Some Consequences of the Baryonic Dark Matter Population

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ABSTRACT

Microlensed double-image quasars have sent a consistent message that the baryonic dark matter consists of a dark population of free-roaming planet mass objects. This population has long been predicted to have formed at the time of recombination, 300,000 years after the Big Bang, when the primordial plasma changed to neutral atoms with an attendant large increase in viscosity of the primordial matter. Following a very brief review of the observational basis for this conclusion and some alternative explanations, we review some probable effects of this population. After the particles formed by the usual gravitational condensation - void separation process, they collapsed on a 100 million year Kelvin-Helmholz time scale, and started their inevitable cooling process. Although not yet satisfactorily modeled, this process should have caused significant evaporation of primordial gas and taken them through the condensation and freezing points of hydrogen on their way to the 2.73 K temperature of the present universe. At the 20 K freezing point they should have frozen from the outside in, creating tremendous crushing central pressures that would have easily produced the rocky cores of planets and Kuiper-Oort cloud objects mysteriously over-abundant in the present solar system. The mystery of how did the universe become re-ionized by a Pop III that should have been seen at redshifts 6 to 8, now under scrutiny from direct spectroscopic observation, is cleanly side-stepped. Probably 99% of the baryonic matter in the universe was sequestered away in the dark matter bodies and does not need to be re-ionized for the universe to have its present transparency in the far ultraviolet. And the Dark Energy mystery will evaporate when it is understood how this population reduces the transparency of the universe. It is probably not a coincidence that the "self replenishing dust" model that explains the HST supernova brightness deficits closely matches the known dependence of extinction from Ly – α clouds upon redshift. If these mysterious
clouds, that should have diffused away on a short time scale, are reforming from slow evaporation of the planet-mass population, they should produce spherical lenses that refract light out of the supernova images to produce a grey reduction of the transparency of the universe.

Subject headings: Galaxy: halo – baryonic dark matter – Microlensing: quasars

1. Introduction and Microlensing Results in Q0957

At the 1996 Sheffield Symposium I reported microlensing results from 15 years of Q0957 monitoring that revealed a persistent, continuous rapid microlensing which indicated that compact planetary mass bodies constitute the baryonic dark matter (Schild, 1996). At the time, the response was, appropriately, ”That’s nice, but it’s just Rudy’s data for Rudy’s quasar.” Today, 8 years on, the rapid microlensing has been confirmed in the 6 additional lens systems having sufficient data for time delay estimation. And new Q0957 observing campaigns have produced evidence for an event with amplitude 1% and time scale of just 12 hours (Colley & Schild 2003). A recent summary of these observational results was presented at the UCLA Dark Matter/Dark Energy 2004 Symposium (Schild, 2004; astro-ph/0406491).

With the observation of rapid microlensing now confirmed, alternative explanations based upon imagined possible quasar structure have fortunately been explored. Thus bright points orbiting in the quasar’s accretion disc have been considered (Gould and Escude-Miralde, 1997; Schechter et al 2003) and dark clouds swarming around the quasar (Wyithe & Loeb, 2002) have been investigated. These schemes have been frustrated by the extreme physics required, especially for the extremely rapid Colley & Schild (2003) event, and by the implied periodicity. But most important, the simulations do not naturally produce the equal positive and negative events seen in the Schild (1999) wavelet analysis and natural to the planet-mass microlensing explanation (Schild & Vakulik, 2004). These points were more extensively reviewed in Schild (2004).

The above results are based upon reasonably rigorous science, with simulations and confirmed observational results. For the remainder of this contribution I examine more tentative explorations, based largely upon back-of-the-envelope calculations, to examine some immediate applications of the discovery. For example, what would such particles look, feel, smell, and taste like?
2. What do the Particles Look, Feel, Smell, and Taste Like?

Remarkably, these questions were already answered at the 1996 Sheffield symposium by hydrodynamics expert Carl Gibson, who predicted their existence from hydrodynamical analysis of the forces operative in the fluid/gas of the expanding universe at times before, during, and after recombination, 300,000 years after the Big Bang. However this hydrodynamical theory has been largely ignored because of its departures from the prevailing CDM theory, whose failures will need to go to completion before the hydrodynamical theory features receive the scrutiny that they deserve.

In the Gibson (1996, 2000) theory, structure formation limited by viscous-diffusive forces already seeded structures on scales of galaxies, clusters, and superclusters during the plasma epoch, before recombination. After the plasma-gas transition the baryonic gas of the universe fragmented at Jeans mass clumps further seeded with planetary mass "Primordial Fog Particles" (PFP's) limited to sub-stellar mass scales by the viscous and gravitational forces in the fluid. Thus the entire baryonic mass of the universe gravitationally collapsed onto primordial scale-free fluctuations but only the planet mass ones succeeded; they survive today as the baryonic dark matter seen in quasar microlensing. Many or most of these PFP particles would in turn be initially contained in globular cluster scale condensations that are often seen today mysteriously appearing in galaxy interactions.

The PFP’s presumably collapsed on the 100 million year Kelvin-Helmholz time scale and then cooled. In their subsequent history they would have swept up dust from supernovae and cool giant stars. In the expanding universe they would presumably have cooled below the hydrogen condensation point, and when passing below the freezing point at 20 K they would have crushed the ices and rocks at their centers to make the solid cores of the planets and the Trans-Neptunian objects seen today.

Gibson (1997) described the PFP’s today as "in solid or liquid state, crusted with 14 billion years of accreted dust." It also seems likely that these are the objects at the cores of the Lyman-alpha clouds seen by the thousand in ultraviolet spectra of quasars.

Today, we do not have an adequate simple model of a planetary mass particle formed at recombination and passively collapsing, reaching its maximum temperature at around 100 million years after recombination, and subsequently cooling. We don’t even know if the PFP’s would be cool enough at their centers for hydrogen to cool through the hydrogen condensation point at 40 K and the freezing point at 20 K. Because galaxy discs are now measured to have temperatures of 30 K (Bendo et al, 2003), there should also have been a point in the asymptotic approach to our 2.73 K background temperature when such Halo PFP objects orbiting galaxy discs went through multiple freezing and melting cycles.
Because the PFP objects are dark, they would be detected by my gravitational microlensing or by chance superpositions against a bright nebular background, as probably seen in the nearest planetary nebula, the Helix (O’Dell & Handron 1996). There they have been interpreted as hydrodynamical or shock instabilities in the expanding shell, even though such interpretations are contradicted by the high masses and densities measured for them (Meaburn et al, 1998). Interpreted as PFP’s seen against the bright nebular background, with surface ablation wearing away their outermost layers, their masses are estimated as $10^{-5} M_\odot$ and their diameters are measured to be $10^{16}$ cm, or 100 times the diameter of Neptune.

These Helix cometary knots are seen in the HST images to occur mostly in clumps, as expected for self-gravitating particles. This would explain why they could not be detected by MACHO microlensing searches, where they would just cause rapid irregular variability rejected by the MACHO search software.

3. The Chemical Enrichment and Re-Ionization of the Universe.

Our cosmology today is challenged by the observational result that reionization of the universe occurred at redshifts around 6.5, indicated by the ultraviolet continuum of hi-z quasars (Fan et al, 2004). Thus a vast population of high-redshift galaxies rich in Pop III stars should exist and supply copious $Ly - \alpha$ photons causing the universal ionization. But actual observations of galaxies at the redshift range 6.5 - 7.5 do not show copious $Ly - \alpha$ emission or extreme luminosity; indeed, the searches produced the conclusion that galaxies are x9 less luminous at the highest observed redshifts than at $z = 3$ (Stanway, et al, 2004; Bunker, A. et al, astro-ph/0403223).

We predict that this Pop III will never be found, because only a small fraction of the baryonic matter of the universe needs to be enriched and ionized if 99% of the primordial baryonic matter is sequestered away in our baryonic dark matter particles. A slow PFP evaporation, seen as $Ly - \alpha$ clouds, would slowly enrich the universe with primordial hydrogen/helium to maintain nearly constant elemental abundances. Quasars probably have sufficient ultraviolet radiation to re-ionize the universe (Escude-Miralde, Hashnelt, & Rees, 2000).
4. Relationship to Ly - α Clouds

The primary reason for accepting the concept of Dark Energy is the supernova brightness curves, but in their analysis (Riess et al, 2004) there has been no allowance for the reduction of the transparency of the universe imposed by the detected Baryonic dark matter component. Significant evidence for transmission losses might long have been seen in the quasar number density peak at z = 1.9. Note that the difference between ordinary universe models and the Goobar et al, (2002, Fig 3A) ”self replenishing dust” normalized to the supernova flux deficit at z = 0.5, is approximately 1.4 magnitudes for the quasar number density peak at z = 1.9.

We now recognize that the existence of quasar Ly - α forest clouds has evidently long been indicating the source of this transmission loss. The presumption that such clouds must be confined by a hot intercloud medium has been rejected on observational grounds, and the clouds should rapidly dissipate away unless they are being continuously refreshed by the expected evaporation of our PFP objects.

It has long been known (Zuo & Lu, 1993) that the density of Ly - α clouds increases with redshift z as $(1 + z)^{2.8}$. It has also been noticed by Goobar et al, (2002) that an absorption law scaling as $(1 + z)^3$ up to $z = 0.5$ and constant thereafter, can explain the supernova brightness - redshift relationship of Riess et al, (2004). We are careful not to use the word ”grey extinction” because the transmission loss may be dominated by refraction in the spherical lenses, which would contribute to the diffuse background radiation of the universe, a controversial topic.

We are easily left with the following conclusion: before accepting the idea that the Hubble expansion is dominated by a mysterious Dark Energy, it is important to calculate the transmission to distant supernovae and quasars as limited by the baryonic dark matter.

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