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May turbulence and fossil turbulence lead to life in the universe?

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Abstract

Turbulence is defined as an eddy-like state of fluid motion where the inertial-vortex forces of the eddies are larger than all the other forces that tend to damp the eddies out. Fossil turbulence is a perturbation produced by turbulence that persists after the fluid ceases to be turbulent at the scale of the perturbation. Because vorticity is produced at small scales, turbulence cascades from small scales to large, providing a consistent physical basis for Kolmogorovian universal similarity laws. Oceanic and astrophysical mixing and diffusion are dominated by fossil turbulence and fossil turbulent waves. Observations from space telescopes show turbulence existed in the beginning of the universe and that its fossils still persist. Fossils of big bang turbulence include a preferred large-scale spin direction, large scale microwave temperature anisotropy patterns, and the dominant dark matter of all galaxies; that is, clumps of $\sim 10^{12}$ frozen hydrogen earth-mass planets that make stars and globular-star-clusters when gravitationally agitated. When the planets were hot gas, we can speculate that they hosted the formation of the first life in a seeded cosmic organic-chemical soup of hot-water oceans as planets merged to form and over-feed the first stars.

1. Introduction

Stratified turbulence and fossil turbulence dominate mixing and diffusion in natural fluids like the ocean and atmosphere, Gibson et al. (2011). Turbulence also controls the formation of astrophysical objects influenced by self-gravity, like stars, star clusters, galaxies and galaxy-clusters, and Proto-Globular-star-Clusters of dark-matter planets

(PGCs), Gibson (1996), Schild (1996), Bershadskii and Sreenivasan (2003). Turbulence provides the large negative stresses required by general relativity theory to drive the big bang and supply the mass-energy of inflation, Gibson (1991, 2004, 2005). Space telescopes cover an ever-widening range of frequencies, and show fossil turbulence evidence that turbulence and collisional fluid mechanics have controlled the formation and evolution of the Universe from the beginning of time to the present day.

Applications to cosmology theory of modern fluid mechanics and the revised definition of turbulence and fossil turbulence (Gibson 2012ab) presented in the Abstract fundamentally change the interpretation of space telescope data. In the opinion of the present author, all observations suggest the standard model of cosmology, based on Dark Energy (Λ), Cold Dark Matter Hierarchical Clustering (ΛCDMHC), and collisionless fluid mechanics, should be replaced by a new cosmology termed Hydro-Gravitational Dynamics (HGD), Gibson (1996), Schild (1996), Gibson & Schild (2012). The dark matter of galaxies is identified by HGD as PGC clumps of frozen primordial gas planets, as first observed and independently claimed as the missing galaxy mass by Schild (1996). Schild's interpretation and discovery of PGC planets as the dominant galaxy dark matter from quasar microlensing is reinforced by infrared detections of the 2009 Herschel space observatory and the 2009 Planck space telescope as discussed below, Juvela et al. (2012). Other authors have noticed problems with the ΛCDMHC scenario, Kroupa (2012).

An unanticipated result of the Gibson (1996) HGD prediction of primordial planet PGC clumps as the source of all stars is that this easily explains how life was formed by wide and early distribution on cosmic scales of PGCs and their planets, with chemically seeded water oceans formed by the planets. Since the first star and the first planet do not appear in the standard model of cosmology until after 300 Myr, the formation of cosmic life becomes extremely problematic for ΛCDMHC. Temperatures are below the freezing point of hydrogen, and the cosmic density is 10^6 less than that at 0.3 Myr for HGD planets. The controversial Hoyle-Wickramasinghe cometary panspermia hypothesis for the beginning of life on Earth, Wickramasinghe (2010), is strongly supported by HGD cosmology and the new data, Gibson, Schild & Wickramasinghe (2011).

HGD cosmology rejects the underlying ΛCDMHC assumptions of collisionless, inviscid, linear, ideal, diffusionless fluid mechanics. From HGD theory, viscous stresses, turbulence, fossil turbulence, and fossil turbulence waves are critical to astrophysics and astronomy, just as they are for oceanography and atmospheric sciences. Summaries of the theories and observations are updated in the present paper, Gibson (2010, 2011), and Gibson, Schild & Wickramasinghe (2011). Herschel and Planck observations are discussed in Section 3.

2. Theory

Understanding astrophysical turbulence requires that the conservation of momentum equations be applied to collisional fluids; that is, to fluids where the mean free path for collisions is smaller than the separation of fluid particles and the scale of causal connection *ct*, where *c* is the speed of light and *t* is the age of the universe since the big bang. The Navier Stokes equations are arranged so that the rate of change of specific momentum **v** equals the sum of forces per unit mass, isolating the negative gradient of the Bernoulli group B of mechanical energy terms $v^2/2 + p/\rho + lw$ (kinetic energy, enthalpy and lost work per unit mass). In most cases of interest, -grad B may be neglected. Thus the non-linear inertial vortex force term $\mathbf{v}\times\boldsymbol{\omega}$ is the source of turbulence when the other forces are negligible, where the vorticity $\boldsymbol{\omega}$ is curl **v**.

The best-known criterion for turbulence to develop is the Reynolds number, which is the ratio of the inertial-vortex force $\mathbf{v}\times\boldsymbol{\omega}$ to the viscous force. Boundary layers thicken until they reach a critical Reynolds number at five times the Kolmogorov length scale before they become turbulent. In stably stratified fluids the turbulence cascades to larger scales by vortex pairing and merging driven by $\mathbf{v}\times\boldsymbol{\omega}$ forces. The ratio of $\mathbf{v}\times\boldsymbol{\omega}$ to the buoyancy force is termed the Froude number. When this grows to a critical value, fossilization, and fossil turbulence wave radiation, begin at the largest eddy sizes, Gibson, Bondur, Keeler, Leung (2011). Transport in the vertical direction in the ocean and atmosphere, and in the radial direction for self-gravitational objects, is termed fossil turbulence wave radiation. The turbulence cascade to large scales thus continues in the vertical direction until limited at a critical Froude number by buoyancy forces at the Ozmidov scale at fossilization, and in the horizontal direction until Coriolis forces cause the waves to fossilize at a critical Rossby number and Rossby radius of deformation. We will be concerned with the weakly turbulent primordial plasma produced by the hot big bang as it expands and cools to form gas.

At the plasma to gas transition from HGD cosmology the Schwarz viscous fragmentation scale ~ $L_{SV} = (\gamma\nu/\rho G)^{1/2}$ rapidly decreases from that of proto-galaxies to that of proto-planets because the kinematic viscosity ν decreases by a factor of 10^{13}, while the rate of strain γ_0 and the density ρ_0 retain constant fossil turbulence values from the 10^{12} s time of first fragmentation to the 10^{13} s time of transition to gas (300,000 years). From heat transfer considerations, the gas also fragments at the Jeans scale $V_{Sound}/(\rho G)^{1/2}$, forming Proto-Globular-star-Cluster PGC clumps of primordial gas (H, He^4) planets. The size of each PGC clump of a trillion planets is ~ $(M_{PGC}/\rho_0)^{1/3}$; that is, about $3x10^{17}$ meters, with planet size ~ $(M_{Earth}/\rho_0)^{1/3} = 5x10^{13}$ meters. As the planets of a PGC form stars, an Oort cavity ~ $(M_{Sun}/\rho_0)^{1/3} = 3.7x10^{15}$ m is formed in the PGC clump, which explains the remarkably narrow range of diameters for cold core filaments observed by the Planck and Herschel satellites discussed in Section 3 as proto-planetary-nebulae PPN, Fig. 3. One of the nearest PGCs to Earth is the AB Doradus Moving Group, where a surprising 4-7 Jupiter "lonely planet" is reported and only 11 stars, Delorme et al. (2012), suggesting a much larger unseen population of rogue planets.

In astrophysics and cosmology the most distinctive fossil of turbulence is the vorticity, conserved as angular momentum per unit area. Fossil vorticity turbulence of the big bang is preserved as weak spin anisotropies at the largest length scales of the cosmic microwave background, as shown in Figure 1. A series of bumps appear in the CMB power spectrum C_l of Fig. 1 that reflect the vortex dynamics of the original big bang turbulence damped at 10^{-27} s by gluon viscosity, Gibson (2005), and subsequent plasma epoch turbulence and supervoid fragmentation triggered at 10^{12} s by big bang turbulence fossils when L_{SV} matched *ct*, Gibson (1996). The narrow ranges of size and mass observed for PGCs (section 3, Fig. 3) is predicted by HGD cosmology because ρ_0 and γ_0 are preserved as fossils of the first fragmentation turbulence.

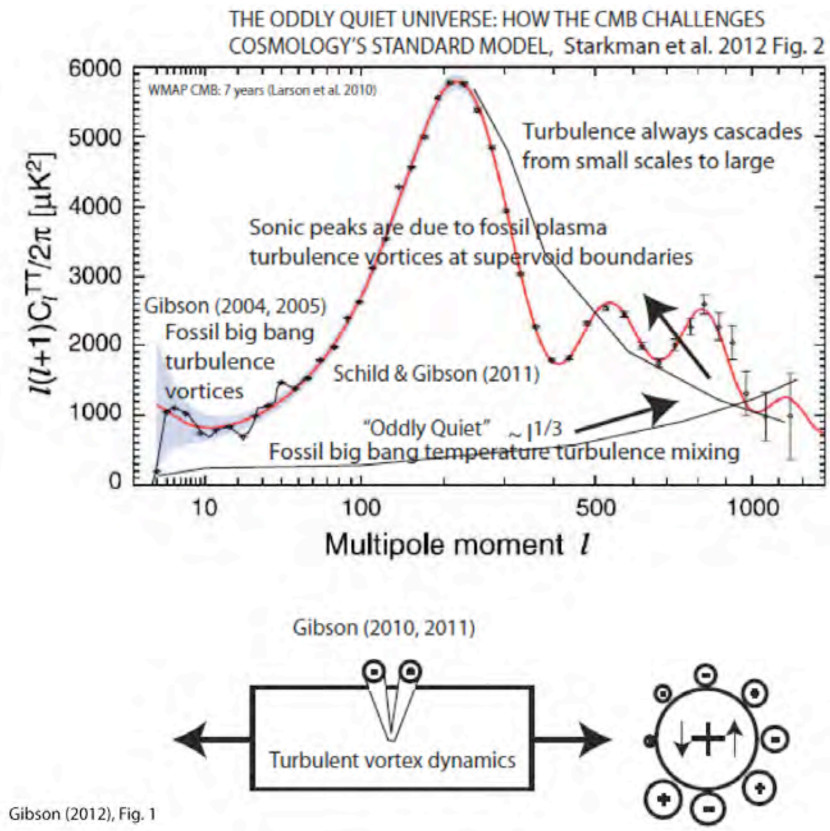

Figure 1. Cosmic microwave background temperature anisotropy spectrum from WMAP satellite.

The largest length scale bumps are on the left of Fig. 1 for l = 2-40. They are labeled "Fossil big bang turbulence vortices" based on the turbulence vortex dynamics model shown at the bottom of Fig. 1 and the Gibson (2004, 2005) theory of big bang turbulence. Fossil big bang temperature turbulence should follow the indicated Corrsin-Obukhov $(1+l)l\ C_l \sim l^{1/3}$ spectral form for turbulent mixing. Cascade directions are shown by the arrows, Gibson (2012b Fig. 4). The large amplitude bumps of Fig. 1 for wavenumbers $l > 200$ reflect secondary vortices produced by expanding superclustervoids from time $t \sim 10^{12}$ seconds after the big bang when the large kinematic viscosity of the plasma first permitted gravitational fragmentation of 10^{47} kg supercluster masses. Superclustervoids expand as rarefaction waves limited by the plasma sound speed $c/3^{1/2}$, where c is the speed of light. Voids of size 10^{25} m observed by radio telescopes are impossible by the standard ΛCDMHC cosmological model where superclusters of galaxies and the voids between them are the last objects to be formed rather than the first.

The main "sonic peak" in Fig. 1 at l ~ 200 reflects the size of sonic expansion reached at the time of plasma to gas transition $t \sim 10^{13}$ seconds. The fragmented supercluster objects retain the spin and density of the plasma as fossils, and so do the smaller cluster and galaxy fragments produced by further cooling before transition to gas. The fossil density from $t \sim 10^{12}$ s appears as that of globular star clusters $\rho_0 \sim 4 \times 10^{-17}$ kg m^{-3}. The fossil spin appears as the close alignment of rich Abell clusters of galaxies, Godlowski (2012). Because the clusters and galaxies are observed to be aligned, the standard model ΛCDMHC is contradicted by Godlowski's paper. Hierarchical clustering HC of cold dark matter CDM halos would produce a random orientation of spins for rich Abell clusters. The fossil big bang turbulence spin also appears as a preferred direction on the sky termed the "axis of evil", Schild & Gibson (2011). Dipole, quadripole, etc. moments of the CMB spherical harmonic directions are found to be all pointing in the same direction; that is, along the axis of evil.

A large amount of gravitational potential energy remains stored in the PGC clumps of planets formed at plasma to gas transition. As shown in Figure 2, the cosmic microwave background radiation appears to be dominated by low frequency synchrotron radiation emitted by merging planets forming larger planets and the first stars soon after the plasma to gas transition, Fornengo et al. (2011).

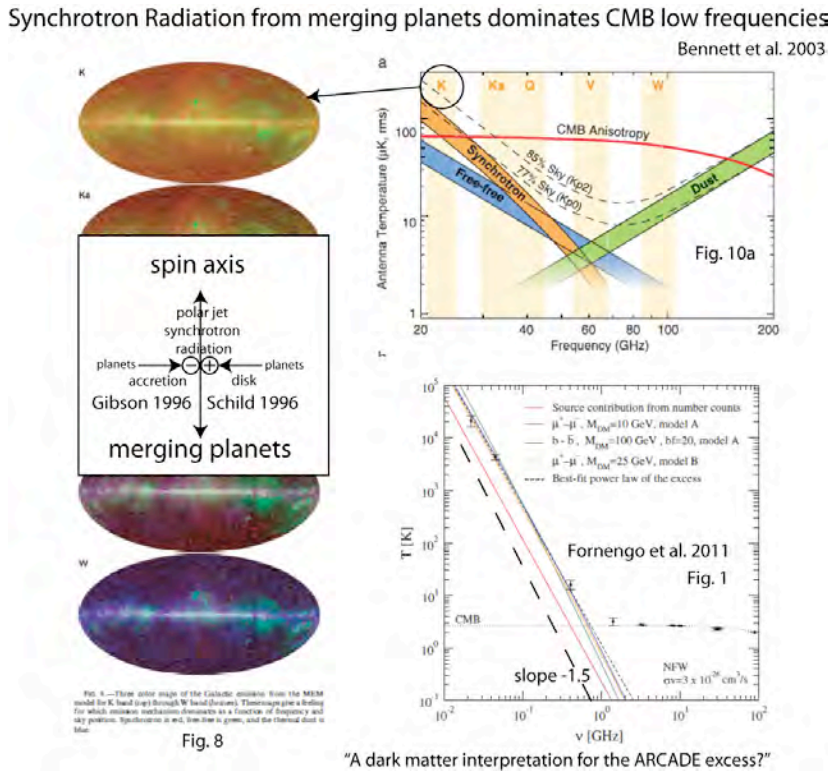

Figure 2. Low frequency synchrotron radiation (Bennett et al. 2003) from the CMB is supplied by merging dark matter planets of Gibson (1996) and Schild (1996), to explain the observed ARCADE excess (Fornengo et al. 2011).

We see from Fig. 2 (cartoon left) that polar jet synchrotron radiation from planet-merging can explain the observed CMB radiation at low frequencies. The planets merge on an accretion disk and form a plasma jet with synchrotron radiation as the central planet approaches star mass. The radiation should begin immediately after the plasma to gas transition. The first stars appear in fossil first-fragmentation gravitational free fall time $t_g = (\rho G)^{-1/2} \sim 10^{12}$ s (30,000 years) from hot gas planets at 300 thousand years, not after hundreds of millions of years of dark ages according to ΛCDMHC.

3. Observations

Recent observations by the Herschel space observatory support the predictions of hydrogravitational dynamics HGD cosmology. Figure 3 show an infrared image of PGCs in the Small Magellanic Cloud, with high resolution images on the left and top. A similar concentration of PGCs is found for the Large Magellanic cloud. The thousands of identical red objects detected by Herschel at 250 μ are described in the NASA webpage http://www.nasa.gov/ mission_pages /herschel/ multimedia/ pia15255.html as "dust", but are actually dark matter PGCs weakly glowing as they form larger planets.

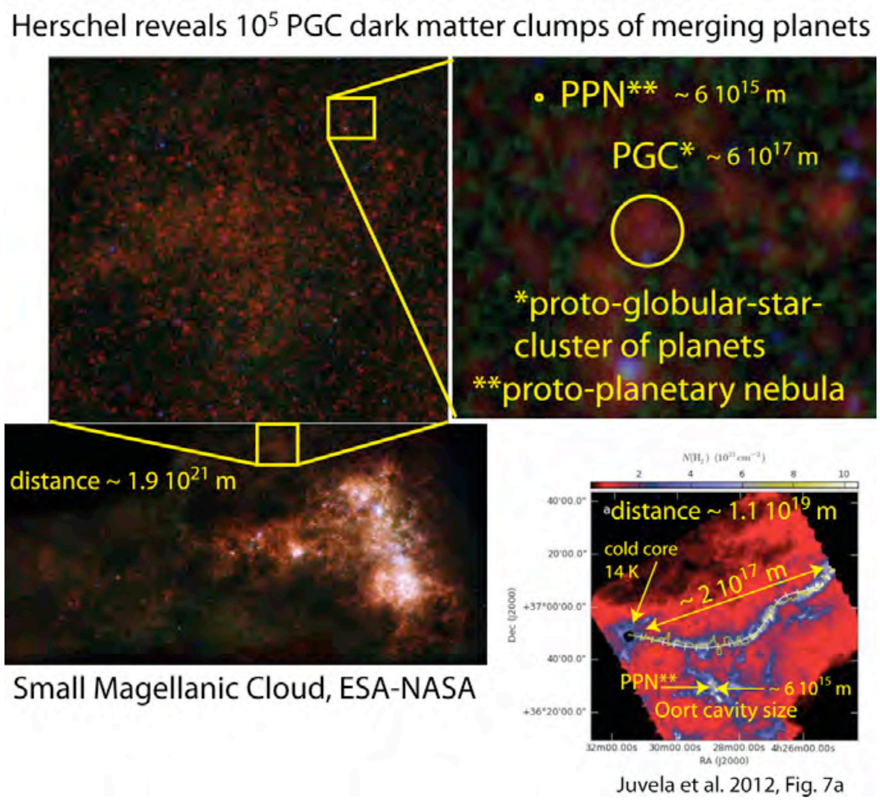

Figure 3. Herschel space observatory images of the dark matter of the Milky Way Galaxy confirms the HGD prediction that the missing mass consists of metastable PGC clumps of frozen primordial gas planets. Red dots seen in the SMC as well as the LMC star clouds are interpreted as dark matter PGCs. Image credit: ESA/NASA/JPL-Caltech/STScI.

By counting the number of PGCs in the upper right hand image of Fig. 3 and measuring the area sizes in the left images it is possible to estimate ~ 100,000 PGCs in the SMC, giving a total mass of 10^{41} kg for the object, or about 0.1% of the mass of the Galaxy. This is close to the usually assumed value. A somewhat larger mass of PGCs is found for the Large Magellanic cloud Herschel image on the same web site. Blue dots, cold cores and filaments (Fig. 3, right) are at the Oort cavity size $6x10^{15}$ m corresponding to the mass of a stellar binary, termed PPN for Proto-Planetary Nebula. According to HGD, planetary nebulae form, not from material ejected by the star, but from planets surrounding the Oort cavity, evaporated by polar plasma jets from central binaries such as white dwarfs nearing supernova Ia conditions due to overfeeding by cometary planets from the PGC, Gibson & Schild (2007).

Star formation in the interior of a PGC is shown by the more nearby image shown at the lower right of Fig. 3, from Juvela et al. (2012, Fig 7a). The PGC is only 1.1×10^{19} m distant, 174 times closer than the SMC, which is at 1.9×10^{21} m. Warm objects are detected along filaments that originate with cold core objects such as that shown on the left, with temperature 14 K matching the triple point of hydrogen. The length of the filaments are comparable to the size of a PGC, 3×10^{17} m. The width of the filaments in all PGCs sampled matches the size of an Oort cavity, 6×10^{15} m, suggesting a constant ρ_0 value in the Galaxy as predicted by HGD.

The erratic positions of the filaments suggest they reflect planet and star formations induced by tidal force tracks of passing PGC centers of gravity through the observed PGC rather than the wakes of objects. It seems clear that the Herschel images of Fig. 3 are showing star formation from dark matter primordial planets in PGCs, as predicted by HGD cosmology.

4. Discussion

Figure 4 shows the location of the Magellanic clouds of PGCs and stars in Galactic coordinates, and their interpretation according to HGD cosmology. Protogalaxies are the smallest objects to form during the plasma epoch, just before the transition to gas at 10^{13} seconds. Because the PGCs are initially composed of hot primordial gas planets, they are collisional and sticky, and form large clumps such as the Magellanic clouds. The first stars form in the protogalaxy of size $L_N = 10^{20}$ meters at the Galaxy center. Most will be the small population II stars of old globular clusters, but some will be larger reflecting significant levels of turbulence, and will soon explode to form the first C, N, O, etc. chemical oxides to seed the hot hydrogen gas planets to form water and metallic iron. At 2 million years the universe cools to the critical temperature of water 647 K so deep hot oceans form on the seeded planets. The millions of possible organic chemical reactions begin their competition for the carbon. If the complex reactions of DNA life can ever form without a miracle, this is the time. This is the biological big bang, Gibson, Wickramasinghe & Schild (2011).

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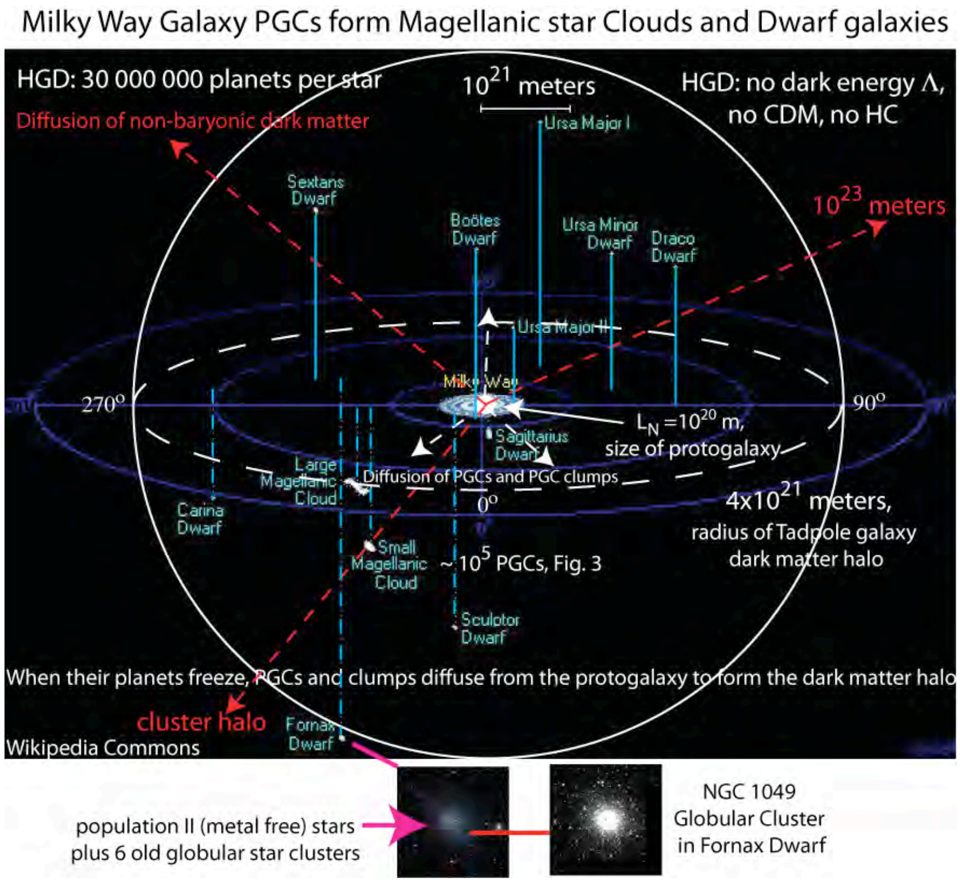

Figure 4. Herschel space observatory images of the dark matter of the Milky Way Galaxy confirms the HGD prediction that the missing mass consists of metastable PGC clumps of frozen primordial gas planets.

As shown in Fig. 4, the protogalaxy-diameter (Nomura scale) $L_N = 10^{20}$ m of the Milky Way (and all galaxies), from HGD cosmology, is 20-25 times smaller that the dark matter halo (dashed white oval) radius formed by diffusion (white dashed arrows) of the nearly collisionless PGCs resulting when their planets freeze. A sharp reduction of planet size from 10^{14} m at fragmentation to 10^7 m at freezing will occur at time t about 30 million years when the temperature T of the Universe cools to the hydrogen triple point 13.8 K. The mean free path for collisions of frozen planets then becomes much larger than the PGC, so the PGCs and any clumps of PGCs that may have formed in the protogalaxy become nearly collisionless and will begin to diffuse away from the Galaxy center to form the dark matter halo. The diameter of the halo shown in Fig. 4 is the same as that observed for the Tadpole Galaxy, ~ 10^{22} meters. This matches the most distant of the Dwarf galaxies Fig. 4 (Fornax). An image of Fornax and one of its six globular clusters is shown at the bottom of Fig. 4. The fact that globular star clusters such as NGC 1049 are identical from galaxy to galaxy and within our Galaxy with a mass density of $\rho_0 = 4x10^{-17}$ kg m^{-3} is strong evidence that the time of first fragmentation was 10^{12} seconds when this was the baryonic density of the expanding universe.

Life formation conditions are optimum before the diffusion of PGCs into the dark matter halo of the Milky Way in Fig. 4. Hot gas planets first formed stars, chemicals and life in the small protogalaxy. The time was 2 million years when the universe temperature decreased to the critical temperature of water 647 K so that liquid water oceans could condense to accelerate the evolution of organic chemistry. Critical temperature water is apolar and dissolves organic chemicals that ordinary water will not. A cosmic soup of 10^{80} merging planets stirred by exploding stars and active galactic nuclei produced and distributed the complexities of DNA life to every corner of the big bang universe. The dark matter hydrogen planets cooled to the freezing point of water at 8 million years, slowing the speed of life evolution. Hoyle-Wickramasinghe variously estimate the probability of spontaneous life formation on Earth in the range one chance in 10^{6500} to 10^{100}. Life formation according to ΛCDMHC cosmology cannot begin till the first star appears at hundreds of millions of years, and the first planets later with little or no distribution of life on cosmic scales. The existence of homogeneous cosmic extraterrestrial life by HGD has probability ~1 versus ~0 for ΛCDMHC cosmology.

5. Conclusions

Modern fluid mechanics is needed to properly interpret the wealth of new information about cosmology provided by modern space telescopes. Gravitational structure formation starting with the big bang is much easier to understand using fluid mechanical concepts of viscosity, diffusion, turbulence, fossil turbulence and fossil turbulence waves, as employed by hydrogravitational dynamics HGD cosmology, than it is using cold dark matter and dark energy concepts that fail to explain the space telescope observations of Figs. 1, 2, 3 and 4. Evidence of spin alignments such as Godlowski (2012) confirms the intrinsically rotational and aligned nature of big-bang-turbulence-vorticity fossils, Gibson (2004, 2005). Fig. 4 summarizes the application of HGD cosmology to explain the dark matter of the Milky Way as highly persistent PGC clumps of primordial planets that produce the stars and randomly dim their supernovae. Evidence that gas planets are very near all stars in all galaxies, and may produce systematic dimming errors in all Supernovae 1a events, raises questions about the 2011 Nobel Prize in Physics, Gibson & Schild (2011). From HGD, $\Lambda = 0$ and the universe ends in a big crunch.

Perhaps the most important consequence of PGC clumps of hydrogen-gas-planets as the dark matter of galaxies is their crucial role in the formation of life. Because all stars form by mergers of the planets in a binary cascade from Earth mass to Solar, the organic chemistry and biological information preserved in the water oceans formed on the planets is shared on a cosmic scale starting within a few million years after the big bang. The fact that life exists on Earth makes first stars at 300-400 Myr after the big bang seem unlikely as predicted by ΛCDMHC since the probability of cosmic life is $\ll 10^{-100}$, and favors first stars at 0.3 Myr and homogeneous cosmic life at 2 Myr as predicted by HGD cosmology with probability ~1.

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