Why HGD papers are not in the Astrophysical Journal (CHG 4/17/2009)

Following is a 1999 review by Ethan Vishniac rejecting two key papers for ApJ describing hydrogravitational dynamics (HGD) structure formation and the quasar microlensing observational evidence, by myself and Rudy Schild (1996) respectively. For the record, the papers were posted in the arXiv:astro-ph archive as arXiv:astro-ph/9908335 and arXiv:astro-ph/9904362v3. Dr. Vishniac is now Chief Editor of the Astrophysical Journal.

The issue referred to by Dr. Vishniac was the subject of many emails back and forth about these papers; that is, whether or not an inviscid expanding universe during the plasma epoch after the big bang should become turbulent simply because the universe is expanding. Edwin Hubble famously established this expansion early in the twentieth century. Strong evidence that the plasma epoch was not fully turbulent is presented by observations showing the cosmic microwave background has extremely small temperature anisotropies ($dT/T \sim 10^{-5}$): two orders of magnitude less than expected for turbulence and turbulent mixing. Therefore either viscous forces or buoyancy forces of gravitational structure formation must have inhibited turbulence at the largest scales. Unfortunately, most cosmologists and astrophysicists like Vishniac in the west know little about Kolmogorovian turbulence and turbulent mixing that predicts this interpretation. Zeldovich and several other Russians working on turbulence as the source of galaxies and galaxy clusters immediately ceased such work when these observations appeared. Although the photon viscosity of the plasma epoch is enormous ($\nu \sim 10^{26}$ m^2 s^{-1}) it is not large enough to prevent turbulence. Therefore gravitational structure formation must have occurred in the plasma epoch to suppress the turbulence. The standard model involves a gravitational condensation of the nearly collisionless non-baryonic dark matter. Cold dark matter (CDM) condensations cannot occur because the NBDM particles are strongly diffusive, by hypothesis.

Numerical simulations referred to by Editor Vishniac cannot be relied on to test turbulence stability or self gravitational stability because the relevant range of scales easily overwhelms the most powerful computers. To permit convergence of the numerical simulations various “numerical viscosities” and other artifacts must be included such as the Plummer scale and the Plummer force. Numerical filters such as the Jeans scale filter are needed to conceal the small scale gravitational fragmentations that occur when viscosity controls structure formation at the Schwarz viscous scale. Because the photon viscosity of the plasma epoch is very large in the plasma epoch it takes 10^{12} seconds (30,000 years) before the scale of causal connection *ct* increases with time *t* after the big bang at the speed of light *c* so it can exceed the Schwarz viscous scale $(\gamma \nu / \rho G)^{1/2}$ giving protosuperclusters and protosupercluster voids.

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Subject: your papers 39001 and 50352
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Dear Drs. Gibson and Schild,

I have carefully gone through your most recent note, the preprint you sent me, as well as the paper from the preprint server mentioned in your note. I regret to say that none of it led me to believe that your model for structure formation is physically reasonable. At this point I am no longer willing to devote time and effort to this process. I am rejecting your two submitted papers, manuscripts 39001 and 50352. I realize that this must be disappointing to you. Frankly, I doubt you can be persuaded at this point, and I don't wish to prolong our discussions, but I feel I owe you one last attempt to explain my position. Notwithstanding, I should stress that as far as I am concerned, this is the end.

First, your argument that a uniform expansion of an inviscid fluid must be unstable to the growth of turbulent eddies is not a reasonable argument. It could, with equal force, be applied to a totally quiescent fluid, where it is immediately obvious that there is no energy available to drive a turbulent cascade. In addition, the proposed driving term will only drive irrotational flows. Finally, the claimed result flies in the face of innumerable numerical simulations, many of them with very large effective Reynolds numbers, which do not recover your result. As far as I know, no one has published a paper explicitly proving the stability of uniform expansion. That may be due to the difficulty in proving nonlinear stability, as opposed to demonstrating a mechanism for instability, but it is also true that such a result wouldn't be considered worth publishing. The stability of many expanding flows is already implicit in simulations of blast waves and virtually every numerical paper on cosmological structure formation.

An inviscid fluid (ie, a fluid with small kinematic viscosity nu) containing density variations is absolutely unstable and will become turbulent starting from rest as the density variations interact with each other by gravitational forces. If the fluid is undergoing uniform expansion with rate of strain gamma it is very easy to construct thought experiments to demonstrate the formation of turbulence. Suppose one connects solid objects of size D<<L such as discs or spheres with cables of length L. The velocity difference V between connected objects is gamma L and the Reynolds number of the turbulence generated will be of order VD/nu = gamma L D / nu. Since nu is arbitrarily small by hypothesis the Reynolds number can be arbitrarily large and turbulent wakes behind the objects will develop. One can easily estimate the tensions in the cables from undergraduate fluid mechanics given the density rho of the fluid assuming Reynolds number independence.

Second, your comments about the irreversible nature of gravitational collapse completely ignore the conservation of energy. Continued collapse requires the loss of thermal energy in order to prevent pressure stabilization. (Your suggestion that infall motion will self-consistently maintain the pressure deficit, or at least prevent a pressure excess, fails to account for the nonlinear scaling of the turbulent pressure term or the fact that the velocity maximum coincides with the maximum gradient, and is therefore not even in the correct location.) Since collapse can't even begin, in the small volumes you favor, unless the temperature is much lower than in the immediate environment, this requires a spontaneous and highly efficient flow of heat from a cold object into a hot environment. I don't understand how you can advocate this, or what alternative there could possibly be that would allow your model to work. I note that your discussion in your paper is entirely qualitative. I do not believe any plausible quantitative model would support you.

It is necessary to distinguish between hydrodynamics and hydrostatics and to use the laws of thermodynamics properly. Starting from a zero velocity fluid with density variablility is hydrodynamics. Pressure support arguments and thermal support arguments are irrelevant. Self-gravitational structure formation is absolutely unstable. Viscosity, turbulence or diffusivity can prevent structure formation depending on the Schwarz viscous, Schwarz turbulent and Schwarz diffusive scales compared to the scale of causal connection *ct*. Collisionless and inviscid numerical simulations are always questionable because assumptions must be made to make them converge. Hydrostatic and thermodynamic arguments become relevant once the voids that develop at density minima and the condensations that develop at density maxima approach equilibria.

Third, your comments about the distribution of primordial objects after their formation reflect a conviction that gravitational interactions cannot alter their clustering pattern. This flies in the face of numerous numerical studies, as well as being an assertion without a supporting argument.

Clearly gravitational interactions influence the clustering patterns of the primordial fog particles (PFPs) in their primordial clumps (PGCs) formed at the time of transition from plasma to gas (decoupling, 10^13 seconds). Most of these objects remain in a state of metastable equilibrium unless they are disturbed to form stars. PGC clumps of PFPs constitute the dark matter of galaxies. This is baryonic dark matter or BDM.

Fourth, your comments about collisionless particles and gravitational clustering ignore the role of gravity in greatly reducing diffusion from a bound gravitational cluster. Since this aspect of gravitational clustering is intuitively obvious, and supported by numerical studies of cosmological structure formation and globular cluster evolution I have to reject your position.

There are no collisionless particles, only weakly collisional particles. The smaller the collision cross-section the larger the diffusivity and the larger the Schwarz diffusion scale. Weakly collisional non-baryonic dark matter NBDM diffuses to such large scales that it leaves protogalaxies to form the halos of galaxy clusters and superclusters of galaxies. NBDM hardly affects the density of the inner halos of galaxies at all.

In your papers you cite approximate numerical agreements between the predictions of your model and observations, notwithstanding the fact that such agreements can be generated from a variety of models. Still, it's fair to cite such things. It is not fair, or reasonable, to ignore abundant contrary evidence.

There is no observational evidence in conflict with the predictions of hydrogravitational dynamics HGD theory, but overwhelming evidence in conflict with LCDMHC cosmology.

I should stress that in arriving at this decision I have consulted with a number of experts in fluid mechanics, on the off chance that I was missing some element of common knowledge from that field that provided a basis for your claims. My conclusion is that your point of view does not represent standard wisdom in fluid mechanics.

My central claim is that viscosity, turbulence and molecular diffusivity are relevant to the formation of gravitational structure in cosmology, contrary to the assumptions made by LCDMHC theory and Jeans 1902. Standard wisdom in fluid mechanics in this century and most of the last should agree that the Jeans 1902 theory based on Euler's equation (no viscosity), linear perturbation stability analysis (no turbulence) and no diffusive effects (no non-baryonic dark matter) makes far too many unjustified assumptions (not to mention the notorious "Jeans Swindle"). Unfortunately, most fluid dynamicists are unaware of the astrophysical and cosmological issues discussed in our papers that are affected by fluid mechanics.

Sincerely,
Ethan T. Vishniac, Science Editor
The Astrophysical Journal