3.4 \times 10^3 \text{ kg/m}^3$  for the Lower mantle is less than  $\rho_{max} = 4.4 \times 10^3 \text{ kg/m}^3$  for the Upper mantle. In our view, Lower mantle is the part of the Earth's DM core.

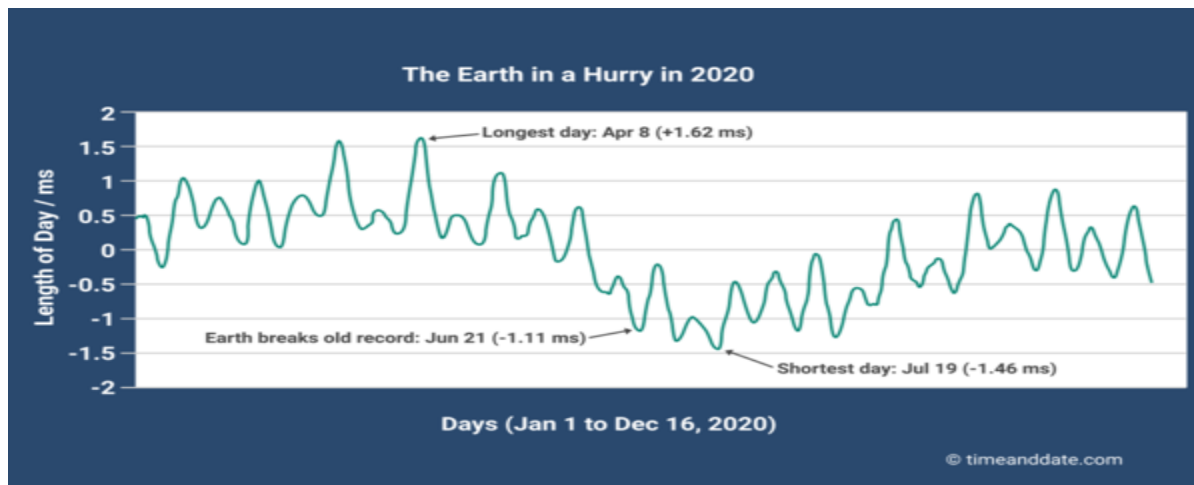
W. Wu, S. Ni, and J. Irving investigated scattered seismic waves traveling inside the Earth to constrain the roughness of the Earth's 660-km boundary [28]. The researchers were surprised by just how rough that boundary is – rougher than the surface layer that we all live on. The roughness was not equally distributed, either; just as the Crust's surface has smooth ocean floors and massive mountains, the 660-km boundary has rough areas and smooth patches [29].

X. Markenscoff in the paper “Volume collapse” instabilities in deep-focus earthquakes: a shear source nucleated and driven by pressure” explains “*the mystery of the long-standing observations in deep-focus earthquakes (400-700 km) by symmetry-breaking instabilities in high-pressure phase transformation, which produce the counterintuitive phenomenon of “volume collapse” producing only shear radiation, with little, or no, volumetric component, even under conditions of full isotropy*” [30].

According to WUM, the 660-km boundary is a boundary between Earth's DM core and Upper mantle with Crust, which were produced by DM core during 4.57 billion years [11]. The deep-focus earthquakes are connected with random mass ejections of DM core happening at the 660-km boundary.

**Random Variations of Earth's Rotational Speed.** G. Jones and K. Bikos in the paper “Earth Is in a Hurry in 2020” wrote [31]:

*“When highly accurate atomic clocks were developed, they showed that the length of a mean solar day can vary by milliseconds. These differences are obtained by measuring the Earth's rotation with respect to distant astronomical objects”.* It turned out that the variations of the daylength throughout 2020 were in the range  $86400 \pm_{-1.46}^{+1.62} \text{ms}$ . *The speed of the Earth's rotation varies constantly because of the complex motion of its molten core, oceans and atmosphere, plus other effects.*



**Fig. 1.** Variation of daylength throughout 2020. The length of day is shown as the difference in milliseconds (ms) between the Earth's rotation and 86,400 seconds. Adapted from [31].

In frames of WUM, random variations of the Earth's rotational speed on a daily basis can be explained by variations in an activity of the Earth's DM core. As the result of DMPs self-annihilation, random mass ejections are happening. During a time of high DM core activity, the Earth's rotational speed is lower (long days) due to increase of their moment of inertia. When random mass ejections are less frequent, the Earth's moment of inertia is decreasing, we observe short days.

Let us analyze the proposed mechanism. The relative change of the daylength throughout 2020 was about  $2 \times 10^{-8}$ . Hence, the relative change of the Earth's moment of inertia must be about  $2 \times 10^{-8}$ . If a layer of a mass  $m$  at radius of  $r$  will shift on  $h$ , the relative change of the Earth's moment of inertia will be about  $\frac{m r h}{M R R} \sim 10^{-8}$ , where  $M$  and  $R$  are the mass and radius of the Earth, respectively. In case of the Atmosphere (see **Table 2**):  $\frac{m}{M} \sim 10^{-6}$ ,  $r \sim R$ , and  $\frac{h}{R} \sim 10^{-2}$ . It means that  $h \sim 64 \text{ km}$ . In case of the Oceans:  $\frac{m}{M} \sim 10^{-4}$ ,  $r \sim R$ , and  $\frac{h}{R} \sim 10^{-4}$ . It means that  $h \sim 640 \text{ m}$ . In case of the boundary Lower mantle – Upper mantle:  $\frac{m}{M} \sim 10^{-5}$ ,  $r \sim R$ , and  $\frac{h}{R} \sim 10^{-3}$ . It means that  $h \sim 6.4 \text{ km}$ .

The estimated values of the masses and shifts show:

- There is no way to explain the random variations of the speed of the Earth's rotation by the complex motion of oceans and atmosphere as it was supposed in [31];
- They can be explained by random mass ejections of the Lower mantle's layer.

**Internal Heating.** The analysis of the Sun's heat for planets in SS yields the effective temperature of Earth of 255 K [32]. The actual mean surface temperature of Earth is 288 K [33]. The higher actual temperature of the Earth is due to the heat generated internally by the planet itself. According to the standard model, the Earth's internal heat is produced mostly through the radioactive decay. The major heat-producing isotopes within Earth are K-40, U-238, and Th-232. The mean global heat loss from Earth is  $44.2 \pm 1.0 \text{ TW}$  [34]. The Earth's Uranium has been thought to be produced in one or more supernovae over 6 billion years ago.

**Radiogenic decay** can be estimated from the flux of geoneutrinos that are emitted during radioactive decay. The KamLAND Collaboration combined precise measurements of the geoneutrino flux from the Kamioka Liquid-Scintillator Antineutrino Detector, Japan, with existing measurements from the Borexino detector, Italy. They found that decay of U-238 and Th-232 together contribute about 20 TW to the total heat flux from the Earth to space. The neutrinos emitted from the decay of K-40 contribute 4 TW. Based on the observations the KamLAND Collaboration made a conclusion that *"heat from radioactive decay contributes about half of Earth's total heat flux"*[35].

**Plutonium-244** with half-life of 80 million years is not produced in significant quantities by the nuclear fuel cycle, because it needs very high neutron flux environments. Any Plutonium-244 present in the Earth's Crust should have decayed by now. Nevertheless, D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature [36].

In WUM, all chemical products of the Earth including isotopes K-40, U-238, Th-232, and Pu-244, are produced within the Earth as the result of the DMPs self-annihilation with the rest energy 1.3 TeV (compare to proton rest energy 938 MeV) [11]. They arrive in the Crust of the Earth due to convection currents in the mantle carrying heat and isotopes from the interior to the planet's surface [37]. According to WUM, the 660-km boundary is a boundary between Dark Matter Reactor and Upper mantle with Crust, which were produced by Dark Matter Reactor during 4.57 billion years and are, in fact, "Homemade" [11].

As a conclusion, the internal heating of all gravitationally-rounded Macroobjects of SS is due to DMPs self-annihilation in their DM cores made up of DMPs (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the Macroobjects. New DMPs freely penetrate through the entire Macroobjects' envelope, get absorbed into the DM cores, and continuously support DMPs self-annihilation.



**Faint Young Sun paradox:** with the young Sun's output at only 70 percent of its current output (see Subsection **Evolution of the Sun**), the early Earth would be expected to be completely frozen, but the early Earth seems to have had liquid water. The issue was raised by astronomers C. Sagan and G. Mullen in 1972 [38]. An unresolved question is how a climate suitable for life was maintained on Earth over the long timescale despite the variable solar output and wide range of terrestrial conditions [39]. Proposed resolutions of this paradox have taken into account greenhouse effects, changes to planetary albedo, astrophysical influences, or combinations of these suggestions.

In frames of WUM, the Upper mantle with Crust are due to DM core activity: the self-annihilation of DMPs in the DM core. As a result of this activity, a thickness of the Upper mantle with Crust is growing in time: the early Earth had a smaller thickness than it is in the present time. Hence, the temperature of the Earth's surface was higher than its calculated temperature based on the Sun's output at that time.

**Expanding Earth** hypothesis asserts that the position and relative movement of continents is at least partially due to the volume of Earth increasing. In 1888 I. O. Yarkovsky suggested that some sort of aether is absorbed within Earth and transformed into new chemical elements, forcing the celestial bodies to expand. Also, the theses of O. C. Hilgenberg (1933, 1974) and N. Tesla (1935) were based on absorption and transformation of aether-energy into normal matter. In spite of the recognition of plate tectonics in the 1970s, scientific consensus has rejected any significant expansion or contraction of Earth [40].

In WUM, the Earth's DM core absorbs new DMPs, and its size is increasing in time  $\propto \tau^{1/2}$ , Hence, there is an expansion of DM core, and its surface (the Upper mantle with Crust) is likewise expanding. Due to DMPs self-annihilation, new chemical elements are created inside of the Upper mantle with Crust. As the result, the relative movement of continents is happening. The Medium of the World with DMPs are, in fact, some sort of aether proposed by Yarkovsky, Hilgenberg, and Tesla.

## 6. Mars

NASA's InSight mission landed on Mars on 26 November 2018. It aims to determine the interior structure, composition and thermal state of Mars, as well as constrain present-day seismicity and impact cratering rates. Such information is key to understanding the differentiation and subsequent thermal evolution of Mars. InSight lander learns Mars interior by monitoring "marsquakes" with magnitude not larger than around 4 on the Richter scale. Mars is just the third celestial body to have its core directly measured with seismic data, following Earth in the early 1900s and the Moon in 2011.

Mars is seismically active, with InSight recording over 450 marsquakes and related events in 2019 [41], [42]. In March 2021, NASA reported, based on measurements of over 500 Marsquakes that the core of Mars is liquid and has a radius of about 1830 km, more than half the radius of Mars and about half the size of the Earth's core. This is significantly larger than models predicted, suggesting a core of lighter elements [43]. Average retrieved core density is  $6 \times 10^3 \text{ kg/m}^3$ .

NASA researchers found that seismic waves must be bouncing off a boundary of  $\sim 1550 \text{ km}$  beneath the surface: the dividing line between Mars's solid mantle and its liquid core. The mantle between the crust and core has a single rocky layer. It is thinner than Earth's and has a different composition which suggests that "*two planets arose from different materials when they formed*". ETH Zurich geophysicist and study co-author A. Khan told that "*this might be the simple explanation why we do not see plate tectonics on Mars*".

The crust of Mars  $48 \pm 24 \text{ km}$  thick is likely highly enriched in radioactive elements that help to heat this layer at the expense of the interior. The crust is far more enriched with radioactive, heat-producing elements by a factor of 13 to 21 relative to the mantle beneath. This enrichment is greater than suggested

by gamma-ray surface mapping and has a moderate-to-elevated surface heat flow. These results could help explain why its volcanoes show up at where they do despite the planet's lack of global plate tectonics [44].

Analysis of the obtained experimental results show that:

- Internal structure of the Mars is close enough to the structure of the Earth:
  - Radius of the Mars core relative to the Mars radius is 0.54 (for the Earth this ratio is 0.55, **Table 2**);
  - Relative thickness of the Mars mantle is 0.46 (for the Earth this ratio is 0.45, **Table 2**);
- Composition of the Mars layers is significantly different from the composition of the Earth layers;
- Average Mars core density  $6 \times 10^3 \text{ kg/m}^3$  is significantly less than the average Earth core density  $12 \times 10^3 \text{ kg/m}^3$ ;
- Seismic waves are bouncing off a boundary between Mars's solid mantle and its liquid core. What is the cause of them?
- Mars crust is far more enriched with radioactive, heat-producing elements by a factor of 13 to 21 relative to the mantle beneath. Where do they come from?

In frames of WUM, these questions can be answered the following way:

- Seismic waves are generated by random mass ejections of the Mars DM core like deep-focus earthquakes, which are connected with random mass ejections of the Earth DM core happening at the 660-km boundary;
- Mars crust is far more enriched with radioactive, heat-producing elements, which are produced within the Mars DM core as the result of DMPs self-annihilation. They arrive to the crust of Mars due to convection currents in the mantle carrying isotopes from the interior to the planet's surface;
- Significantly smaller Mars core density is important because the self-annihilation of DMPs depends on the density squared. It explains why the actual mean Mars surface temperature of 215 K is slightly higher than an effective temperature of 210 K due to the Sun's heat [45]. At the same time, the actual mean Earth surface temperature of 288 K [33] is significantly higher than an effective temperature of 255 K due to the Sun's heat [32].

## 7. The Moon

The Moon is a differentiated body, being composed of a geochemically distinct crust, mantle, and planetary core. Based on geophysical techniques, the crust is estimated to be on average about 50 km thick. Moonquakes have been found to occur deep within the mantle of the Moon about 1,000 km below the surface. Several lines of evidence imply that the lunar core is small, with a radius of about 350 km or less. The size of the lunar core is only about 20% the size of the Moon itself, in contrast to about 50% as is the case for most other terrestrial bodies. The composition of the lunar core is not well constrained, but most believe that it is composed of metallic iron alloy with a small amount of sulfur and nickel [46].

In 2010, a reanalysis of the old Apollo seismic data on the deep moonquakes using modern processing methods confirmed that the Moon has an iron rich core with a radius of  $330 \pm 20$  km. The same reanalysis established that the solid Inner core made of pure iron has a radius of  $240 \pm 10$  km. The core is surrounded by the partially (10 to 30%) melted layer of the Lower mantle with a radius of  $480 \pm 20$  km (thickness  $\sim 150$  km). These results imply that 40% of the core by volume has solidified. The density of the liquid outer core is about  $5 \times 10^3 \text{ kg/m}^3$ . The temperature in the core is probably about 1600–1700 K [47].

In 2019, a reanalysis of nearly 50 years of data collected from the Lunar Laser Ranging experiment with lunar gravity field data from the GRAIL mission, shows that for a relaxed lunar **fluid core** with non-hydrostatic lithospheres, the core-mantle boundary has a radius  $381 \pm 12$  km [48].

In WUM, the internal structure of the Moon can be explained the same way as it was done for the Earth and Mars. It is worth noting that the DM core of the Moon is much less than DM core of the Earth. This result is in good agreement with the proposed in our Model mechanism of the Moon creation: DM Core of the Moon was born as the result of the Rotational Fission of the Earth DM Core 4.57 billion years ago.

## 8. Planets and Moons

**Jupiter** radiates more heat than it receives from the Sun [49]. Giant planets like Jupiter are hundreds of degrees warmer than current temperature models predict. Until now, the extremely warm temperatures observed in Jupiter's atmosphere (about 970 C [50]) have been difficult to explain, due to lack of a known heat source [11]. T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere [51].

**Saturn** radiates 2.5 times more energy than it receives from the Sun [52]. Despite consisting mostly of hydrogen and helium, most of Saturn's mass is not in the gas phase, because hydrogen becomes a non-ideal liquid when the density is above  $10 \text{ kg/m}^3$ , which is reached at a radius containing 99.9% of Saturn's mass. The temperature, pressure, and density inside Saturn all rise steadily toward the core, which causes hydrogen to be a metal in the deeper layers [53].

Standard planetary models suggest that the interior of Saturn is similar to that of Jupiter, having a small rocky core surrounded by hydrogen and helium, with trace amounts of various volatiles [54]. This core is similar in composition to Earth but is denser. In 2004, scientists estimated that the core must be 9–22 times the mass of the Earth [55], [56], which corresponds to a diameter of about 25,000 km [57]. This is surrounded by a thicker liquid metallic hydrogen layer, followed by a liquid layer of helium-saturated molecular hydrogen that gradually transitions to a gas with increasing altitude. The outermost layer spans 1,000 km and consists of gas. Saturn has a hot interior, reaching 11,700 °C at its core.

C. R. Mankovich and J. Fuller in the paper “A diffuse core in Saturn revealed by ring seismology” compare structural models with gravity and seismic measurements to show that the data can only be explained by a diffuse, stably stratified core-envelope transition region in Saturn extending to approximately 60% of the planet's radius and containing approximately 17 Earth masses of ice and rock [58].

**Uranus** radiates 1.1 times more energy than it receives from the Sun [59]; **Neptune** – 2.6 times [60]. The most fascinating result was obtained for the smallest gravitationally-rounded Macroobject – **Mimas** with a mean density  $1.15 \times 10^3 \text{ kg/m}^3$  and the temperature  $\approx 64 \text{ K}$ . **Figure 2** illustrates the unexpected and bizarre pattern of daytime temperatures found on it. It is worth noting that the self-annihilation of DMPs inside of the Mimas DM core is efficient with the core density about  $10^3 \text{ kg/m}^3$ , and the Mimas temperature is significantly higher than the effective temperature calculated based on the heat it receives from the Sun.

S. Kamata, *et al.* report that “*many icy Solar System bodies possess subsurface oceans. To maintain an ocean, Pluto needs to retain heat inside*”. Kamata, *et al.* show that “*the presence of a thin layer of gas hydrates at the base of the ice shell can explain both the long-term survival of the ocean and the maintenance of shell thickness contrasts. Gas hydrates act as a thermal insulator, preventing the ocean from completely freezing while keeping the ice shell cold and immobile. The most likely guest gas is methane*” [62].

According to WUM, the internal heating of all gravitationally-rounded Macroobjects of the Solar system is due to DMPs self-annihilation in their cores made up of DMPs (1.3 TeV). The amount of energy produced due to this process is sufficiently high to heat up the Macroobjects.

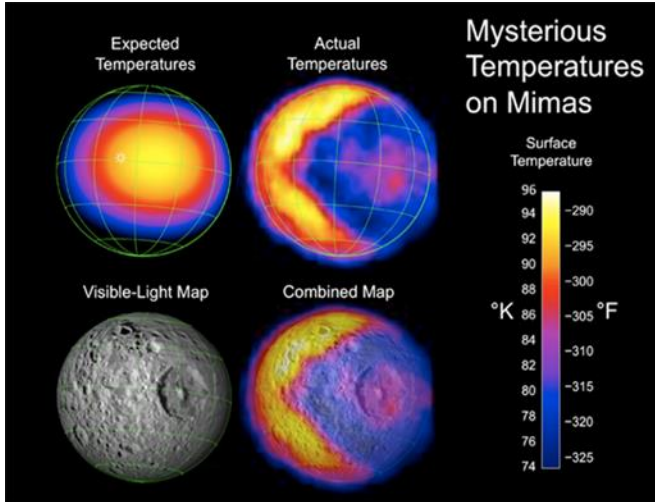


Figure 2. Mimas pattern of daytime temperatures. Adapted from [61].

## 9. Dark Matter Reactors

The following facts support the existence of **Dark Matter Cores** in Macroobjects:

- E. Fossat, *et al.* found that Solar Core rotates  $3.8 \pm 0.1$  faster than the surrounding envelope;
- J. Zhang, *et al.* concluded that the Earth's inner core is rotating faster than its surface by about 0.3 – 0.5 degrees per year;
- T. Guillot, *et al.* found that a deep interior of Jupiter rotates nearly as a rigid body, with differential rotation decreasing by at least an order of magnitude compared to the atmosphere;
- W. Wu, S. Ni, and J. Irving were surprised by just how rough the Earth's 660-km boundary is – rougher than the surface layer that we all live on;
- The variations of the Earth daylength throughout 2020 were in the range  $86400_{-1.46ms}^{+1.62ms} s$  ;
- D. C. Hoffman, *et al.* in 1971 obtained the first indication of Pu-244 present existence in Nature.
- Giant planets like **Jupiter** are hundreds of degrees warmer than current temperature models predict. **Saturn** radiates 2.5 times more energy than it receives from the Sun; **Uranus** – 1.1 times; **Neptune** – 2.6 times;
- Many Icy Solar system bodies including **Pluto** possess subsurface oceans.

The radiuses of the DM cores of the different Macroobjects of SS are presented in **Table 3**.

**Table 3.** The radius of the DM core of the different Macroobjects in the Solar system.

Macroobject	Sun	Saturn	Earth	Mars	Moon	Mimas
Radius, km $\times 10^3$	487	34.9	3.52	1.83	0.381	< 0.2

In WUM, Macroobjects' cores are essentially Dark Matter Reactors fueled by DMPs. All chemical elements, compositions, radiations are produced by Macroobjects themselves as the result of DMPs self-annihilation. The diversity of all gravitationally-rounded Macroobjects in the Solar system is explained by the differences in their DM cores (mass, size, density, composition). The DM Reactors at their cores (including Earth) are very efficient and provide enough energy for the internal heating and all their geological processes like

volcanos, quakes, mountains' formation through tectonic forces or volcanism, tectonic plates' movements, etc. All gravitationally-rounded Macroobjects in hydrostatic equilibrium, down to Mimas in Solar system, prove the validity of WUM.

## 10. Conclusion

WUM does not attempt to explain all available cosmological data, as that is an impossible feat for any one article. Nor does WUM pretend to have built an all-encompassing theory that can be accepted as is. The Model needs significant further elaboration, but in its present shape, it can already serve as a basis for a new Cosmology proposed by Paul Dirac in 1937. The Model should be developed into the well-elaborated theory by the entire physical community. In our view, great experimental results and observations achieved by Astronomy in the last decades should be analyzed through the prism of a New Paradigm – Hypersphere World-Universe Model [1]. Solar System became Experimental Laboratory for astrophysicists to check their theories!

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