Interpretation of the Helix Planetary Nebula using Hydro-Gravitational-Dynamics: Planets and Dark Energy

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ABSTRACT

Hubble Space Telescope (HST/ACS) images of the Helix Planetary Nebula (NGC 7293) are interpreted using the hydro-gravitational-dynamics theory (HGD) of Gibson 1996-2006. HGD predicts that baryonic-dark-matter (BDM) dominates the mass of galaxies (Schild 1996) as Jovian (promordial-fog-particle, PFP) Planets (JPPs) in proto-globular-star-cluster (PGC) clumps within galaxy halo diameters surrounding its stars. From HGD, supernova Ia (SNe Ia) events normally occur in planetary nebulae (PNe) within PGCs where binary clustering cascades of merging planets produce central binary star systems. As central stars of PNe, binaries exchange mass and accrete JPPs to grow white-dwarfs to $1.44M_\odot$ instability within ionized (Oort cloud) cavities bounded by evaporating JPPs. SNe Ia events are thus intermittently obscured by radiation-inflated JPP atmospheres producing systematic SNe Ia distance errors, so the otherwise mysterious “dark energy” concept is unnecessary. HST/ACS and WFPC2 Helix images show $> 7000$ cometary globules, here interpreted as gas-dust cocoons of...
JPPs evaporated by beamed radiation from its white-dwarf plus companion central binary star system. Mass for growing the stars, the PNe, and possibly a SNe Ia event, is accreted gravitationally from ambient BDM JPPs. Measured JPP masses $\approx 3 \times 10^{25}$ kg with spacing $\approx 10^{14}$ m support the HGD prediction that the density $\rho$ of galaxy star forming regions fossilize the density $\rho_0 \approx (3 - 1) \times 10^{-17}$ kg m$^{-3}$ existing at 30,000 years in the plasma-epoch, when proto-superclusters fragmented in the expanding universe giving the first gravitational structures.


1. Introduction

Brightness values of Supernovae Ia (SNe Ia) events, taken as standard candles for redshift values $0.01 < z < 2$, depart significantly from those expected for the decelerating expansion of a flat universe (Riess et al. 2004). Departures indicate a recent dimming at all frequencies by about 30%, but with large scatter attributed to uncertainty in the SNe Ia models. For $\geq 15$ years of study the evidence has accumulated with no explanation other than an accelerating, rather than the expected decelerating, expansion of the universe presumed to reflect a negative pressure from a time dependent $\Lambda(t)$ “cosmological constant” component of the Einstein equations termed “dark-energy”. Hubble Space Telescope Advanced Camera for Surveys (HST/ACS) images have such high signal to noise ratios that both the scatter and the dimming are statistically significant over the full range of $z$ values. At large $z \geq 0.46$ any “uniform grey dust” systematic error can be eliminated, indicating flat universe deceleration until a “cosmic jerk” to acceleration for $z \leq 0.46$. The “dark energy” interpretation is made from SNe Ia observations because no alternative explanation exists in the commonly accepted (but fluid mechanically untenable) $\Lambda$-cold-dark-matter ($\Lambda$CDM) hierarchically clustering cosmological theory ($\Lambda$CDMHCC, Table 2).

In the following we suggest just such an alternative explanation exists for the observed intermittent SNe Ia brightness dimming. New scenarios are clearly required for planetary nebulae (PNe) formation and for star formation, star evolution and star death when a massive population of Jovian planets is recognized as the baryonic dark matter (BDM) and the interstellar medium. All stars are born from these planets, which also collect and recycle the dust and water of exploding stars to produce terrestrial planets and life. The JPP BDM mass is about 30 times the luminous mass of stars in an average galaxy. BDM is predicted to be dense star-forming clumps of frozen primordial gas planets by hydro-gravitational-dynamics (HGD) theory (Gibson 1996; Gibson 2000; Gibson 2001; Gibson 2004; Gibson 2005). Sev-
eral major adjustments to standard cosmological, astrophysical, and astronomical models are required by HGD as summarized elsewhere (Gibson 2006a; Gibson 2006b).

Jovian rogue planets dominating inner halo galaxy mass densities matches the identical, but completely independent, interpretation offered from Q0957+561A,B quasar microlensing observations (Schild 1996). Repeated, continuous, observations of the Q0957 lensed quasar and other lensed quasar systems have now firmly established the fact that the mass of galaxies within all radii containing the stars must be dominated by planets (Colley & Schild 2003; Schild 2004a; Schild 2004b; Gibson 2006a; Gibson 2006b). The non-baryonic dark matter of galaxies (probably a mix of neutrino flavors, mostly primordial) with mass about 30 times the baryonic mass is super-diffusive and presently forms large outer galaxy halos or galaxy cluster halos. From HGD, its major dynamical role is to continue the decelerating expansion of the universe toward zero velocity (or slightly less) by its large scale gravitational forces.

According to HGD, SNe Ia explosions always occur in PNes within massive dense (proto-globular-star-cluster; ie, PGC) clumps of frozen primordial planets (primordial-fog-particles or PFPs) that form larger planets and finally stars as binaries. Planetary nebulae are not just brief puffs of illuminated gas and dust from dying stars in a vacuum, but are manifestations of the thirty million primordial dark matter planets that surround every star. Whenever a central star gets hot or makes a plasma jet with its close companion the surrounding JPP planets illuminated by the jet evaporate and become visible as a PNe. PNes thus appear out of the dark whenever dying white-dwarf (WD) carbon stars slowly grow at the expense of their companion stars (Hamann et al. 2003; Pena et al. 2004) to the Chandrasekhar limit of $1.44M_{\odot}$.

When JPPs are agitated to high speeds, rapid growth of the central binary star formed from the resulting enhanced JPP accretion process may prevent the formation of a collapsing carbon core in either star so that no white dwarf and no SNe Ia can result. Massive stars up to the Eddington limit of $110M_{\odot}$ may form in this way and will swiftly die as Supernova IIab. The speed $V_{JPP}$ of the planets within a PGC and the size and composition of their gas-dust atmospheres are clearly critical parameters to the formation of larger planets, stars, and PNe, and will be the subject of future studies (see Fig. 2 below). These parameters are analogous to the small protein chemicals used for bacterial quorum sensing in symbiotic gene expressions (Loh & Stacey 2003) by providing a form of PGC corporate memory. Numerous dense, cold, water-maser and molecular-gas-clumps detected by radio telescopes in red giants and PNe (Miranda et al. 2001; Tafoya et al. 2007) are very likely JPPs and should be studied as such to reveal important JPP parameters such as $V_{JPP}$.

Powerful, hot, beamed, plasma-jet radiation from a growing central PNe binary will evaporate and illuminate previously frozen H-He gas of the ambient densely packed Jovian
planets that dominate the interstellar medium. A gentle rain of JPP comets on the central stars of PNe permits the possibility that any WD may slowly grow its carbon core to the Chandrasekhar limit. As the carbon core mass grows, its density and angular momentum increase along with the strength of the plasma beam created by mass exchanges within the binary stars, with strong increases in the WD surface temperature, photon radiation, and observable PNe mass $M_{PNe}$. Strong JPP rains lead to Wolf-Rayet (C,N and O class) stars and C-stars cloaked in massive envelopes of evaporated JPPs that have also been misinterpreted as superwind ejecta. Such stars are typically found in spiral galaxy (accretion) disks, where tidally agitated dark PGCs that have gradually diffused away from their primordial protogalaxy are captured and accreted back toward the core according to HGD theory.

SNe Ia events are therefore likely to be intermittently dimmed by Oort-rim distant JPP-atmospheres evaporated by the increasing radiation prior to the event that has ionized and accreted all JPPs in the Oort cloud cavity. The new scenario of SNe Ia formation by gradual WD growth of slowly dying $\leq M_\odot$ size stars fed by JPP comets is slower than the standard model SNe Ia events (see §2.3.1) where superwinds dump most of the mass of relatively short-lived $3-9M_\odot$ intermediate size stars into the ISM. Few SNe Ia events are seen at large redshifts, and this may be why. Evidence of a massive (several $M_\odot$) H-rich circumstellar medium at distances of up to nearly a light year ($10^{16}$ m) after the brightness maximum has been reported from slow fading SNe Ia events (Woods-Vasey et al. 2004).

From HGD, stars form from planets as binaries or complex binary systems in PGCs from the binary accretional cascade of the dark matter PFPs to form larger mass JPPs (Jovian-PFP-Planets). Rogue stars like the sun were likely ejected from triplets or formed from a binary merger. Without HGD, it is a mystery that stars form as binaries (and that stars form at all). When a gas cloud collapses it forms only one star and does not fragment into the multiplicity observed (O’Shea & Norman 2006). Atmospheres of these H-He baryonic dark matter planets on SNe Ia lines of sight can account for the observed random dimming of SNe Ia as an intermittent “nonlinear grey dust” systematic error, rather than requiring the highly revolutionary $\Lambda(t)$ “dark energy” scenario. The “grey dust” of ambient JPPs is nonlinear because it gets more opaque when it gets hot, forming dusty JPP planet atmospheres. It is intermittent because clear lines of sight may exist to SNe Ia events and their halos of radiation inflated JPP “dust particles”. No dimming of the SNe Ia light will occur for several months while it is within the Oort cloud cavity of this size.

Theories describing the death of small and intermediate mass stars ($0.5-9M_\odot$) to form white-dwarfs and planetary nebulae are notoriously unsatisfactory (Iben 1984). Neglecting ambient JPPs of HGD, observations of PNe mass and composition indicate that most of the matter for such stars is inexplicably expelled (Knapp et al. 1982) when they form dense
carbon cores and die. Models of PNe formation have long been admittedly speculative, empirical, and without meaningful theoretical guidance (Iben 1984). A counter-intuitive but empirical “Reimer’s Wind” expression gives stellar mass loss rates \( \sim LR/M \) inversely proportional to the mass \( M \) of the star dumping its mass, where \( L \) is its huge luminosity (up to \( 10^6L_\odot \)) and \( R \) is its huge radius (up to \( 10^2R_\odot \)). Why inversely? Super winds must be postulated to carry away unexpectedly massive stellar envelopes of surprising composition by forces unknown to fluid mechanics or physics in unexpectedly dense fragments.

Radiation pressure, even with dust and pulsation enhancement, is inadequate to explain the AGB superwind (Woitke 2006), and shock wave effects cannot explain the large densities of the Helix cometary knots (§3). All these surprises vanish when one recognizes that the interstellar medium consists of primordial H-He planets rather than a hard vacuum. From HGD, most planetary nebulae contain \( \approx 100M_\odot \) of unevaporated JPPs by assuming a PNe size of \( 2 \times 10^{16} \) m and a BDM density in star forming regions of \( 2 \times 10^{-17} \) kg m\(^{-3} \). Less than 10% of these JPPs must be evaporated and ionized to form the unexpectedly massive stellar envelopes in place rather than ejected as superwinds. Why is it credible that a star can dump 94% of its mass into the ISM when it forms a carbon core?

By coincidence, the direction opposite to the peak Leonid meteoroid flux in November 2002 matched that of the closest planetary nebula (PNe) Helix (NGC 7293), so that the Hubble Helix team of volunteers could devote a substantial fraction of the 14 hour Leonid stand-down period taking photographs with the full array of HST cameras, including the newly installed wide angle Advanced Camera for Surveys (ACS). A composite image was constructed with a 4 m telescope ground based image mosaic (O’Dell et al. 2004) to show the complete system. Helix is only 219 (198-246) pc \( \approx 6.6 \times 10^{18} \) m from earth (Harris et al. 2007) with one of the hottest and most massive known central white dwarf stars (120,000 K, \( M_{WD} \approx M_\odot \)), and is also the dimmest PNe (Gorny et al. 1997). With a close (dMe) X-ray companion (Guerrero et al. 2001) it powerfully beams radiation and plasma into the interstellar medium (ISM) surroundings. Thus Helix provides an ideal laboratory to test our suggestion (Gibson 1996; Schild 1996) that the ISM of star forming regions of galaxies and the baryonic-dark-matter (BDM) of the universe are both dominated by dense collections of volatile frozen-gas planets.

Both the ISM and the BDM mass densities \( \rho \) are large \( (\rho_{ISM} \approx \rho_{BDM} \approx 10^4 \times \langle \rho_G \rangle \approx \rho_0 \approx (3 - 1) \times 10^{-17} \) kg m\(^{-3} \) and are dominated by Jovian frozen-H-He primordial-fog-particle (PFP) Planets (JPPs) from which all stars and planets have formed. The Galaxy inner-halo \( (D \leq 10^{22}m) \) average density \( \langle \rho_G \rangle \approx 10^{-21} \) kg m\(^{-3} \) includes little of the highly diffusive non-baryonic dark matter (NBDM). According to our HGD paradigm, most Galactic star formation occurs in \( \rho_0 \) primordial proto-globular-star-cluster (PGC) clumps of PFPs
with baryonic mass density $\rho_{BDM}$ reflecting the large $\rho_{FS} = \rho_0$ existing at the time of the first gravitational structure formation 30,000 years after the big bang (Gibson 1996). HGD contradicts many aspects of (ΛCDM) cold-dark-matter hierarchical-clustering-cosmology (Gibson & Schild 2003abc). HGD predicts that big bang fossil turbulence patterns (Gibson 2004; Gibson 2005) of baryonic matter rather than NBDM triggered gravitational fragmentation, and that BDM dominates the average density $\langle \rho_b \rangle$ for luminous star-forming regions of galaxies.

From HGD, the primary acoustic peak observed in cosmic microwave background (CMB) spectra reflects plasma gravitational fragmentation at sonic (maximum rarefaction wave) speed to form proto-supercruster-voids at the acoustic $ct/3^{1/2}$ scale (Gibson 2000). Most of the $\approx 10^6$ dark PGCs that gravitationally fragmented from the proto-Galaxy after plasma-gas transition at 300,000 years slowly diffused to form the dark inner BDM halo while the NBDM rapidly diffused and eventually fragmented to form the outer Galaxy halo (Gibson 2000). From the HST/ACS images of the Tadpole merger, the inner halo is baryonic and homogeneous except for dark-dwarf-galaxy PGC clusters. Its large 130 kpc radius ($R = 4 \times 10^{21}$ m) is revealed by young-globular-clusters (YGCs) and stars triggered into formation by tidal forces and radiation from the merging VV29cdef galaxy fragments (Gibson & Schild 2003a). In spiral galaxies, most star formation occurs in the disk. From HGD the disk is formed by accreting PGCs, so the interstellar medium of the disk should be that of a PGC; that is, trillions of frozen PFPs and JPPs in metastable equilibrium with their evaporated gas at the high average baryonic mass density of the time of first structure.

From HGD it is no accident that the outer Jovian planets of the solar system are large and gassy and that the hundreds of extra-solar planets now discovered by precision astronomy are also large Jovians, often apparently in their final stages of accretion by the central star. The iron-nickel cores of all the inner terrestrial solar planets suggest these were once JPPs cores, formed by gravitational melting within the JPPs from collected dust particles of atoms and molecules produced in the hot reducing conditions of supernovae. The unexpected “Methuselah planet” discovered in the metal-poor ancient globular cluster M4 (Sigurdsson et al. 2003) is a JPP candidate, one of many billions of JPPs still available in M4 from HGD. Stars do not produce planets: planets produce stars.

In this paper §3 we compare HST/ACS Helix observations, plus other PNe observations, with hydro-gravitational-dynamics theory and previously proposed explanations of cometary globule and planetary nebula formation. Planetary nebulae from HGD are not just transient interactions of gas clouds emitted by dying stars, but the baryonic dark matter brought out of cold storage and made visible by hot carbon-star white dwarfs and the plasma beams they produce as they extract fuel from companion stars and pile up more carbon until the SNe Ia
limit is reached. In §3 a new interpretation of Oort cloud comets and the Oort cloud itself appears naturally, along with evidence (Matese et al. 1999) of Oort comet deflection by an \( \approx 3 \times 10^{27} \) kg solar system \( \geq \) Jupiter-mass JPP at the Oort cloud distance \( \approx 3 \times 10^{15} \) m.

A detection of PFPs in Helix is discussed in §4 and a detection of 40 000 Helix JPP atmospheres in the infrared is discussed in §5.

In the following §2 we review hydro-gravitational-dynamics theory and some of the supporting evidence, and compare the PNe predictions of HGD with standard PNe models and the observations in §3. We discuss our “nonlinear grey dust” alternative to “dark energy” in §4 and summarize results in §5. Finally, in §6, some conclusions are offered.

2. Theory

2.1. HGD structure formation

Standard CDMHC cosmologies are based on ill-posed, over-simplified fluid mechanical equations, an inappropriate assumption that the fluid is collisionless, and the assumption of zero density to achieve a solution. This obsolete Jeans 1902 theory neglects non-acoustic density fluctuations, viscous forces, turbulence forces, particle collisions, and the effects of diffusion on gravitational structure formation, all of which can be crucially important in some circumstances where astrophysical structures form by self gravity. Jeans did linear perturbation stability analysis (neglecting turbulence) of Euler’s equations (neglecting viscous forces) for a completely uniform ideal gas with density \( \rho \) only a function of pressure (the barotropic assumption) to reduce the problem of self-gravitational instability to one of gravitational acoustics.

To satisfy Poisson’s equation for the gravitational potential of a collisionless ideal gas, Jeans assumed the density \( \rho \) was zero in a maneuver appropriately known as the “Jeans swindle”. The only critical wave length for gravitational instability with all these questionable assumptions is the Jeans acoustical length scale \( L_J \) where

\[
L_J \equiv V_S/(\rho G)^{1/2} \gg (p/\rho^2 G)^{1/2} \equiv L_{JHS},
\]

(1)

\( G \) is Newton’s gravitational constant and \( V_S \approx (p/\rho)^{1/2} \) is the sound speed.

The related Jeans hydrostatic length scale \( L_{JHS} \equiv [p/\rho^2 G]^{1/2} \) given in the equation and has been misinterpreted by Jeans 1902 and others as an indication that pressure itself somehow prevents gravitational condensation on all scales smaller than \( L_J \). Although the two scales appear to be equal they are not. The ratio \( h = p/\rho \) in \( L_{JHS} \) is the stagnation specific
enthalpy for a gravitational condensation or rarefaction streamline, and is initially zero from Bernoulli’s equation \( B = p/\rho + \frac{v^2}{2} = \text{constant} \) from the first law of thermodynamics for such adiabatic, isentropic, ideal gas flows at the beginning of structure formation, where \( v \) is the fluid speed. In the initial stages of gravitational instability, pressure is completely a slave to the velocity. “Where the speed is greatest the pressure is least” while \( B \) is constant, quoting the usual statement of Bernoulli’s law. For supersonic real gasses and plasmas the specific enthalpy term \( p/\rho \) aquires a factor of \( \approx 5/2 \) famously neglected by Newton in his studies of acoustics without the second law of thermodynamics (Pilyugin & Usov 2007).

Pressure and thermal support are concepts relevant only to hydrostatics. For hydrodynamics, where the velocity is non-zero, pressure appears in the Navier-Stokes momentum equation only in the \( \nabla B \approx 0 \) term. Non-acoustic density extrema are absolutely unstable to gravitational structure formation (Gibson 1996; Gibson 2000). Minima trigger voids and maxima trigger condensates at all scales not stabilized by turbulent forces, viscous forces, other forces, or diffusion (see Eqs. 3-5 and Table 1 below). The Jeans acoustic scale \( L_J \) is the size for which pressure can equilibrate acoustically without temperature change in an ideal gas undergoing self gravitational collapse or void formation, smoothing away all pressure forces and all pressure resistance to self gravity. The Jeans hydrostatic scale \( L_{JHS} \) is the size of a fluid blob for which irreversibilities such as frictional forces or thermonuclear heating have achieved a hydrostatic equilibrium between pressure and gravitation in a proto-Jovian-planet or proto-star. \( L_{JHS} \) is generically much smaller than \( L_J \) and has no physical significance until gravitational condensation has actually occurred and a hydrostatic equilibrium has been achieved.

When gas condenses on a non-acoustic density maximum due to self gravity a variety of results are possible. If the amount is much larger than 100 \( M_\odot \), a turbulent maelstrom, superstar, and possibly a black hole (or magnetosphere eternally collapsing object MECO) may appear. If the amount is small, a gas planet, brown dwarf, or small star can form in hydrostatic equilibrium as the gravitational potential energy is converted to heat by turbulent friction and radiated. The pressure force \( F_P \approx p \times L^2 \) matches the gravitational force of the star or gas planet at \( F_G \approx \rho^2 GL^4 \) at the hydrostatic Jeans scale \( L_{JHS} \). Pressure \( p \) is determined by a complex mass-momentum-energy balance of the fluid flow and ambient conditions. A gas with uniform density is absolutely unstable to self gravitational structure formation on non-acoustic density perturbations at scales larger and smaller than \( L_J \) and is unstable to acoustical density fluctuations on scales larger than \( L_J \) (Gibson 1996). Pressure and temperature cannot prevent structure formation on scales larger or smaller than \( L_J \). Numerical simulations showing sub-Jeans scale instabilities are systematically rejected as “artificial fragmentation” based on this misconception (Truelove et al. 1997).
Density fluctuations in fluids are not barotropic as assumed by Jeans 1902 except rarely in small regions for short times near powerful sound sources. Density fluctuations that triggered the first gravitational structures in the primordial fluids of interest were likely non-acoustic (non-barotropic) density variations from turbulent mixing of temperature or chemical species concentrations produced by the big bang (Gibson 2001) as shown by turbulent signatures (Bershadskii and Sreenivasan 2002) in the cosmic microwave background temperature anisotropies. From Jeans’ theory without Jeans’ swindle, a gravitational condensation on an acoustical density maximum rapidly becomes a non-acoustical density maximum because the gravitationally accreted mass retains the (zero) momentum of the motionless ambient gas. The Jeans 1902 analysis was ill posed because it failed to include non-acoustic density variations as an initial condition.

Fluids with non-acoustic density fluctuations are continuously in a state of structure formation due to self gravity unless prevented by diffusion or fluid forces (Gibson 1996). Turbulence or viscous forces can dominate gravitational forces at small distances from a point of maximum or minimum density to prevent gravitational structure formation, but gravitational forces will dominate turbulent or viscous forces at larger distances to cause structures if the gas or plasma does not diffuse away faster than it can condense or rarify due to gravity. The erroneous concepts of pressure support and thermal support are artifacts of the erroneous Jeans criterion for gravitational instability. Pressure forces could not prevent gravitational structure formation in the plasma epoch because pressures equilibrate in time periods smaller that the gravitational free fall time \((\rho G)^{-1/2}\) on length scales smaller than the Jeans scale \(L_J\), and \(L_J\) in the primordial plasma was larger than the Hubble scale of causal connection \(L_J > L_H = ct\), where \(c\) is light speed and \(t\) is time. Therefore, if gravitational forces exceed viscous and turbulence forces in the plasma epoch at Schwarz scales \(L_{ST}\) and \(L_{SV}\) smaller than \(L_H\) (Table 1) then gravitational structures will develop, independent of the Jeans criterion. Only a very large diffusivity \((D_B)\) could interfere with structure formation in the plasma. Diffusion prevents gravitational clumping of the non-baryonic dark matter (cold or hot) in the plasma epoch because \(D_{NB} \gg D_B\) and \((L_{SD})_{NB} \gg L_H\).

Consider the gravitational response of a large body of uniform density gas to a sudden change at time \(t = 0\) on scale \(L \ll L_J\) of a rigid mass perturbation \(M(t)\) at the center, either a cannonball or vacuum beach ball depending on whether \(M(0)\) is positive or negative (Gibson 2000). Gravitational forces will cause all the surrounding gas to accelerate slowly toward or away from the central mass perturbation. The radial velocity \(v_r = -GM(t)tr^{-2}\) from integrating the radial gravitational acceleration, and the central mass increases at a rate \(dM(t)/dt = -v_r 4\pi r^2 \rho = 4\pi \rho GM(t)t\). Separating variables and integrating gives

\[
M(t) = M(0)e^{\pm 2\pi \rho Gt^2}, t \ll t_G
\]
respectively, where nothing much happens for time periods less than the gravitational free fall time 
\[ t_G = (\rho G)^{-1/2} \]
except for a gradual build up or depletion of the gas near the center.

For condensation, at \( t = 0.43t_G \) the mass ratio \( M(t)/M(0) \) for \( r < L \) has increased by only a factor of 2.7, but goes from 534 at \( t = t_G \) to \( 10^{11} \) at \( t = 2t_G \) during the time it would take for an acoustic signal to reach a distance \( L_I \). Hydrostatic pressure changes are concentrated at the Jeans hydrostatic scale \( L_{JHS} \ll L_I \). Pressure support and the Jeans 1902 criterion clearly fail in this exercise.

The diffusion velocity is \( D/L \) for diffusivity \( D \) at distance \( L \) and the gravitational velocity is \( L(\rho G)^{1/2} \). The two velocities are equal at the diffusive Schwarz length scale
\[ L_{SD} \equiv [D^2/(\rho G)]^{1/4}. \] (3)

Weakly collisional particles such as the hypothetical cold-dark-matter (CDM) material cannot possibly form clumps, seeds, halos, or potential wells for baryonic matter collection because the CDM particles have large diffusivity and will disperse, consistent with observations (Sand et al. 2002). Diffusivity \( D \approx V_p \times L_c \), where \( V_p \) is the particle speed and \( L_c \) is the collision distance. Because weakly collisional particles have large collision distances with large diffusive Schwarz lengths the non-baryonic dark matter (possibly neutrinos) is the last material to fragment by self gravity and not the first as assumed by CDM cosmologies. The first structures occur as proto-superccluster-voids in the baryonic plasma controlled by viscous and weak turbulence forces, independent of diffusivity \( (D \approx \nu) \). The CDM seeds postulated as the basis of CDMHCC never happened because \( (L_{SD})_{NB} \gg ct \) in the plasma epoch. Because CDM seeds and halos never happened, hierarchical clustering of CDM halos to form galaxies and their clusters never happened (Gibson 1996; Gibson 2000; Gibson 2001; Gibson 2004; Gibson 2005; Gibson 2006a; Gibson 2006b).

Cold dark matter was invented to explain the observation that gravitational structure formed early in the universe that should not be there from the Jeans 1902 criterion that forbids structure in the baryonic plasma because \( (L_J)_B > L_H \) during the plasma epoch (where sound speed approached light speed \( V_S = c/\sqrt{3} \)). In this CDM cosmology, non-baryonic particles with rest mass sufficient to be non-relativistic at their time of decoupling are considered “cold” dark matter, and are assumed to form permanent, cohesive clumps in virial equilibrium that can only interact with matter and other CDM clumps gravitationally. This assumption that CDM clumps are cohesive is unnecessary, unrealistic, and fluid mechanically untenable. Such clumps are unstable to tidal forces because they lack the particle collisions to produce any cohesive forces to hold them together (Gibson 2006a).

Numerical simulations of large numbers of falsely cohesive CDM clumps show a tendency for the clumps to clump further due to gravity to form “dark matter halos”, justifying the
cold dark matter hierarchical clustering cosmology (CDMHCC). The clustering “halos” grow to $10^6 M_\odot$ by about $z = 20$ (Abel et al. 2002) as the universe expands and cools and the pre-galactic clumps cluster. Gradually the baryonic matter (at $10^{16}$ s) falls into the growing gravitational potential wells of the CDM halos, cools off sufficiently to form the first (very massive and very late at 300 Myr) Population III stars whose powerful supernovas reionized all the gas of the universe (O’Shea & Norman 2006).

However, observations show this never happened (Aharonian et al. 2006; Gibson 2006a). Pop-III photons are not detected, consistent with the HGD prediction that they never existed and that the first stars formed at $10^{13}$ s (0.3 Myr) and were quite small except at the cores of PGCs at the cores of the protogalaxies. The missing hydrogen cited as (“Gunn-Peterson trough”) evidence for reionization is actually sequestered as JPPs. As we have seen, CDMHCC is not necessary since the Jeans 1902 criterion is incorrect and baryons can begin gravitational structure formation during the plasma epoch when the horizon scale exceeds the largest Schwarz scale (Gibson 1996; Gibson 2000).

Clumps of collisionless or collisional CDM would either form black holes or thermalize in time periods of order the gravitational free fall time $(\rho G)^{-1/2}$ because the particles would gravitate to the center of the clump by core collapse where the density would exponentiate, causing double and triple gravitational interactions or particle collisions that would thermalize the velocity distribution and trigger diffusional evaporation. For collisional CDM, consider a spherical clump of perfectly cold CDM with mass $M$, density $\rho$, particle mass $m$ and collision cross section $\sigma$. The clump collapses in time $(\rho G)^{-1/2}$ to density $\rho_c = (m/\sigma)^{3/2}M^{-1/2}$ where collisions begin and the velocity distribution thermalizes. Particles with velocities greater than the escape velocity $v \approx 2MG/r$ then diffuse away from the clump, where $r = (M/\rho)^{1/3}$ is the initial clump size. For typically considered CDM clumps of mass $\approx 10^{36}$ kg and CDM particles more massive than $10^{-24}$ kg (WIMPs with $\sigma \approx 10^{-42}$ m$^2$ small enough to escape detection) the density from the expression would require a collision scale smaller than the clump Schwarzschild radius so that such CDM clumps would collapse to form black holes. Less massive motionless CDM particles collapse to diffusive densities smaller than the black hole density, have collisions, thermalize, and diffuse away. From the outer halo radius size measured for galaxy cluster halos it is possible to estimate the non-baryonic dark matter particle mass to be of order $10^{-35}$ kg (10 ev) and the diffusivity to be $\approx 10^{30}$ m$^2$ s$^{-1}$ (Gibson 2000). Thus, CDM clumps are neither necessary nor physically possible, and are ruled out by observations (Sand et al. 2002). It is recommended that the CDMHC scenario for structure formation and cosmology be abandoned.

The baryonic matter is subject to large viscous forces, especially in the hot primordial plasma and gas states existing when most gravitational structures first formed (Gibson 2000).
The viscous forces per unit volume $\rho \nu \gamma L^2$ dominate gravitational forces $\rho^2 G L^4$ at small scales, where $\nu$ is the kinematic viscosity and $\gamma$ is the rate of strain of the fluid. The forces match at the viscous Schwarz length

$$L_{SV} \equiv (\nu \gamma / \rho G)^{1/2},$$

(4)

which is the smallest size for self gravitational condensation or void formation in such a flow. Turbulent forces may permit larger mass gravitational structures to develop; for example, in thermonuclear maelstroms at galaxy cores to form central black holes. Turbulent forces $\rho \varepsilon^{2/3} L^{8/3}$ match gravitational forces at the turbulent Schwarz scale

$$L_{ST} \equiv \varepsilon^{1/2} / (\rho G)^{3/4},$$

(5)

where $\varepsilon$ is the viscous dissipation rate of the turbulence. Because in the primordial plasma the viscosity and diffusivity are identical and the rate-of-strain $\gamma$ is larger than the free-fall frequency $(\rho G)^{1/2}$, the viscous and turbulent Schwarz scales $L_{SV}$ and $L_{ST}$ will be larger than the diffusive Schwarz scale $L_{SD}$, from (3), (4) and (5).

The criterion for structure formation in the plasma epoch is that both $L_{SV}$ and $L_{ST}$ become less than the horizon scale $L_H = ct$. Reynolds numbers in the plasma epoch were near critical, with $L_{SV} \approx L_{ST}$. From $L_{SV} < ct$, gravitational structures first formed when $\nu$ first decreased to values less than radiation dominated values $c^2 t$ at time $t \approx 10^{12}$ seconds (Gibson 1996), well before $10^{13}$ seconds which is the time of plasma to gas transition (300,000 years). Because the expansion of the universe inhibited condensation but enhanced void formation in the weakly turbulent plasma, the first structures were proto-supercluster-voids in the baryonic plasma. At $10^{12}$ s

$$(L_{SD})_{NB} \gg L_{SV} \approx L_{ST} \approx 5 \times L_K \approx L_H = 3 \times 10^{20} \text{m} \gg L_{SD},$$

(6)

where $(L_{SD})_{NB}$ refers to the non-baryonic component and $L_{SV}$, $L_{ST}$, $L_K$, and $L_{SD}$ scales refer to the baryonic (plasma) component. Acoustic peaks inferred from CMB spectra reflect acoustic signatures of the first gravitational void formation as well as the voids themselves.

As proto-supercluster mass plasma fragments formed, the voids filled with non-baryonic matter by diffusion, thus inhibiting further structure formation by decreasing the gravitational driving force. The baryonic mass density $\rho \approx 2 \times 10^{-17} \text{ kg/m}^3$ and rate of strain $\gamma \approx 10^{-12} \text{ s}^{-1}$ were preserved as hydrodynamic fossils within the proto-supercluster fragments and within proto-cluster and proto-galaxy objects resulting from subsequent fragmentation as the photon viscosity and $L_{SV}$ decreased prior to the plasma-gas transition and photon decoupling (Gibson 2000). As shown in Eq. 6, the Kolmogorov scale $L_K \equiv [\nu^3 / \varepsilon]^{1/4}$ and the viscous and turbulent Schwarz scales at the time of first structure matched the horizon
scale \( L_H \equiv ct \approx 3 \times 10^{20} \) m, freezing in the density, strain-rate, and spin magnitudes and directions of the subsequent proto-cluster and proto-galaxy fragments of proto-superclusters. Remnants of the strain-rate and spin magnitudes and directions of the weak turbulence at the time of first structure formation are forms of fossil vorticity turbulence (Gibson 1999).

The quiet condition of the primordial gas is revealed by measurements of temperature fluctuations of the cosmic microwave background radiation that show an average \( \delta T/T \approx 10^{-5} \) much too small for any turbulence to have existed at that time of plasma-gas transition \( (10^{13} \) s). Turbulent plasma motions are strongly damped by buoyancy forces at horizon scales after the first gravitational fragmentation time \( 10^{12} \) s. Viscous forces in the plasma are inadequate to explain the lack of primordial turbulence \( (\nu \geq 10^{30} \text{ m}^2 \text{ s}^{-1} \) is required but, after \( 10^{12} \) s, \( \nu \leq 4 \times 10^{26}, \) Gibson 2000). The observed lack of plasma turbulence proves that large scale buoyancy forces, and therefore self gravitational structure formation, must have begun in the plasma epoch \( \approx 10^{11} - 10^{13} \) s.

The gas temperature, density, viscosity, and rate of strain are all precisely known at transition, so the gas viscous Schwarz mass \( L_{SV}^3 \rho \) is easily calculated to be about \( 10^{24} \text{ kg}, \) the mass of a small planet, or about \( 10^{-6} M_\odot, \) with uncertainty about a factor of ten. From HGD, soon after the cooling primordial plasma turned to gas at \( 10^{13} \) s \((300,000 \text{ yr})\), the entire baryonic universe condensed to a fog of planetary-mass primordial-fog-particles (PFPs) that prevented collapse at the Jeans mass. These gas-cloud objects gradually cooled, formed H-He rain, and eventually froze solid to become the baryonic dark matter and the basic material of construction for stars and everything else, about \( 30 \times 10^6 \) rogue planets per star.

The Jeans mass \( L_J^3 \rho \) of the primordial gas at transition was about \( 10^6 M_\odot \) with about a factor of ten uncertainty, the mass of a globular-star-cluster (GC). Proto-galaxies fragmented at the PFP scale but also at this proto-globular-star-cluster PGC scale \( L_J \), although not for the reasons given by the Jeans 1902 theory. Density fluctuations in the gaseous proto-galaxies were absolutely unstable to void formation at all scales larger than the viscous Schwarz scale \( L_{SV} \). Pressure can only remain in equilibrium with density without temperature changes in a gravitationally expanding void on scales smaller than the Jeans scale. From the second law of thermodynamics, rarefaction wave speeds are limited to speeds less than the sonic velocity. Density minima expand due to gravity to form voids subsonically. Cooling could therefore occur and be compensated by radiation in the otherwise isothermal primordial gas when the expanding voids approached the Jeans scale. Gravitational fragmentations of proto-galaxies were then accelerated by radiative heat transfer to these cooler regions, resulting in fragmentation at the Jeans scale and isolation of proto-globular-star-clusters (PGCs) with the primordial-gas-Jeans-mass.

These \( 10^{36} \) kg PGC objects were not able to collapse from their own self gravity because
of their internal fragmentation at the viscous Schwarz scale to form $10^{24-25}$ kg PFPs. The fact that globular star clusters have precisely the same density $\approx \rho_0$ and primordial-gas-Jeans-mass from galaxy to galaxy proves they were all formed simultaneously soon after the time of the plasma to gas transition $10^{13}$ s. The gas has never been so uniform since, and no mechanism exists to recover such a high density, let alone such a high uniform density, as the fossil turbulent density value $\rho_0 \approx 2 \times 10^{-17}$ kg/m$^3$. Young globular cluster formation in BDM halos in the Tadpole, Mice, and Antennae galaxy mergers (Gibson & Schild 2003a) show that dark PGC clusters of PFPs are remarkably stable structures, persisting without disruption or star formation for more than ten billion years.

### 2.2. Observational evidence for PGCs and PFPs

Searches for point mass objects as the dark matter by looking for microlensing of stars in the bulge and the Magellanic clouds have detected only about 20% of the expected amount, leading to claims by the MACHO/OGLE/EROS consortia that this form of dark matter has been observationally excluded (Alcock et al. 1998). These studies have all assumed a uniform rather than a clumped distribution with a non-linear frictional accretion cascade for the “massive compact halo objects” (MACHOs), and unfortunately used sampling frequencies appropriate for stellar rather than small planetary mass objects. Since the PFPs within PGC clumps must accretionally cascade over a million-fold mass range to produce JPPs and stars their statistical distribution becomes an intermittent lognormal that will profoundly affect an appropriate sampling strategy and microlensing data interpretation. This rules out the exclusion of PFP mass objects as the baryonic dark matter (BDM) of the Galaxy by MACHO/OGLE/EROS (Gibson & Schild 1999). OGLE campaigns focusing on large planetary mass ($10^{-3} M_\odot$) to brown dwarf mass objects have revealed 121 transiting and orbiting candidates, some with orbits less than one day (Udalski et al. 2003). This supports the frictional PFP binary accretional cascade predicted by HGD as the dominant mechanism of star formation.

Evidence that planetary mass objects dominate the BDM in galaxies has been gradually accumulating and has been reviewed (Gibson & Schild 2003b). Cometary knot candidates for PFPs and JPPs appear whenever hot events like white dwarfs, novas, plasma jets, Herbig-Haro objects, and supernovas happen, consistent with the prediction of HGD that the knots reveal Jovian planets that comprise the BDM, as we see for the planetary nebulae in the present paper. However, the most convincing evidence for our hypothesis, because it averages the dark matter over much larger volumes of space, is provided by one of the most technically challenging areas in astronomy; that is, quasar microlensing (Schild 1996). Several years and
many dedicated observers were required to confirm the Schild measured time delay of the Q0957 lensed quasar images so that the twinkling of the subtracted light curves could be confirmed and the frequency of twinkling interpreted as evidence that the dominant point mass objects of the lensing galaxy were of small planetary mass.

By using multiple observatories around the Earth it has now been possible to accurately establish the Q0957 time delay at $417.09 \pm 0.07$ days (Colley et al. 2002, 2003). With this unprecedented accuracy a statistically significant microlensing event of only 12 hours has now been detected (Colley & Schild 2003) indicating a PFP with Moon-mass only $7.4 \times 10^{22}$ kg. An additional microlensing system has been observed (Schechter et al. 2003) and confirmed, and its time delay measured (Ofek and Maoz 2003). To attribute the microlensing to stars rather than planets required Schechter et al. 2003 to propose relativistic knots in the quasar. An additional four lensed quasar systems with measured time delays show monthly period microlensing. These studies support the prediction of HGD that the masses of their galaxy lenses are dominated by small planetary mass objects as the baryonic dark matter (Burud et al. 2000, 2002; Hjorth et al. 2002).

Flux anomalies in four-quasar-image gravitational lenses have been interpreted as evidence for the dark matter substructure predicted by CDM halo models (Dalal and Kochanek 2002), but the anomalies may also be taken as evidence for concentrations of baryonic dark matter such as PGCs, especially when the images are found to twinkle with frequencies consistent with the existence of planetary mass objects. Evidence that the small planetary objects causing high frequency quasar image twinkling are clumped as PGCs is indicated by the HE1104 (Schechter et al. 2003) damped Lyman alpha lensing system (DLA $\equiv$ neutral hydrogen column density larger than $10^{24.3}$ m$^{-2}$), suggesting PGC candidates from the evidence of gas and planets. Active searches are underway for quasar lensing DLAs with planetary frequency twinkling that can add to this evidence of PGCs.

Perhaps the most irrefutable evidence suggesting that galaxy inner halos consist mostly of baryonic PGC-PFP clumps are the HST/ACS images of an aligned row of 42 – 46 YGCs (see §2.3.2 and Fig. 1) precisely tracking the frictionally merging galaxy fragments VVcdef in the Tadpole system (Gibson & Schild 2003a). Concepts of collisionless fluid mechanics and collisionless tidal tails applied to merging galaxy systems are rendered obsolete by these images. Numerous YGCs are also seen in the fragmenting galaxy cluster Stephan’s Quintet (Gibson & Schild 2003c). The mysterious red shifts of this dense HGC galaxy cluster support the HGD model of sticky beginnings of the cluster in the plasma epoch, where viscous forces of the baryonic dark matter halo of the cluster have inhibited the final breakup due to the expansion of the universe to about 200 million years ago and reduced the transverse velocities of the galaxies to small values so that they appear aligned in a thin pencil by perspective.
Close alignments of QSOs with bright galaxies (suggesting intrinsic red shifts) have been noted for many years (Hoyle et al. 2000) that can more easily be explained by HGD.

### 2.3. Planetary Nebula formation

#### 2.3.1. The standard model

According to the standard model of white dwarf and planetary nebula formation, an ordinary star like the sun burns less than half of its hydrogen and helium to form a hot, dense, carbon core (Busso et al. 1999; Iben 1984). A small part forms a progressively less dense atmosphere that expands from $\approx 10^9$ m to $10^{11}$ m or more to form a cool 3000 K red giant cocoon around the carbon center. The remaining mass is transferred to an envelope, to a companion star, or expelled somehow as a superwind to the interstellar medium. Transfer of large amounts of white dwarf mass to the companion star seems possible and even likely, but expulsion of significantly large masses to the ISM by as superwind is problematic for such tiny stars orders of magnitude lighter than the Eddington limit. Radiation pressures are much too small for such massive ejections either as winds, plasma beams, or clumps, even assisted by dust and pulsations (Woitke 2006). Interpretation of nuclear chemistry from spectral results to describe the physical processes of stellar evolution to form white dwarfs is limited by a poor understanding of stratified turbulent mixing physics (Herwig 2005). New information about carbon stars is available at the critical infrared spectral bands of cool AGB stars from the *Spitzer Space Telescope* (Lagadec et al. 2006) but the mass loss problem remains unsolved. Possible (and crucial) contributions of mass and luminosity from the ISM are not taken into account in the standard models of PNe formation.

The neutral atmosphere of the red giant with density $\rho \approx 10^{-17}$ kg m$^{-3}$ is eventually expelled along with the massive (unobserved) envelope by (unexplained) dynamical and photon pressures when the hot, $T \approx 10^5$ K, dense, $\rho \approx 10^{10}$ kg m$^{-3}$, carbon core is exposed as a white dwarf star with no source of fuel unless accompanied by a donor companion. The density of this $10^{16}$ kg atmosphere expanded to the distance of the inner Helix radius is trivial ($\approx 10^{-29}$ kg m$^{-3}$). At most this could bring the PNe ejected atmosphere density to a small fraction ($\approx 10^{-3}$) of $\rho \approx 10^{-14}$ kg m$^{-3}$ values observed in the knots (Meaburn et al. 1998). Why are small and intermediate mass main sequence stars (1–9 $M_\odot$) so inefficient that they burn only a small fraction of their initial mass before they die to form (0.5–1.44 $M_\odot$) white dwarfs?

From radio telescope measurements (Knapp et al. 1982) larger stars up to 9$M_\odot$ form white dwarfs and companions with huge envelopes that have complex histories with super-
wind Asymptotic Giant Branch (AGB) periods where most of the assumed initial mass of the star is mysteriously expelled into the ISM (Busso et al. 1999). The possibility is not mentioned in the literature that the ISM itself could be supplying the unexpectedly large, luminous, envelope masses and superwind mass losses inferred from radio and infrared telescope measurements (Knapp et al. 1982), OH/IR stars (de Jong 1983), and from star cluster models (Claver et al. 2001). It has been proposed in versions of the standard model that either shock wave instabilities (Vishniac 1994; Vishniac 1983) produce cometary knots that are somehow ejected by the central stars, or that a fast wind impacts the photo-ionized inner surface of the dense ejected envelope giving Rayleigh-Taylor instabilities that produce the cometary globules and radial wakes observed (Garcia-Segura et al. 2006; Capriotti 1973). Such models produce cometary globule densities much smaller than observed, and require globule wake densities much larger than observed.

Several problems exist for such standard PNe models without HGD. Huge \((3 - 9 M_\odot)\) H-He masses observed in PNe are richer in other species and dust than one would expect to be expelled as stellar winds or cometary bullets during any efficient solar mass star evolution, where most of the star’s H-He fuel should presumably be converted by thermonuclear fusion to carbon in the core before the star dies. More than a solar mass of gas and dust is found in the nebular ring of Helix, with a dusty H-He-O-N-CO composition matching that of the interstellar medium rather than winds from the hydrogen-depleted atmosphere of a carbon star. The cometary globules are too massive and too dense to match any Rayleigh-Taylor instability model. Such models (Garcia-Segura et al. 2006) give cometary globule densities of only \(\rho \approx 10^{-19} \text{ kg m}^{-3}\) compared to \(\rho \approx 10^{-14} \text{ kg m}^{-3}\) observed.

The closest AGB C star is IRC+10216 (Mauron & Huggins 1999). It is brighter than any star at long wavelengths, but invisible in the blue from strong dust absorption. Loss rates inferred from its brightness are large \((2 \times 10^{-5} M_\odot/\text{yr})\). The possibility that the mass indicated by the brightness could have been brought out of the dark in place has not been considered. Multiple, fragmented and asymmetric rings are observed, indicating a central binary. The rings are irregular and extend to \(4 \times 10^{15}\) m, with central brightness of the envelope confined to \(2 \times 10^{14}\) m. It seems likely that the ring structures observed represent evaporation wakes of Jovian orbital planets in response to the red giant growth and powerful radiation from the central stars. Rather than superwinds outward we see the effects of enhanced JPP accretion inward, clearing the Oort cloud cavity prior to PNe formation.

The maximum density increase due to a Mach 6 hypersonic shock waves in astrophysical gases is only about a factor of six, not \(10^5\). Rayleigh-Taylor instability, where a low density fluid accelerates a high density fluid, causes little change in the densities of the two fluids. Turbulence dispersion of nonlinear thin shell instabilities (Vishniac 1994; Vishniac 1983)
should decrease or prevent shock induced or gravitational increases in density. The masses of the inner Helix cometary globules are measured and modeled to be $\gg 10^{25}$ kg, larger than expected for PFP planets that have not merged with others. No mechanism is known by which such massive dense objects can form or exist near the central star. Neither could they be ejected without disruption to the distances where they are observed. Measurements of proper motions of the cometary knots would provide a definitive test of whether the knots are in the gas and expanding at the outflow velocity away from the central binary, as expected in the standard model, or moving randomly with some collapse component toward the center. Proper motion measurements to date (O’Dell et al. 2002) suggest they are mostly moving randomly with virial PGC speeds (also see Fig. 2 below in §3).

### 2.3.2. The HGD model

According to HGD, stars are formed by accretion of PFP planets, larger Jovian PFP planets (JPPs), and brown and red dwarf stars within a primordial PGC interstellar medium. The accretion mechanism is likely to be binary, where two PFPs or Jovians experience a near collision so that frictional heating of their atmospheres produces evaporation of the frozen H-He planets and an increase in the amount of gas in their atmospheres. This results in a non-linear “frictional hardening” of the binary planets until the two objects merge, and explains why “3 out of every 2 stars is a binary” (Cecilia Helena Payne-Gaposchkin). This classic astronomical overstatement could actually be true if one of the “stars” is a binary and the other a binary of binaries or a triplet of two binaries and a rogue. Binary stars are the signature result of star formation from planets.

Exotic binary star and planet systems are highly likely from the non-linear nature of HGD star and JPP planet formation. Heating from a binary PFP merger results in a large atmosphere for the double-mass PFP that will increase its cross section for capture of more PFPs. Evidence is accumulating that most PNe central stars are binaries as expected from HGD (De Marco et al. 2004; Soker 2006; Moe & De Marco 2006). One of the brightest stars in the sky is Gamma Velorum in Vela, with two binaries and two rogues all within $10^{16}$ m of each other, the nominal size of a PNe. One of the binaries is a WR star and a blue supergiant B-star with $1.5 \times 10^{11}$ m (1 AU) separation. From aperture masking interferometry using the 10-m aperture Keck I telescope, another WR-B binary is the pinwheel nebula Wolf-Rayet 104 in Sagitarrius, where the stars are separated by $3 \times 10^{11}$ m (3 AU) and are $10^5$ brighter than the sun (Tuthill et al. 1999). How much of the apparent brightness and apparent masses of these systems is provided by evaporating JPPs? The pinwheel nebula dust clouds are surprising this close to large hot stars ($\approx 50$K) that should reduce dust to
atoms. Complex shock cooling induced dust models from colliding superwinds (Usov 1991; Pilyugin & Usov 2007) to explain the dust of pinwheel nebulae are unnecessary if the stars are accreting a rain of dusty evaporating JPPs.

Large PFP atmospheres from mergers and close encounters increase their frictional interaction with other randomly encountered ambient PFP atmospheres. This slows the relative motion of the objects and increases the time between their collisions and mergers. Radiation to outer space will cause the PFP atmospheres to cool and eventually rain out and freeze if no further captures occur, leading to a new state of metastable equilibrium with the ambient gas. To reach Jupiter mass, $10^{-6} M_\odot$ mass PFPs and their growing sons and daughters must pair 10 times ($2^{10} \approx 10^3$). To reach stellar mass, 20 PFP binary pairings are required ($2^{20} \approx 10^6$). Because of the binary nature of PFP structure formation through JPPs, it is clear that double stars and complex systems will result, as observed, and that the stars will have large numbers of large gassy planets that the stars capture in orbit or absorb, as observed.

Rocky and nickel-iron cores of planets like the Earth and rock-crusted stainless-steel Mercury in this scenario are simply the rocky and iron-nickel cores of Jupiters that have processed the SiO dust, water, organics, iron and nickel particles accumulated gravitationally from supernova remnants in their cores and in the cores of the thousands of PFPs that they have accreted to achieve their masses. Rather than being accreted as comets by the growing star, these massive JPPs were captured in orbits and their gas layers evaporated as their orbits decayed to leave terrestrial planets (Vittone & Errico 2006).

Without PFPs, the existence of rocks and unoxidized iron cores of planets is a mystery. It has been known since the end of the bronze age that very high temperatures are needed for carbon to reduce iron oxides to metallic iron, as will happen in supernovas IIab where hydrogen, silicon and carbon will form oxides by reducing any oxides of iron and nickel to metal particles. All this stardust will be swept up by gravitational fields of the PFPs, which should by now be deeply crusted with magnetic talcum powder after their thirteen billions of years in existence as interstellar gravitational vacuum cleaners. Samples of cometary material confirm large quantities of stardust in comet tails and in comet bodies. Crashing a 364 kg object into Jupiter comet Tempel 1 revealed a deep crust of 1-100 micron particle size low strength powder (A’Hearn et al. 2005; Feldman et al. 2006; Sunshine et al. 2006).

In preliminary analysis, particles collected by NASA’s Stardust mission from the Wild 2 comet show a very hot origin near a star or stars other than the sun.

Large gas planets from PFP accretion cascades may form gently over long periods, with ample time at every stage for their atmospheres to readjust with ambient conditions and return to metastable states of random motion. These are probably the conditions under
which the old globular star clusters (OGCs) in the halo of the Milky Way Galaxy formed their small long-lived stars, and their large ancient planets (Sigurdsson et al. 2003). However, if the PFP accretional cascade is forced by radiation or tidal forces from passing stars or ambient supernovae, a more rapid cascade will occur where the PFP atmospheres become large and the relative motions become highly turbulent.

The turbulence will mix the PFPs and their large planet descendants and inhibit large average density increases or decreases. In this case another instability becomes possible; that is, if the turbulence weakens the creation of large central density structures, but enhances accretion to form large planets and brown dwarfs, the increase of density can become so rapid that buoyancy forces may develop from the density gradients. This will suddenly damp the turbulence at the Schwarz turbulence scale $L_{ST}$ (see Table 1) to produce fossil turbulence (Gibson 1999) in a volume containing many solar masses of gas, PFPs and JPPs.

Turbulence fossilization due to buoyancy creates a gravitational collapse to the center of the resulting non-turbulent gas and PFPs from the sudden lack of turbulence resistance. A fossil turbulence hole in the ISM will be left with size determined by the turbulence levels existing at the beginning of fossilization. The accretion of the planets and gas within the hole will be accelerated by the rapidly increasing density. The total mass of the stars produced will be the size of the “Oort cloud” hole times the ISM density. If the mass is many solar masses then the superstars formed will soon explode as supernovae, triggering a sequence of ambient PFP evaporations, accretional cascades, and a starburst that may consume the entire dark PGC and PFPs to produce a million stars and a young globular cluster (YGC) or a super-star cluster (Tran et al. 2003).

Numerous YCCs are triggered into star formation by galaxy mergers, such as the merging of two galaxies and some fragments revealing a 130 kpc ($4 \times 10^{21}$ m) radius baryonic dark matter halo in the VV29abcdef Tadpole complex imaged by HST/ACS immediately after installation of the ACS camera (Benitez et al. 2004). Figure 1 shows an SSC dwarf galaxy, revealed in the baryonic dark matter halo of the central Tadpole galaxy VV29a by a dense narrow trail of YGCs pointing precisely to the spiral star wake produced as the dwarf blue galaxy VV29c and companions VV29def merged with VV29a (Gibson & Schild 2003a).

Planetary nebulae form when one of the smaller stars formed by PFP accretion uses up all its H-He fuel to form a dense carbon core with temperature less than $8 \times 10^8$ K; the star forms a white dwarf and the high temperatures and radiation pressure of the white dwarf expel the atmosphere of the final asymptotic giant branch red giant star (eg: Arcturus). Red giant stars have envelope diameters $\approx 10^{12}$ m and atmospheric densities $\approx 10^{-17}$ kg m$^{-3}$ with a $6 \times 10^6$ m diameter $\rho \approx 10^{10}$ kg m$^{-3}$ carbon star core (Chaisson & McMillan 2001), so the total mass expelled is only $\approx 10^{16}$ kg, or $\approx 10^{-8} M_\odot$, much less than the gas mass values...
(3 – 1) × \( M_\odot \) claimed to be observed in planetary nebulae from their luminosity. Without HGD, this much gas is mysterious.

Because the white dwarf is likely to have a companion star, as observed for Helix and Cats-Eye (Guerrero et al. 2001) and easily inferred for many other PNe’s (O’Dell et al. 2002), it is likely that the companion will receive mass from the growing red giant phase of the dying star and donate mass to the white dwarf phase. Both can receive mass from the JPP rain. The white dwarf has small size and high density, and is likely to spin rapidly with a strong magnetic field pole near its spin axis. The spinning magnetic field lines at the white dwarf poles capture the incoming plasma from its companion star to produce powerful plasma jets perpendicular to the plane of rotation of the two stars. The accretion disk of the white dwarf may shield some of its radiation and broadly beam some of its radiation. The following observations show the effects of such plasma beams in PNe.

3. Observations

Figure 2 is an HST image of the Large Magellanic Cloud PNe N66 (SMP 83, WS 35, LM1-52) at a distance of \( 1.7 \times 10^{21} \) m, taken on 06/26/1991 with the European Space Agency Faint Object Camera (FOC) filtered for 540 seconds at the 5007 Å doubly ionized oxygen emission line (O III). This remarkable object is the only confirmed PNe where the central star is classified as a Wolf-Rayet of the nitrogen sequence type (WN). LMC-N66 has recently exhibited highly variable brightness, with an indicated mass loss rate increase from 1983 to 1995 by a factor of 40 (Pena et al. 1997). Its central binary is surrounded by a looped \( 5 – 6 M_\odot \) PNe of bright cometary globules, interpreted in Fig. 2 as partially evaporated JPPs. From spectral analysis and modeling the central binary system is a 1.2\( M_\odot \) white dwarf with a non-degenerate companion that is building the WD toward the Chandrasekhar limit and a SN Ia event in \( \approx 10^5 \) years (Pena et al. 2004; Hamann et al. 2003). Part of the mass stream to the WD is ejected as a mutating plasma beam that evaporates JPPs in the looped arcs shown in Fig. 2. The mass \( M_{PNe} \) of the observed nebular material is more than 5\( M_\odot \). From HGD this implies about 5% of the 100\( M_\odot \) PFPs and JPPs of the interstellar medium within the luminous range of the PNe have been brought out of the dark by radiation and plasma jets from the central star system.

Some of the JPPs in Fig. 2 have detectable O III emission wakes that indicate JPP velocities \( V_{JPP} \) are in random directions with virial values, as expected from HGD. The virial velocity \( V_{vir} = (2MG/r)^{1/2} \) for a PGC is about \( 1.7 \times 10^4 \) m/s, where \( M \) is mass, \( G \) is Newton’s constant, and \( r \) is the PGC radius. In PGC metastable equilibrium the PFP speed should be somewhat less than \( V_{vir} \) due to gas friction and the growth of JPPs and the
rate of star formation should be low.

Wolf-Rayet (WR) stars are very bright, red, and until recently have been claimed to be massive $\geq 20 M_\odot$ with large mass loss rates. They are often found with surrounding nebulae (Morgan et al. 2003), generally in galaxy disks where PGCs are accreted and where $V_{JPP}$ values should be large. High He, C, N, and O concentrations suggest final stages of evolution toward white dwarf status for at least one of the central stars. HST images reveal most WRs to be binary or multiple star systems, with numerous dense clumps in their envelopes that appear to be evaporating JPPs as in Fig. 2. Much of their mass and much of their large mass loss rates seems to be the result of bright evaporating JPPs near central dying stars misinterpreted as massive stellar envelopes and superwinds (see WR124 in nebula M1-67, STSci-1998-38 in the HST archives). From the 1998 news release the clumps have mass $2 \times 10^{26}$ kg and scale $10^{14}$ m, giving a large density of $10^{-16}$ kg m$^{-3}$. How can such dense objects be ejected from a star?

Figure 3 shows a standard model white dwarf mass evolution diagram (Claver et al. 2001) for planetary nebulae in Praesepe (circles) and Hyades (squares) star clusters, compared to Helix and LMC-N66. In an 80 PNe collection (Gorny et al. 1997), Helix has the most massive central white dwarf. It is also the dimmest, and therefore has the smallest PNe mass $M_{PNe}$ (shown as an open star in Fig. 3). From HGD, observed $M_{PNe}$ masses should not be interpreted as the initial masses $M_{Initial}$ of central white dwarfs, as assumed using the standard PNe model (Weidemann 2000). Any central WD of a PNe has the possibility to grow to the SNe Ia size by accretion of JPPs, as shown by the LMC-N66 (hexagon) point in Fig. 3. In the final stages of growth, the WD will likely be surrounded by a PNe similar to that of Helix, where the central sphere has been depleted of JPPs by gravity to form the central stars and the nebular material is formed by radiative evaporation of JPPs to form large atmospheres. Thus supernova Ia events will always be subject to intermittent dimming depending on the line of sight. PNe can appear around hot central stars at any time during the life of the star, which is more than $10^{10}$ years for the small stars leading to SNe Ia events, not $10^4$ years as assumed in the standard model.

Figure 4 shows a mosaic of nine HST/ACS images from the F658N filter ($H_\alpha$ and N II) that enhances the ionized cometary globules and their hydrogen tails (http://archive.stsci.edu/hst/helix/images.html). A sphere with radius $5 \times 10^{15}$ m is shown providing ample primordial-fog-particles (PFPs) with mass density $2 \times 10^{-17}$ kg m$^{-3}$ to form two central solar mass stars by accretion of PFPs. The large comets closest to the central stars must be evaporating massive planets (Jupiters) to survive measured evaporation rates of $2 \times 10^{-8} M_\odot$ year$^{-1}$ (Meaburn et al. 1998) for the 20,000 year age of Helix. Massive planets are formed in the accretional cascade of PFPs to form stars according to HGD. The younger (2,000 year old)
planetary nebula Spirograph (IC 418) shown below shows shock wave patterns from the supersonic stellar winds but no cometary PFP candidates within its fossil turbulence accretion sphere corresponding to the Oort cloud source of long period comets.

Is the sun surrounded by its accretion sphere bounded by an Oort cloud of planets at the inner boundary of a PFP dominated interstellar medium? In a remarkable application of celestial mechanics to Oort cloud comets ("Cometary evidence of a massive body in the outer Oort cloud") a multi-Jupiter mass perturber within $5^\circ$ of the Galactic plane has been inferred (Matese et al. 1999). Out of 82 "new" first-time entrant long period comets with orbit scales less than $10^{16}$ m, 29 have aphelion directions on the same great circle, suggesting that the galactic-tide-Saturn-Jupiter loss cylinder has been smeared inward along the track of the perturber. In an apparently independent 99.9% detection (Murray 1999) gives the object a retrograde orbit with period of $5.8 \times 10^6$ years assuming it is gravitationally bound to the sun, and excludes a variety of explanations (eg: star encounter, solar system ejection) for its existence as extremely unlikely. The object is easy to explain from HGD as one of many JPPs on the inner surface or our Oort cloud as in Figs. 4 for Helix, Fig. 7 for Eskimo and Fig. 8 for Dumbbell PNe.

Assuming density $\rho_0$, the inner spherical nebular shell for Helix contains $\approx 20M_\odot$ of dark PFPs, from which $1.5 \times M_\odot$ has been evaporated as gas and dust (Speck et al. 2002). Evidence for bipolar beamed radiation is shown by the brighter regions of the nebula in Fig. 4 at angles 10 and 4 o’clock, and by the light to dark transition after 11:30 suggesting the bipolar beam is rotating slowly clockwise. Note that the tails of the comets are long ($\approx 10^{15}$ m) before 11:30 and short or nonexistent afterward. Rayleigh-Taylor instability as a mechanism to produce the globules (Capriotti 1973) gives densities much too low. The beam appears to have started rotation at about 1 o’clock with deep penetration of the radiation on both sides, revolved once, and is observed with its bright edge at 11:30 having completed less than two revolutions to form the Helix spiral.

Figure 5 shows a Hubble Space Telescope Helix WFPC2 1996 image to the northeast in Helix where the closest comets to the center are found (O’Dell & Handron 1996). The cometary globules have size about $10^{13}$ m and measured atmospheric mass $3 \times 10^{25}$ kg, with spacing $\approx 10^{14}$ m, as expected for gas planets with some multiple of this mass in a relic concentration corresponding to the primordial ($\rho_0$) plasma density $(3 - 1) \times 10^{-17}$ kg m$^{-3}$ at the time of first structure 30,000 years after the big bang. Most of these largest cometary globules probably have larger mass planets than PFPs at their cores to have survived the minimum 20,000 year lifetime of the Helix planetary nebula with measured mass loss rates of order $10^{-8}M_\odot$ year$^{-1}$ (Meaburn et al. 1998). These are termed Jovian PFP planets (JPPs). The spacing of the cometary knots becomes closer for distances farther from the central
stars, consistent with these objects having PFPs or small JPPs at their cores.

Figure 6 shows an example of the new ACS/WFPC composite images from the northern region of Helix confirming the uniform density of the cometary globules throughout the nebula. From HGD this reflects the uniform ambient distribution of verialized, dark-matter, frozen PFPs and JPPs in the surrounding ISM with primordial density $\rho_0 \geq 10^{-17}$ kg m$^{-3}$. This BDM provides the raw material to produce the central binary stars of the PNe by binary hierarchical clustering. Once it begins the star formation is highly non-linear. The more clustering the more gas. The more gas the more clustering. Thus the larger JPPs in the Jupiter mass range are more likely to be found at Oort cloud distances near the edge of the star accretional cavity and the brown dwarfs near the center or merged as stars. Within the ionized cavity of the PNe the PFPs have been evaporated by photon radiation from the hot stars or accreted as comets. Images and properties of “knots” in Helix, Eskimo, Dumbbell and other PNe (O’Dell et al. 2002) are consistent with this PFP-JPP star formation interpretation.

Figure 7 shows the Eskimo planetary nebula (NGC 2392), which at 2.4 kpc is 11 times more distant from earth than Helix (Gorny et al. 1997), but is still close enough for numerous cometary globules to be resolved by HST cameras. The PNe is smaller than Helix and has a central shocked region with no comets, just like the small, even younger, Spirograph nebula shown at the bottom of Fig. 4. Eskimo PNe has a few very large widely separated cometary globules dominating its brightness, suggesting these may be evaporating JPPs with multi-Jupiter masses. Note the large gas wakes without cometary globules at the 6 o’clock position (in the beard). Presumably these were even brighter while their JPPs were evaporating, possibly while the carbon mass of the central white dwarf was near its minimum with most of its mass transferred to a companion. Such a scenario could account for the empirical “Reimers Wind” expression giving an unexpected inverse mass loss proportionality to WD mass. As more WD carbon accumulates from the companion and accreted JPP comets the PNe brightness would be somewhat diminished since the largest inner JPPs surrounding the small WD would by then have been evaporated.

Figure 8 shows details of the central region of the Dumbbell planetary nebula featuring numerous cometary globules and knots. The spacing of the objects is consistent with PFP and JPP planets with average mass density $\approx 10^4$ times the average $10^{-21}$ kg m$^{-3}$ for the Galaxy. Because of their primordial origin, planets with this same density $\rho_0$ dominate the mass and species content of the ISM in all galaxies, fossilizing the primordial baryonic density from the time of first structure in the plasma epoch 30,000 years after the big bang as predicted by HGD. The dumbbell morphology reflects the existence of a binary central star system and its plasma beam jet to evaporate JPPs at the Oort cloud edge.

Figure 9 summarizes hydro-gravitational-dynamics (HGD) theory leading to the formation of the baryonic dark matter (Gibson 2005). A Planck scale quantum-gravitational instability triggers big bang turbulent combustion. The resulting turbulent temperature patterns are fossilized by nucleosynthesis in the energy epoch as random H-He density fluctuations, which seed the first gravitational formation of structure by fragmentation at the horizon and Schwarz viscous scale in the plasma epoch \( L_H \approx L_{SV} \), Table 1. The first gravitational structures are super-cluster-voids starting at \( 10^{12} \) seconds and growing until the plasma-gas transition at \( 10^{13} \) s (300,000 years).

The smallest gravitational fragments from the plasma epoch are proto-galaxies formed by fragmentation along stretching turbulent vortex lines of the weak plasma turbulence. The kinematic viscosity reduction by a factor of \( 10^{13} \) gave two fragmentation scales and structures in the primordial gas; that is, the Jeans acoustic scale and PGCs, and the viscous Schwarz scale and PFPs. With time the planetary mass PFPs freeze to form the baryonic dark matter. Some small fraction accrete to form JPPs and stars. Because SNe Ia stars are likely to occur in PGCs surrounded by PFPs and JPPs, a random “nonlinear grey dust” dimming of the supernova brightness is likely.

Figure 10 shows the proposed interpretation of the ground based (open circle) and (Riess et al. 2004) HST/ACS (solid circle) SNe Ia dimming for red shifts \( 0.01 \leq z \leq 2 \). The wide scatter of the amount of SNe Ia dimming appears to be real, and is consistent with our “nonlinear grey dust” model, where a random amount of absorption should be expected depending on the line of sight to the supernova and the degree of evaporation of the baryonic dark matter interstellar medium. A “uniform grey dust” systematic dimming increases with \( z \) contrary to observations. The “dark energy” concept seems unlikely because it requires a radical change in the physical theory of gravity. HGD requires changes in the standard (CDMHCC) model of gravitational structure formation and the interpretation of planetary nebulae. The slight random dimming found in the observations is just what one expects from “nonlinear grey dust” formed as the growing hot carbon star evaporates its Oort cloud of ambient planets to form large, cold, dirty atmospheres that may be on the line of sight to the SNe Ia that eventually occurs. Planetary nebulae such as the Helix and other PNe described above illustrate the process we are suggesting. Radiation from the proto-SNe Ia can be directly from the carbon star or from plasma jets formed as the companion star feeds its growth.

Figure 11 shows a closeup view of JPPs and PFPs in the northern rim of the Helix Oort cavity imaged in molecular hydrogen \( H_2 \) at 2.12 microns (O’Dell et al. 2007). The distance scales are derived from the new O’Dell et al. images and a trigonometric parallax estimate of
219 (198-246) pc for the distance to Helix (Harris et al. 2007). O’Dell et al. 2007 conclude \( \text{H}_2 \) is in local thermodynamic equilibrium, as expected for evaporated planet atmospheres produced by intense radiation and not by any shock phenomenon.

5. Discussion of results

HGD theory combined with high resolution space telescope observations require major changes in the standard models of cosmology, star formation, star death, and planetary nebulae formation. Bright gases of clumpy gas nebulae surrounding dying small (white dwarf) stars with companions in close binaries provide clear evidence for the existence of the millions of frozen primordial planets (PFPs and JPPs) per star in dense primordial clumps (PGC) suggested (Gibson 1996; Schild 1996) as the baryonic dark matter and interstellar medium. Even though the primordial planets are dark and distant they make their presence known because of their enormous total mass, and because they are the raw material for everything else. PFPs appear to be detectable in Helix from their \( \text{H}_2 \) signal at 2.12 microns (Fig. 11). JPPs with molecular atmospheres in great abundance (≈ 40,000) are detected in Helix from their 5.8 and 8 micron purely rotational lines of molecular hydrogen from the infrared array camera IRAC on the Spitzer space telescope with Helix resolution of \( 6 \times 10^{13} \) m (Hora et al. 2006). Since these are produced by the central binary plasma jet they represent a small fraction of the > 100\( M_\odot \) of JPPs in its range. Similar results are obtained from the NICMOS NIC3 camera with the 2.12 micron molecular hydrogen filter from HST (Meixner et al. 2006).

When disturbed from equilibrium by tidal forces or radiation, JPP planets grow to stellar mass by binary accretion with neighbors where friction of close encounters causes growth of planetary atmospheres, more friction, merger, reprocessing and cooling to a new state of metastable equilibrium with shrinking planetary atmospheres as the gases refreeze. This non-linear binary cascade to larger size gas planets in pairs and pairs of pairs leads to star formation as stellar binaries within the PGC clumps. It explains the presence of the massive JPPs that persist in Helix in the shells closest to the central stars, as shown in Figs. 4, 5, 6, 10 and 11. HGD theory explains why most stars are binaries and why most galaxies and galaxy clusters are not: stars are formed by hierarchical clustering of planets not condensation within gas clouds, and galaxies and galaxy clusters are formed by gravitational fragmentation of plasma, not by hierarchical clustering of CDM halos. The CDMHCC paradigm should be abandoned.

Hundreds of PNe are observed in the LMC and SMC galaxies, interpreted from HGD as tidally agitated star forming clumps of PGCs in the BDM halo of the Milky Way equivalent
to the super-star-cluster (SSC) of YGCs formed in the BDM halo of the Tadpole (VV29) merger. Fig. 1 (Tran et al. 2003; Gibson & Schild 2003a) shows the SSC as a linear string of $\geq 42$ young globular star clusters with star formation triggered by passage of one of the merging galaxy fragments (VV29cdef) passing through the BDM halo of VV29a. The YGCs have 3-10 Myr ages, showing they must have been formed in place and not ejected as a frictionless tidal tail in this 500 Myr old merging system. Collisionless fluid mechanical modeling of galactic dynamics and frictionless tidal tails should be abandoned.

One of the LMC PNe (LMC-N66) has recently shown strong brightness variation and appears to be in the final stages of WD growth leading to a SNe Ia event (Pena et al. 2004). Fig. 2 shows an archive HST image at the 5007 Å wavelength OIII emission line. The heavy rain of JPPs on the central stars appears to be adding carbon to the WD and fueling a powerful plasma beam that brings JPPs and their O III wakes out of the dark to diameters $\approx 2 \times 10^{16}$ m, a region containing $\geq 100M_\odot$ of JPPs using the primordial density $\rho_0 \approx 2 \times 10^{-17}$ kg m$^{-3}$ from HGD. The wakes point in random directions, indicating that the evaporating JPP velocities $V_{JPP}$ are large and random, consistent with the apparent rapid JPP accretion rates and white dwarf growth in the central binary.

From HGD and the observations it seems clear that stars form as binary star systems from primordial planets within PGC clumps of planets. Unless the JPPs are strongly agitated the stars formed will be small and the one that dies first is likely to transfer much of its mass in its red giant phase to the companion. The white dwarf can then grow to the Chandrasekhar limit drawing mass from the companion and accreted JPPs. Because SNe Ia events result from dying small stars that have very long lives, we can understand why it took nearly 10 billion years with red shift $z = 0.46$ for “dark energy” effects to appear, and why SNe Ia events are not seen at red shifts much larger than 1.

6. Conclusions

High resolution wide angle HST/ACS images and 4m ground based telescope images (O’Dell et al. 2004) confirm and extend the previous WFPC2 HST picture of the Helix planetary nebula (O’Dell & Handron 1996) showing thousands of closely-spaced cometary globules. These are interpreted from HGD as a generic feature of PNe where JPP frozen planets of the BDM ISM are partially evaporated by plasma beams from a growing central white dwarf binary. Globule atmospheric masses ($\approx 2 \times 10^{25}$ kg) are larger than earth-mass ($6 \times 10^{24}$ kg). Globule sizes are larger than the solar system out to Pluto ($10^{13}$ m), with large unexplained densities ($\approx 10^{-14}$ kg m$^{-3}$). Evaporation rates from the largest cometary globules suggest they possess Jupiter mass or larger frozen-gas-planet cores (Meaburn et al. 1998),
consistent with absorption measurements showing masses $\geq 10^{25}$ kg for the Helix cometary globule atmospheres (Meaburn et al. 1992; Huggins et al. 2002).

Models of planetary nebula formation (Capriotti 1973; Garcia-Segura et al. 2006) where Rayleigh-Taylor instabilities of a postulated (unexplainably) dense and massive superwind outer shell are triggered by collision with a later, rapidly expanding, less-dense, inner shell to form the globules, cannot account for the morphology, regularity, and large observed densities and masses of the globules. Speculations that accretional shocks or variable radiation pressures in stars can trigger gravitational instabilities (Vishniac 1994; Vishniac 1983) to achieve such large density differences underestimate powerful turbulence, radiation, and molecular dispersion forces existing in stellar conditions that would certainly smooth away any such dense globules.

No convincing mechanism exists to produce or expel dense objects from the central stars of PNe, although the existence of very dense OH and SiO maser cloudlets near red giants are observed by high resolution radio telescopes (Alcock & Ross 1986a; Alcock & Ross 1986b) that are almost certainly evaporating JPPs from their high densities $\rho \geq 10^{-9}$ kg m$^{-3}$. Such densities cannot be achieved by shocks in the relatively thin red giant atmospheres, envelopes, and ISM. Shock fronts can be seen to exist in younger PNe than Helix (Figures 4 and 7) but are not accompanied by any cometary globules. Models for white dwarf and planetary nebula formation (Busso et al. 1999; Iben 1984) cannot and do not explain either the cometary globules or the tremendous loss of mass for stars with initial mass $M_{\text{Initial}} = 1 - 9 M_\odot$ by superwinds to form white dwarfs with final mass only $M_{\text{Final}} = 0.5 - 1 M_\odot$ (Fig. 3). Complex models for star formation and evolution with PNe are consistently presented as empirical.

We conclude that a better model (Fig. 9) for interpreting the observations is provided by hydro-gravitational-dynamics theory (HGD), where the brightest cometary globules are indeed comets formed when radiation and plasma jets from the white dwarf and its companion evaporate and reveal volatile frozen gas planets of the ISM at Oort cloud distances. The planets are JPP Jovian accretions of primordial-fog-particle (PFP) Mars-mass frozen H-He objects formed at the plasma to gas transition 300,000 years after the big bang (Gibson 1996), consistent with quasar microlensing observations showing the lens galaxy mass is dominated by rogue planets “likely to be the missing mass” (Schild 1996).

From HGD and all observations, these planetary PFPs and JPPs dominate the mass and gasses of the BDM inner halo mass of galaxies within a radius of about 100 kpc ($3 \times 10^{21}$ m). Proto-galaxies formed during the plasma epoch fragmented after transition to gas at primordial Jeans and Schwarz scales (Table 1) to form proto-globular-star-cluster (PGC) clouds of PFPs that comprise the BDM and ISM of the inner galaxy halos. From HST/ACS Helix images and previous observations, the density of the Galaxy disk ISM is that of proto-
superclusters formed 30,000 years after the big bang; that is, \( \rho_0 \approx 2 \times 10^{-17} \text{ kg/m}^3 \), preserved as a hydrodynamic fossil and revealed by the \((10 - 4) \times 10^{13} \text{ m separations of the PFP candidates (cometary globules) observed in Helix that imply this density (Fig. 11).}

HST images of other nearby planetary nebula support our interpretation. Cometary globules brought out of the dark by beamed radiation from a central white dwarf and companion star are a generic rather than transient feature of planetary nebulae. Thus, the ISM is dominated by small frozen accreting planets with such small separations that the mass density is that of a PGC, which is \( \approx 10^4 \) larger than that of the Galaxy. Standard PNe models that suggest planetary nebulae are brief (10^4 year) puffs of star dust from dying white dwarfs by superwinds (Fig. 3) must be discarded. Large PNe masses \( M_{PNe} \) formed by the evaporation of JPPs (Fig. 2) must not be confused with \( M_{Initial} \) for the white dwarf. Infrared detections of dense molecular hydrogen clumps in Helix from both HST and *Spitzer* space telescopes provide \( \approx 40,000 \) JPP candidates (O’Dell et al. 2007; Meixner et al. 2006; Hora et al. 2006) from the \( \geq 1000M_\odot \) mass of JPPs and PFPs expected to exist in the observed \( 2.5 \times 10^{16} \text{ m radius of Helix from HGD.} \)

From HGD, most stars form as binary pairs from the binary accretion of baryonic dark matter PFP and JPP planets in PGC clumps leaving Oort cloud size holes in the ISM. When one of the stars in a binary forms a white dwarf it can draw on the fuel of its companion and accreted JPPs to form a PNe of cometary globules (Fig. 2) and a proto-SNe Ia from the growing central stars (Fig. 3). Radiation from the pair can be seen as precessing plasma jets that evaporate rings of cometary globules as in the Helix PNe (Figs. 4, 5, 6, 10, 11) and in other planetary nebulae (Figs. 2, 7, 8). These JPP atmospheres give the “nonlinear grey dust” random-systematic-error-dimming indicated in Fig. 10. Therefore both the “dark energy” concept and the ΛCDM cosmology that dark energy requires are problematic.

Most of the information in this paper would not be available without the heroic work and dedication of astronaut John Mace Grunsfeld whose amazing preparation and skills in the fourth space telescope repair mission made HST/ACS images possible.

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Fig. 1.— Trail of 42 young-globular-star-clusters (YGCs) in a dark dwarf galaxy examined spectroscopically by Tran et al. 2003 using the Keck telescope. The 1" Echellette slit and a loose super-star-cluster (SSC arrow) are shown at the left. Ages of the YGCs range from 3-10 Myr. The aligned YGC trail is extended by several more YGGs (arrow on right) and points precisely to the beginning, at $10^{21}$ m distance, of the spiral star wake of VV29c in its capture by VV29a. The baryonic dark matter halo of Tadpole is revealed by a looser trail of YGCs extending to a radius of $4 \times 10^{21}$ m from VV29a, or 130 kpc (Gibson & Schild 2003a).
Fig. 2.— HST/FOC 5007 Å image (HST archives, 6/26/1991) of distant \((1.7 \times 10^{21} \text{ m})\) LMC/N66 PNe with a central \(1.2M_\odot\) WD-companion close binary rapidly growing toward SN Ia formation (Pena et al. 2004). Wakes in O III emission (magnified inserts) show random velocities \(V_{JPP}\) of the evaporating planets. From its spectrum the central star is a Wolf-Rayet of class WN. Arc-like patterns show strong nutating plasma beams from the binary have evaporated \(\approx 5M_\odot\) of the ambient JPPs (Fig. 3). From HGD and \(\rho_0\) the \(2.5 \times 10^{16} \text{ m}\) radius nebular sphere for LMC/N66 should contain \(\geq 1000M_\odot\) of Jovian planets.
Fig. 3.— Mass evolution of white dwarf stars to the Chandrasekhar limit by accretion of JPPs. The standard PNe model incorrectly estimates the initial white dwarf mass $M_{\text{Initial}}$ to be the total PNe mass $M_{\text{PNe}}$, but this includes the mass of evaporated JPPs. Measurements for the N66 PNe of Fig. 2 (hexagon) and the Helix PNe of Figs. 4-6 (star) are compared to star cluster PNe of Praesepe (circles) and Hyades (squares) (Claver et al. 2001). Infrared detection of JPP atmospheres in Helix indicate $M_{\text{PNe}} \geq 40M_\odot$ (Hora et al. 2006).
Fig. 4.— Helix Planetary Nebula HST/ACS/WFC F658N image mosaic. A sphere with radius $3 \times 10^{15}$ m corresponds to the volume of primordial-fog-particles (PFPs) with mass density $\rho_0 = 3 \times 10^{-17}$ kg m$^{-3}$ required to form two central stars by accretion. The comets within the sphere are from large gas planets (Jupiters, JPPs) that have survived evaporation rates of $2 \times 10^{-8} M_\odot$/year (Meaburn et al. 1998) for the 20,000 year kinematic age of Helix. The younger planetary nebula Spirograph (IC 418) shown below with no PFPs is within its accretion sphere. From HGD the $2.5 \times 10^{16}$ m radius nebular sphere for Helix contains $\geq 1000M_\odot$ of dark PFP and JPP planets, from which $1.5 \times M_\odot$ has been evaporated as detectable gas and dust (Speck et al. 2002).
Fig. 5.— Helix Planetary Nebula HST/WFPC2 1996 image (O’Dell & Handron 1996) from the strongly illuminated northeast region of Helix containing the comets closest to the central stars ($\approx 2 \times 10^{15}$ m) with embedded $\geq 0.4$ Jupiter-mass planet atmospheres.
Fig. 6.— Detail of closely spaced cometary globules to the north in Helix from the 2002 HST/ACS images at the dark to light transition marking the clockwise rotation of the beamed radiation from the binary central star. Comets (evaporating JPPs) in the dark region to the right have shorter tails and appear smaller in diameter since they have recently had less intense radiation than the comets on the left. Two puffs of gas deep in the dark region suggest gravitational collection by planet gravity occurred during the several thousand years since their last time of strong irradiation. PFPs are detected in Fig. 11 (circle).
Fig. 7.— The Eskimo planetary nebula (NGC 2392) is $\approx 12$ times more distance from earth than Helix, but still shows numerous evaporating PFP and JPP candidates in its surrounding interstellar medium in the HST/WFPC images. The nebula is smaller and younger than Helix, with a central shocked region like that of Spirograph in Fig. 4.
Fig. 8.— Close-up image of the Dumbbell planetary nebula (M27, NGC 6853) shows numerous closely spaced, evaporating, irradiated PFP and JPP candidates in its central region. The PNe is at a distance $\approx 500$ pc, with diameter $\approx 2 \times 10^{16}$ m. The white dwarf central star appears to have a companion from the double beamed radiation emitted to produce the eponymous shape. The lack an apparent accretional hole may be the result of a different viewing angle (edgewise to the binary star plane of radiation) than the face-on views of Ring, Helix (Fig. 4) and Eskimo (Fig. 7).
Fig. 9.— Hydro-Gravitational-Theory (HGD) description of the formation of structure by gravity (Gibson 2005). The cosmic-microwave-background (CMB) (a) viewed from the Earth (b) is distant in both space and time and stretched into a thin spherical shell along with the plasma and energy epochs and the big bang (c and d). Fossils of big bang turbulent temperature form fossil density turbulence patterns in H-He density (black dots) that trigger gravitational structures in the plasma epoch as proto-supercluster-voids that fill with non-baryonic dark matter by diffusion. The smallest structures emerging from the plasma epoch are proto-galaxies. These fragment at proto-globular-star-cluster (PGC) and primordial-fog-particle (PFP) scales to form the baryonic dark matter (Gibson 1996; Schild 1996), proposed as the “nonlinear grey dust” sources of SNe Ia dimming and the “dark energy” concept.
Fig. 10.— Dimming of SNE Ia magnitudes as a function of redshift $z$ (Riess et al. 2004). The “uniform grey dust” systematic error is excluded at large $z$, but the “nonlinear grey dust” systematic error from baryonic dark matter PFP and JPP evaporated planet atmospheres is not. Frozen planets constitute the Oort cloud, which is the inner surface of the spherical hole left in a PGC when the two central stars are formed by accretion of PFPs and JPPs. Some of these are evaporated to form a planetary nebula (PNe) when one of the stars dies to form a white dwarf. The PNe is made permanent by plasma jets and direct radiation evaporating Oort cloud PFPs and JPPs to give “nonlinear grey dust” as the white dwarf is fed to supernova Ia size by its companion.
Fig. 11.— Detail of Helix image in H$_2$ from Figs. 1 and 2 of O’Dell et al. 2007. Distance scales have $\approx 10\%$ accuracy (Harris et al. 2007) by trigonometric parallax, giving a Helix distance 219 pc with HST pixel $3.3 \times 10^{12}$ m, the size of PFPs identified as the smallest light and dark objects. Such PFPs are not detected closer than $\approx 5 \times 10^{15}$ m from the binary central star (Fig. 4) because they have been evaporated by its radiation and plasma beam.
Table 1. Length scales of self-gravitational structure formation

<table>
<thead>
<tr>
<th>Length scale name</th>
<th>Symbol</th>
<th>Definition(^a)</th>
<th>Physical significance(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeans Acoustic</td>
<td>(L_J)</td>
<td>(V_s/[\rho G]^{1/2})</td>
<td>Ideal gas pressure equilibration</td>
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<tr>
<td>Jeans Hydrostatic</td>
<td>(L_{JH})</td>
<td>([p/\rho^2 G]^{1/2})</td>
<td>Hydrostatic pressure equilibration</td>
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<td>Schwarz Diffusive</td>
<td>(L_{SD})</td>
<td>([D^2/\rho G]^{1/4})</td>
<td>(V_D) balances (V_G)</td>
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<tr>
<td>Schwarz Viscous</td>
<td>(L_{SV})</td>
<td>([\gamma \nu/\rho G]^{1/2})</td>
<td>Viscous force balances gravitational force</td>
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<tr>
<td>Schwarz Turbulent</td>
<td>(L_{ST})</td>
<td>(\varepsilon^{1/2}/[\rho G]^{3/4})</td>
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<tr>
<td>Kolmogorov Viscous</td>
<td>(L_K)</td>
<td>([\nu^3/\varepsilon]^{1/4})</td>
<td>Turbulence force balances viscous force</td>
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<tr>
<td>Nomura Protogalaxy</td>
<td>(L_N)</td>
<td>([L_{ST}]_{CMB})</td>
<td>10(^{20}) m proto-galaxy fragmentation scale</td>
</tr>
<tr>
<td>Ozmidov Buoyancy</td>
<td>(L_R)</td>
<td>([\varepsilon/N_3]^{1/2})</td>
<td>Buoyancy force balances turbulence force</td>
</tr>
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<td>Particle Collision</td>
<td>(L_C)</td>
<td>(m \sigma^{-1} \rho^{-1})</td>
<td>Distance between particle collisions</td>
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<tr>
<td>Hubble Horizon</td>
<td>(L_H)</td>
<td>(ct)</td>
<td>Maximum scale of causal connection</td>
</tr>
</tbody>
</table>

\(^a\)\(V_s\) is sound speed, \(\rho\) is density, \(G\) is Newton’s constant, \(D\) is the diffusivity, \(V_D \equiv D/L\) is the diffusive velocity at scale \(L\), \(V_G \equiv L[\rho G]^{1/2}\) is the gravitational velocity, \(\gamma\) is the strain rate, \(\nu\) is the kinematic viscosity, \(\varepsilon\) is the viscous dissipation rate, \(N \equiv [g \rho^{-1} \partial \rho/\partial z]^{1/2}\) is the stratification frequency, \(g\) is self-gravitational acceleration, \(z\) is in the opposite direction (up), \(m\) is the particle mass, \(\sigma\) is the collision cross section, \(c\) is light speed, \(t\) is the age of universe.

\(^b\)Magnetic and other forces (besides viscous and turbulence) are negligible for the epoch of primordial self-gravitational structure formation (Gibson 1996).
### Table 2. Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning</th>
<th>Physical significance</th>
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<tr>
<td>BDM</td>
<td>Baryonic Dark Matter</td>
<td>PGC clumps of JPPs from HGD</td>
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<tr>
<td>CDM</td>
<td>Cold Dark Matter</td>
<td>Questioned concept</td>
</tr>
<tr>
<td>CMB</td>
<td>Cosmic Microwave Background</td>
<td>Plasma transition to gas after big bang</td>
</tr>
<tr>
<td>HCC</td>
<td>Hierarchical Clustering Cosmology</td>
<td>Questioned CDM concept</td>
</tr>
<tr>
<td>HCG</td>
<td>Hickson Compact Galaxy Cluster</td>
<td>Stephan’s Quintet (SQ=HGC 92)</td>
</tr>
<tr>
<td>HGD</td>
<td>Hydro-Gravitational-Dynamics</td>
<td>Corrects Jeans 1902 theory</td>
</tr>
<tr>
<td>ISM</td>
<td>Inter-Stellar Medium</td>
<td>Mostly PFPs and gas from JPPs</td>
</tr>
<tr>
<td>JPP</td>
<td>Jovian PFP Planet</td>
<td>H-He planet formed by PFP accretion</td>
</tr>
<tr>
<td>ACDMHCC</td>
<td>Dark-Energy CDM HCC</td>
<td>Questioned concepts</td>
</tr>
<tr>
<td>NBDM</td>
<td>Non-Baryonic Dark Matter</td>
<td>Includes (and may be mostly) neutrinos</td>
</tr>
<tr>
<td>OGC</td>
<td>Old Globular star Cluster</td>
<td>PGC that formed stars at $t \approx 10^6$ yr</td>
</tr>
<tr>
<td>PFP</td>
<td>Primordial Fog Particle</td>
<td>Earth-mass BDM primordial planet</td>
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<tr>
<td>PGC</td>
<td>Proto-Globular star Cluster</td>
<td>Jeans-mass protogalaxy fragment</td>
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<tr>
<td>SSC</td>
<td>Super-Star Cluster</td>
<td>A cluster of YGCs</td>
</tr>
<tr>
<td>YGC</td>
<td>Young Globular star Cluster</td>
<td>PGC forms stars at $t \approx$ now</td>
</tr>
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