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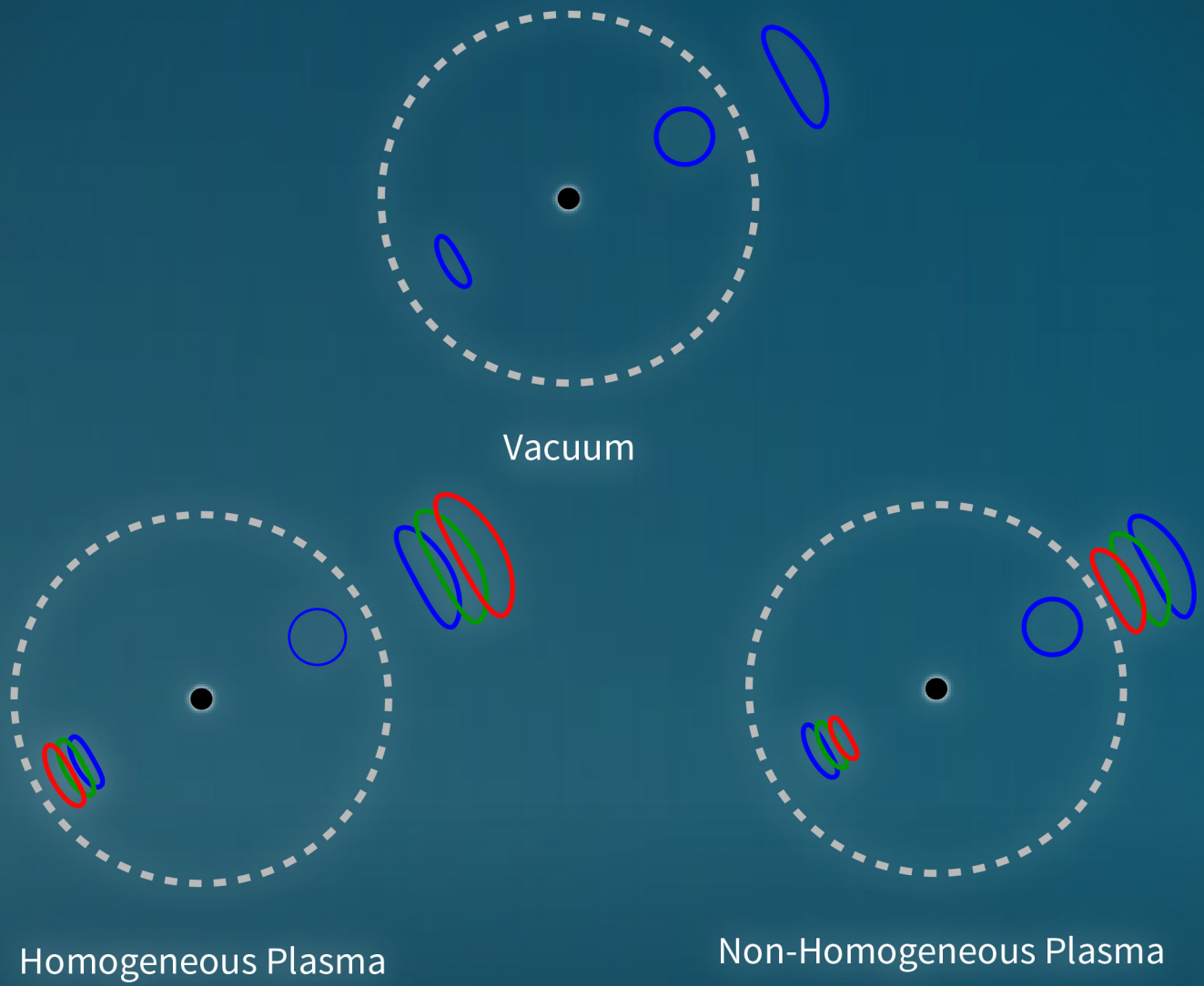

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Comment

Oscillating Stars and the Evidence of Dark Matter. A Comment on "Can the Periodic Spectral Modulations Observed in 236 Sloan Sky Survey Stars Be Due To Dark Matter Effects?" by F. Tamburini and I. Licata

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Dark matter is probably the most fascinating enigma of modern physics. Its evidence is on all the astrophysical scales, from the local ones, inside our galaxy, to the outer galaxies, to the masses of galaxies, to the cosmological scales [1,2]. If we consider the standard cosmological model, based on general relativity and observed families of elemental particles, dark matter is inevitable: it needs to explain the formation and stability of all observed cosmic structures. Likewise, a series of observations based on the brightness distance of Type Ia supernovae, the cosmic background radiation, the distribution of cosmic structures, the so-called baryonic acoustic oscillations, and other observables, clearly indicate that cosmological fluid is experiencing an accelerate expansion. The cause of this fact is generally attributed to the cosmological constant or to an undefined form of dark energy that would accelerate the Universe [3].

Despite these macroscopic evidences, despite the fact that general relativity always receives new confirmations (the recent discovery of gravitational waves is one of the most striking recent examples), the fundamental constituents of dark matter and obscure energy appear extremely elusive. All direct and indirect research of particle with mass interacting gravitationally but not electromagnetically seem to be unsuccessful today. From a general point of view, the Standard Model of elemental particles seems to be extremely solid without leaving room for other "exotic" particles. On the other hand, even modifying the so-called gravitational sector can be problematic if the alternate theories of general relativity do not reproduce the results of the latter, which are experimentally well-founded, at least at local scales [4].

In this complex research framework, a recent work on the prestigious research journal *Physica Scripta*, Fabrizio Tamburini of ZKM in Karlsruhe and MSC-BW in Stuttgart and Ignazio Licata of ISEM in Palermo, could represent a totally original turning point in the research landscape of candidates for dark matter [5].

The two researchers started from the recent data reported for main sequence stars under the Sloan Digital Sky Survey collaboration. For 236 of these stars, Borra and Trottier [6] exhibited an extremely regular periodic modulation in the spectrum. Signals appear so regular that they even suggest an intelligent source of them within the SETI program that seeks extraterrestrial civilizations. Tamburini and Licata, on the other hand, considering the theoretical characteristics of weak interacting massive particles (WIMPs) and axions (among the major candidates for dark matter), indicate in this modulation as clear evidence for axions. In particular, Tamburini and Licata, starting from the frequencies observed, have established a plausible range for the mass of the axion that overlaps with the range obtained recently from Borsanyi et al. from Lattice QCD calculations including Standard Model particles [7]. In other words, the frequency modulation observed in these 236 stars would be due to oscillations of axions. These particles could be clustered into astrophysical structures inside stars or form the so-called 'boson stars' and, above all, the particles would be compatible with the

Standard Model as they would explain the CP (charge-parity) symmetry breaking found in strong interactions [8]. It is premature to say that the work of Tamburini and Licata is 'direct' evidence for dark matter, but it is certainly a very important indication in that direction.

The preprint is available at https://arxiv.org/abs/1611.02586.

Conflicts of Interest: The author declares no conflict of interest.

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