INVITED COMMENTARY BY PROFESSOR GREG MATLOFF

Dept. of Physics, New York City College of Technology, CUNY, 300 Jay Street, Brooklyn, NY 11201, USA.
GMatloff@citytech.cuny.edu

Gregory Matloff is Professor of Physics at NYCCT and a Hayden Associate at the American Museum of Natural History. He is a Fellow of the BIS and a Corresponding Member of the International Academy of Astronautics. He is interested in interstellar travel, SETI, and Earth defense from asteroid impacts.

Olaf Stapledon and Conscious Stars: Philosophy or Science?

A visionary aspect of Olaf Stapledon's 1937-vintage masterwork *Star Maker* is his speculation regarding the role of consciousness in the universe, especially the possibility that stars possess a form of volition. We may never know whether Stapledon had access to Zwicky's early measurements on anomalous stellar and galactic motions (that have evolved into the Dark Matter hypothesis) or instead based his musing upon more ancient sources, but we wonder whether there might be a scientific basis for the concept that stars engage in a form of cosmic dance and their motion around the galactic center is only partially constrained by gravity.

Dark Matter has been invoked to explain an aspect of stellar kinematics. Instead of revolving around the center of their galaxy in the manner of planets around their Sun (with innermost worlds moving faster) stars tend to circle the centers of their galaxies as if they are mounted on the spokes of a rigid wheel (with outermost stars moving faster). For decades, astronomers have searched in vain for a mysterious, invisible component to the universe's mass, which may out-mass visible matter. Some astronomers are becoming skeptical regarding the existence of Dark Matter and are entertaining alternative hypothesis such as modifications to Newtonian gravitational theory. Such modifications might be different at galactic and cosmological distances [1].

The work described here started as a philosophical essay regarding Stapledon's conscious stars as an alternative to Dark Matter. Unexpectedly, supporting evidence was located. Since this evidence is falsifiable, it is argued that Stapledon's concept should properly be regarded as speculative science as opposed to purely deductive philosophy.

We next speculate briefly on what consciousness is and how it might be manifested in a star. Then methods that a conscious star might use to alter its galactic trajectory are considered, followed by a discussion of the stellar kinematical evidence supporting Stapledon and how it can be falsified or verified by future work.

More has perhaps been written about consciousness than any other phenomenon we experience. And it still remains a mystery. Some, like Walker, conclude that consciousness cannot be defined and must be considered as the immediate experience of the world around us and our internal thoughts and emotions [2]. Bohm believes that conscious thought is a process rather than an object [3]. Kafatos and Nadeau argue that this process in some pantheistic sense permeates the entire universe [4,]. Theories have been developed to fit this elusive phenomenon into the physical sciences [5,6].

It is posited here that consciousness is built into the structure of the universe [4]. Like gravitation, it cannot be explained by independently invoking fields or matter, but requires the interaction of both. The quantum-physics-based theories of organic consciousness generally postulate that the universal consciousness field interacts with electrically conducting nanostructures within the nervous system. In higher animals, the ~20 nm inter-synaptic spacing between neurons has been suggested as locations for quantum-level events contributing to consciousness [7]. Since all eukaryotic cells contain microtubles, these have been suggested as centers for "microbial consciousness" [8].

Quantum tunneling, quantum entanglement, and the Casimir Effect have been suggested as the "active agents" of consciousness [7,9,10]. The Casimir Effect—a pressure caused by vacuum fluctuations—is a component of molecular bonds. Since some stars have molecules in their upper layers, it is assumed here that Casimir-effect vacuum fluctuations in molecules present in the upper layers of cooler stars are responsible for stellar consciousness.

Consciousness & Stellar Motions: Possibilities & Observation

If a conscious star decides to alter its rate of galactic revolution, do physical mechanisms exist? There are several methods that could be applied by a conscious star to speed up by ~100 km/s over a time interval of ~ 1 billion terrestrial years.

Perhaps the most likely is for the star to eject a unipolar jet of material moving at a few hundred km/s. Young stars could accomplish this since they form in galactic regions with abundant mass. But most jets ejected by young stars are bipolar, as evidenced by any college astronomy text or the Hubble website.

Since massless photons have linear momentum and mature stars eject lots of photons, perhaps photon radiation pressure could be evoked as a means of altering star trajectories. But stellar photon emission tends to be isotropic.

A third possibility exists although it is far from accepted by mainstream physics. During the 1970's, a group of American theoretical physicists centered at the Stanford Research Institute investigated psychokinesis (PK)—in which a conscious mind can operate remotely to alter the properties of physical objects. The controversy that still swirls around their efforts and results is described with great clarity by MIT physics professor David Kaiser [11].

No matter what the mechanism of trajectory alteration, a literature search was conducted to determine whether galactic motions are different for hot stars rare in molecules and cooler star. Since the 1950's, such a variation—dubbed Parenago's Discontinuity—has been recognized. Figure 1 presents from two sources a plot of the solar motion of main sequence stars versus B-V color index [12, 13]. The data set in Ref. [13] is derived from Hipparcos observations of 5000+ nearby stars. From a tabulation of the spectral-type correspondence with star color index, Parenago's Discontinuity around B-V = 0.6 corresponds to early

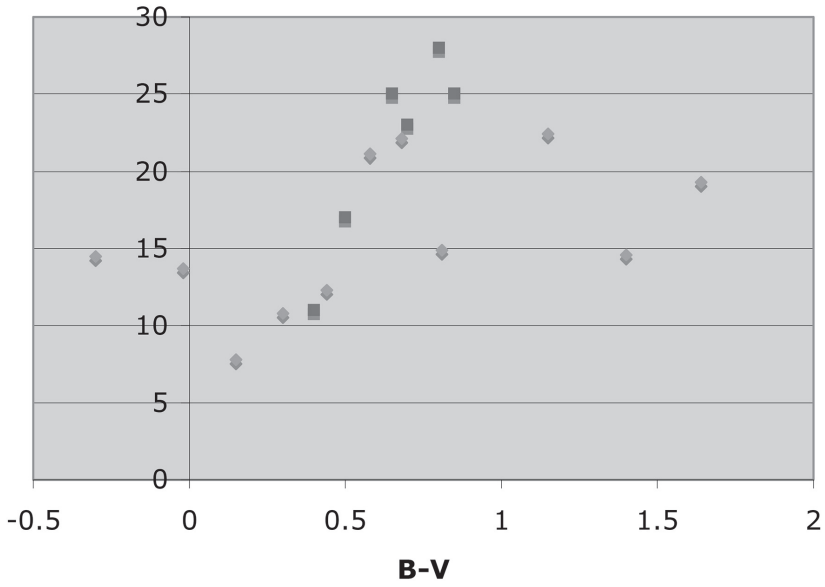

Fig. 1 Solar motion in direction of galactic rotation (V) vs. star colour index (B-V) Diamond data points from Gilmore & Zeilik. Square data points from Binney *et al.*

G-dwarf stars such as the Sun [14]. From a published table of main sequence residence times, a G-dwarf should live for ~10 billion years [15].

Binney *et al*. suspect that the faster velocities for cool, red, long-lived stars occurs because gravitational scattering increases with star age [13]. This seems unlikely since F0 stars (B-V = 0.3) reside on the main sequence for a few billion years and the open clusters within which stars form disperse within a few hundred million years [16]. This Note assumes that the explanation resides instead with the abundance of molecules in a star's upper layers. Molecules are absent or rare in the spectra of hot, blue stars (low B-V); molecules such as CO are present in the Sun's photosphere [17]; infrared spectral signatures of TiO and ZrO are observable in M2 dwarf stars (B-V ≈ 1.5) [17].

This short commentary will not alone heal Descartes' separation of consciousness from the physical world. However, this dualistic approach may no longer be valid since consciousness may be necessary for the well-validated theory of quantum mechanics [6]. It will be interesting to see whether computers with molecular-sized elements begin to display conscious behavior.

Any scientific theory must be falsifiable (or verifiable) by experiment or observation. That is indeed true here. The data used to prepare Ref. [13] utilized statistics for 5610 stars. It is not impossible that Parenago's Discontinuity will be invalidated by the observations of ~1 billion stars planned for the forthcoming Gaia mission.

Observational work will hopefully demonstrate the existence or non-existence of unipolar stellar jets. Hopefully, the very controversial PK experiments reviewed in Ref. [11] can be repeated under a more controlled setting and the controversy regarding this subject can be resolved.

It is of course possible that a more conventional explanation for anomalous stellar motions will prove to be correct. But it is also possible (although perhaps less likely) that stellar consciousness may turn out to be a partial cause for these effects. In that case, Olaf Stapledon will have the last laugh.

The author is grateful for the suggestions of A. Crowl, reviewers and an anonymous colleague and K. Long for presenting this work at the Olaf Stapledon Symposium at BIS headquarters in London, 23 November 2011. Special thanks to P. Gilster for posting a version of this work on his Centauri Dreams blog.

References

1. S. Capozziello, L. Consiglio, M. De. Laurentis, G. De Rosa, and C. Di Donata, "The Missing Matter Problem: From the Dark Matter Search to Alternative Hypothesis", arXiv:1110.5026v1 [astro-ph.CO] 23 October 2011.
2. E.H. Walker, "*The Physics of Consciousness*", Perseus, Cambridge, MA, 2000.
3. D. Bohm, *"Wholeness & the Implicate Order*", Routledge & Kegan Paul, London, 1980.
4. M. Kafatos and R. Nadeau, "*The Conscious Universe*", Springer-Verlag, NY, 1990. Also see R. Penrose, "*The Emperor's New Mind*", Oxford U.P., NY, 1989.
5. H. P. Stapp, "*Mind, Matter & Quantum Mechanics*", Springer-Verlag, NY, 1993.
6. B. Rosenblum and F. Kuttner, "*Quantum Enigma: Physics Encounters Consciousness*", Oxford U.P., NY, 2006.
7. E.H. Walker, "The Nature of Consciousness", *Mathem. Biosci.*, **7**, pp.131-178, 1970.
8. L. Margulis, "The Conscious Cell", in *Cajal and Consciousness (Annals of the New York Academy of Sciences*, Vol. **929**), P.C. Marijuan (Ed), pp.55-70, 2001.
9. R. Penrose, "Quantum Computation, Entanglement & State Reduction", *Philosophical Transactions of the Royal Soc., London A*, **356**, pp.1927-1939, 1998.
10. B. Haisch, "*The God Theory*", Weiser, San Francisco, CA, 2006.
11. D. Kaiser, "*How the Hippies Saved Physics*", Norton, NY, 2011.
12. G.F. Gilmore & M. Zeilik,"Star Populations & the Solar Neighborhood", in *Allen's Astrophys. Quantities*, 4th ed., A.N. Cox (Ed), Springer-Verlag, NY, 2000, Chap. 19.
13. J.J. Binney, W. Dehnen, N. Houk, C.A. Murray & M. J. Preston, "Kinematics of Main Sequence Stars from Hipparcos Data", in *Proc. ESA Symposium 'Hipparcos-Venice '97,' ESA SP-402*, Venice, Italy 13-16 May 1997, pp.473-477, July, 1997.
14. J.S. Drilling and A.U. Landolt, "Normal Stars", in *Allen's Astrophys. Quantities*, 4th ed., A.N. Cox (Ed), Springer-Verlag, NY, 2000, Chap. 15.
15. R.A. Freitas Jr., "*Xenology: An Introduction to Scientific Study of Extraterrestrial Intelligence and Civilization*", 1st ed., Xenology Res. Inst., Sacramento, CA, 1979.
16. E. Chaisson and S. McMillan, "*Astronomy Today*", 6th ed., Pearson Addison-Wesley, San Francisco, CA, 2008.
17. G.F. Sitnik and M.Ch. Pande, "Two Decay Processes for CO Molecules in the Solar Photosphere", *Soviet Astronomy*, **11**, pp.588-591, 1968.