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Editorial Commentary

Planck spectrum shows evidence of big bang and plasma epoch turbulence

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ABSTRACT

The Planck space satellite observation of the cosmic microwave background temperature anomaly spectrum (Ade et al. 2013) shows evidence of the Planck scale turbulent combustion event that triggered the big bang (Gibson 2004, 2005). A similar fossil turbulence pattern is observed reflecting turbulence generated during the plasma epoch, where protosupercluster and protosuperclustervoid fragmentation (Gibson and Schild 2010ab, Bershadskii and Sreenivasan 2002, 2003, Bershadskii 2006) is stretched by the expansion of the universe.

INTRODUCTION

Flows of natural fluids are generally affected or dominated by turbulence[1]. Unfortunately, turbulence is perceived as an unsolved, impossibly difficult problem. No definition of turbulence is widely accepted. Lists of symptoms are offered instead, and a misleading limerick. Turbulence is random, nonlinear and diffusive. This much is agreed. What is not agreed is that turbulence in Nature is subject to fossilization, and that most turbulent transport in natural fluids requires a complex interaction between a variety of persistent fossil turbulence[2] states and the internal waves radiated by these fossils. Most mixing of temperature and salinity in the ocean occurs over long time periods due to fossil turbulence and fossil turbulence waves (Beamed Zombie Turbulence Maser Action mixing chimneys, described in the Journal of Cosmology Volume 21). It is suggested here that space telescope (Spitzer, Planck, Herschel, WMAP) observations require cosmological and astrophysical fluids to obey the same Kolmogorovian universal similarity laws that are inferred from terrestrial turbulence observations.

THEORY

Increasingly accurate and precise measurements of the cosmic microwave background have been provided by a variety of space telescopes, balloon telescopes,

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[1] Turbulence is defined as an eddy-like state of fluid motion where the inertial-vortex forces of the eddies are larger than any other forces that tend to damp the eddies out, Gibson (1996).

[2] Fossil turbulence is defined as a perturbation in any hydrophysical field produced by turbulence that persists after the fluid is no longer turbulent at the scale of the perturbation, Gibson (1996).

and modified ground based telescopes. Generally the observations have been interpreted based on the standard collisionless-inviscid-linear cosmological model ΛCDMHC, where the Sonic Peak at wavenumber $l = 200$ is described as a "baryon oscillation" of the plasma, which is assumed to have fallen into potential wells formed by mergers of cold dark matter condensates that have hierarchically clustered (HC) to form "CDM halos". Gibson and Schild have repeatedly complained about the inadequacy of this model for cosmology, astrophysics and astronomy that are dominated by neglected viscous and turbulence effects, from all observations.

From the Planck space telescope Collaboration, the Ade et al. (2013) TT spectrum (their Fig. 1) agrees with spectra from previous studies. However, the authors note in their Abstract that: "Despite the success of the six-parameter ΛCDM model in describing the Planck data at high multipoles, we note that this cosmology does not provide a good fit to the temperature power spectrum at low multipoles. The unusual shape of the spectrum in the multipole range $20 < l < 40$ was seen previously in the WMAP data and is a real feature of the primordial CMB anisotropies. The poor fit to the spectrum at low multipoles is not of decisive significance, but is an "anomaly" in an otherwise self-consistent analysis of the Planck temperature data".

Fluid mechanical interpretations of CMB spectra have been proposed, starting with Gibson (1996), supported by observations of Schild (1996), and the precise turbulent mixing interpretations for the plasma epoch suggested by Bershadskii and Sreenivasan (2002, 2003), Bershadskii (2006), Gibson and Schild (2010ab), and Gibson (2013ab). Possible fluid mechanical origins of the anomalies of the TT spectrum of Figure 1 are not discussed by the Planck Collaboration.

OBSERVATIONS

The Planck Collaboration Cosmological Parameters (Ade et al. 2013) include the CMB temperature spectrum as their first figure, shown in Figure 1. A prominent peak in the spectrum at multipole $l = 200$ with higher order bumps at larger multipoles is presented as evidence for "baryon oscillations". Such linear resonant sounds are inconsistent with the fact that the baryonic plasma is more viscous than the rocks of the Earth aesthenosphere layer by a factor of $>10^4$. Gibson (2000) computes the kinematic viscosity of the plasma at time $t = 10^{12}$ seconds (the time of first fragmentation) to be $4\text{x}10^{26}$ m^2 s^{-1}. The amplitude of the oscillation is quite astounding when it is interpreted as a baryonic fluid sound, which would be near the threshold for pain if it were at audible frequencies in air. Such a loud sound in the otherwise gently expanding primordial plasma has no physical basis. Bershadskii (2006) infers a Taylor microscale Reynolds number $\lambda \sim 45$ for the plasma, only slightly larger than critical. For the big bang, $\lambda \sim 1000$.

Instead, the "sonic peak" with two oscillations is more easily interpreted from HGD cosmology as a fossil turbulence signature of plasma epoch turbulence.

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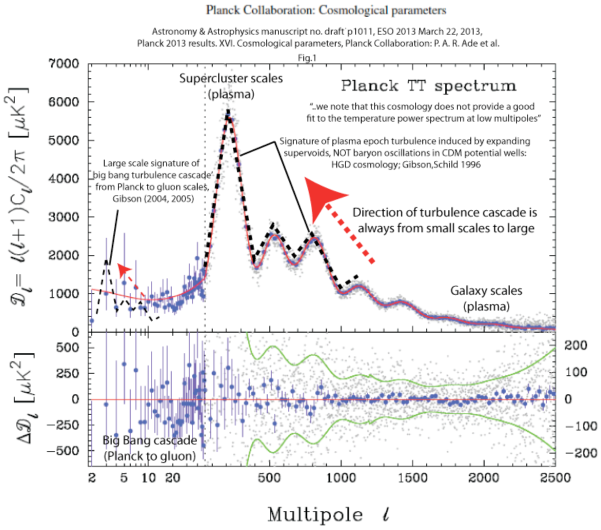

Turbulence signatures in plasma and big bang epochs

Figure 1. Turbulence signatures that appear in the Planck TT spectrum at the largest (big bang turbulence) scales cannot be explained by the standard ΛCDMHC model.

A dark dashed line in Fig. 1 shows the characteristic signature of fully developed turbulence, which starts at the viscous-inertial-vortex-force (Kolmogorov) length scale and cascades to the largest possible energy (Obukhov) scales, as shown by the red arrows. The physical basis of this universal turbulence signature is shown in Figure 2. The light dashed line on the left is the signature of big bang turbulence.

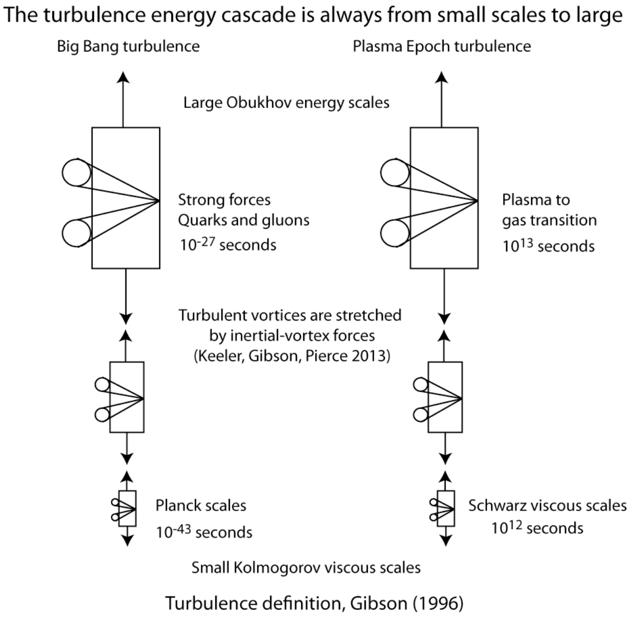

Figure 2. Following the Gibson (1996) definitions of turbulence and fossil turbulence, the Planck Collaboration (2013) TT spectrum reflects signatures of both Planck scale turbulence (left) and plasma epoch scale turbulence (right).

Vortex lines are stretched for both big bang (left) and plasma epoch (right) turbulence (Fig. 1). The volume of the vortices increases by entrainment. Power is supplied by vortex line stretching (black arrows) by the expanding universe. Secondary vortices form and wrap around the primary vortices, as shown.

Turbulence begins at the Kolmogorov scale where the inertial vortex forces $\vec{v} \times \vec{\omega}$ of a shear flow exceeds the viscous forces, where $\vec{v}$ is the velocity and $\vec{\omega} = \nabla \times \vec{v}$ is the vorticity. During the big bang event the Kolmogorov and Planck scales are identical, about 10^{-35} m (left bottom of Fig. 2), Gibson (2004, 2005), with cascade to the largest possible energy (Obukhov) length scale ~ 10^{-27} m, where gluon viscous forces damp the turbulence as quarks and gluons appear at temperatures $<10^{32}$ K.

Figure 3 shows a harbor seal with demonstrated skills at detecting fossil vorticity turbulence patterns in stratified waters like the ocean. Wakes of prey fish are turbulent for short periods of a few seconds, but their fossils persist for much longer periods since seals in Antarctica survive months of winter darkness without migrating.

Seal whiskers have evolved to detect complex fossil vorticity turbulence patterns

Spedding (2013). Fig. 10a

Fossil vorticity turbulence persists long after the turbulence has been damped

Figure 3. This trained harbor seal can track a fossilized turbulent wake in the dark after the turbulence has been damped by stable stratification, Spedding (2013). Not only the wakes but the directions of the wakes are detectable for long periods. Antarctic (Weddell) seals dive to hundreds of meters for periods up to an hour in winter, finding widely separated air holes from their own wakes.

The seal whiskers in Fig. 3 have alternating sizes to match the universal turbulence signature of one large vortex and two proportionately smaller vortices. Polarized spectra may further test the big bang and plasma turbulence patterns suggested in Fig. 1 and Fig. 2.

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CONCLUSIONS

The Planck Collaboration results, shown in Fig. 1, support the proposal of HGD cosmology that turbulence always cascades from small scales to large. Universal Kolmogorovian similarity of all turbulence provides a simple, recognizable, pattern, as illustrated in Fig. 2. The pattern appears to persist from the big bang turbulent combustion event for the smallest monopoles of the CMB, and also from the larger monopoles of turbulence during the plasma epoch, misinterpreted as baryon oscillations in cold dark matter scenarios. The concept of a sonic peak and its harmonics from baryon oscillations should be abandoned, along with many other aspects of ΛCDMHC cosmology that neglect effects of collisional fluid mechanics. The fossil vorticity turbulence patterns inferred in the Planck CMB using HGD cosmology are recognized by sophisticated terrestrial pinnipeds, Fig. 3.

REFERENCES

1. Ade, P. A. R., et al. (Planck Collaboration of 300 Authors, 104 Institutions) Planck 2013 results. XVI. Cosmological parameters, Astronomy & Astrophysics manuscript no. draft p1011, arXiv:1303.5076v1, 20 Mar, 2013.
2. Bershadskii, A., and Sreenivasan, K. R., Multiscaling of cosmic microwave background radiation, Phys. Lett. A, 299, 149-152, 2002
3. Bershadskii, A., and Sreenivasan, K. R., Extended self-similarity of the small-scale cosmic microwave background anisotropy, Phys. Lett. A, 319, 21-23, 2003
4. Bershadskii, A., Isotherms clustering in cosmic microwave background, Phys. Lett. A, 360, 210-216, 2006.
5. Gibson, C. H., Turbulence in the ocean, atmosphere, galaxy and universe, Appl. Mech. Rev., 49, no. 5, 299-315, 1996
6. Gibson, C. H., Turbulent mixing, diffusion and gravity in the formation of cosmological structures: The fluid mechanics of dark matter, J. Fluids Eng., 122, 830-835, 2000
7. Gibson, C.H., The first turbulence and the first fossil turbulence. Flow, Turbulence and Combustion, 72, 161–179, 2004
8. Gibson, C.H., The first turbulent combustion, Combust. Sci. and Tech., 177: 1049–1071, arXiv:astro-ph/0501416, 2005
9. Gibson, C. H., Turbulence and turbulent mixing in natural fluids, Physica Scripta, Turbulent Mixing and Beyond 2009, T142, 014030, doi: 10.1088 /0031-8949/2010 /T142/0140302010, arXiv:1005.2772v4, 2010
10. Gibson, C. H., May turbulence and fossil turbulence lead to life in the universe?, Journal of Cosmology, Vol. 22(12), 10158-10162, 2013
11. Gibson, C. H., Why the Dark Matter of Galaxies is Clumps of Micro-Brown-Dwarfs and Not Cold Dark Matter, Journal of Cosmology, Vol. 15, 6030-6053, 2010
12. Gibson, C. H., Plasma jets reveal the dark matter of galaxies as frozen gas planets in clumps, Editorial Comment, Journal of Cosmology, 22, 10578-10575, 2013.
13. Gibson, Carl H. & Rudolph E. Schild, Turbulent Formation of Protogalaxies at the End of the Plasma Epoch: Theory and Observation, Journal of Cosmology, 6, 1351-1360, 2010

14. Gibson, Carl H. & Rudolph E. Schild, Formation of Planets by Hydrogravitational Dynamics, Journal of Cosmology, Vol. 15, 6184-6199, 2010
15. Gibson, C. H., R. E. Schild & N. C. Wickramasinghe, The origin of life from primordial planets, Int. J. Astrobiol. 10(2), 83-98, 2011
16. Gibson, C. H., N. C. Wickramasinghe, and R. E. Schild, First Life in the Oceans of Primordial-Planets: The Biological Big Bang, Journal of Cosmology, Vol. 11, 3490-3499, 2010
17. Keeler, R. N., C. H. Gibson, J. G. Pierce, Helicity and the Inverse Turbulence Cascade, Journal of Cosmology, Vol. 21, pp 9816-9829, 2013
18. Schild, R., Microlensing variability of the gravitationally lensed quasar Q0957 + 561 A,B, ApJ, 464, 125, 1996
19. Spedding, G. R., Wake Signature Detection, Annu. Rev. Fluid Mech., 46, 273–302, 2014.