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Is Dark Matter Composed of Neutrinos?

Peter A Sturrock*

Department of Astrophysics and Cosmology, Stanford University, California, United State

Theory

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***For Correspondence:** Peter A Sturrock, Department of Astrophysics and Cosmology, Stanford University, California, United State;

Email: kaba@kiya.ac.jp

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ABSTRACT

Some recently discovered properties of low-energy nuclear physics open the possibility that dark matter may be composed of neutrinos. Recent studies in low-energy nuclear physics have shed light on the potential composition of dark matter, suggesting that neutrinos could be a viable candidate. Neutrinos, lightweight subatomic particles with little to no interaction with matter, have long been hypothesized as potential dark matter constituents. The discovery of oscillation between different types of neutrinos has sparked further investigation into their properties and their potential role as dark matter. If neutrinos were found to be the dominant component of dark matter, it would revolutionize our understanding of the universe. Further research will focus on detecting and understanding the properties of these elusive particles to determine their role in the dark matter puzzle.

Keywords: Shed light; Subatomic particles; Neutrinos; Dark matter; Dark matter puzzle

DESCRIPTION

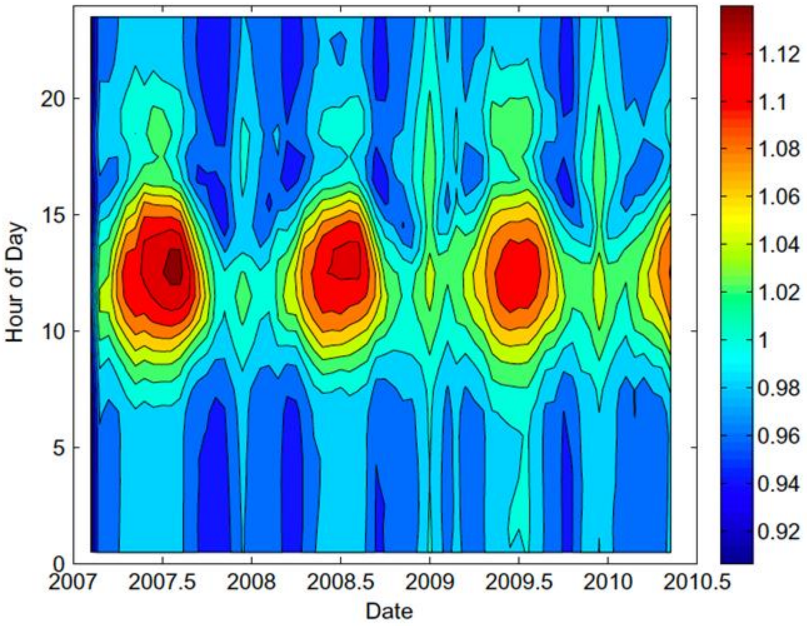
Neutrinos are difficult to detect. The cross-section for the interaction of a neutrino with an electron or proton is of order 10^{-46} cm^2. As a result, super-kamiokande registers only 14 counts per day [1].

However, there is evidence that some different but related experiments yield far higher neutrino-related count rates [2]. For instance, a low-energy nuclear-physics experiment, designed and implemented by the late Gideon Steinitz at the Geological Survey of Israel, yields several thousand counts per hour [3].

We have found a remarkably close correspondence between measurements of this experiment and those of Super-Kamiokande, from which we infer that the GSI experiment responds directly or indirectly - to neutrinos, but possibly not to solar neutrinos [4]. Figure 1, which presents a plot of count rate as a function of both day of year and hour of day, shows that the count rate is a maximum near June [5]. This eliminates as a principal source the sun, for which the maximum would occur in January. The figure shows a maximum in June, which indicates a galactic source [6].

The possible role of neutrinos in relation to the GSI experiment has been examined recently [7]. Figure 1 shows a weak enhancement near noon in January (the expected timing of a solar signal), but a much stronger signal in June, which is the expected timing of a galactic signal. From the ratio of these two figures (using the solar measurement for calibration), one can estimate the neutrino flux (here identified as a signal of galactic origin) to be of order 1012 .0 cm^{-2} s^{-1}. The influence of neutrinos over the GSI count rate may derive from the inverse beta-decay process [8].

Figure 1. Count rate as a function of day of year and hour of day. Is this a snapshot of dark matter?



Adopting the inflow speed (as determined by the solar gravitational field) to be 106.6 cm s^{-1}, we may infer the number density of galactic neutrinos to be 104.5 cm^{-3}. This neutrino density can supply the estimated mass density of local dark matter (10-29 g cm^{-3}) if neutrinos have a mass of order 0.2 eV, which is compatible with current laboratory estimates [9]. Hence the amplitude of the GSI signal is consistent with a galactic influence of neutrinos with a spatial modulation that has a depth of modulation comparable with that inferred for the solar neighborhood. According to these calculations, there should be no difficulty in constructing a neutrino telescope. I am indebted to Timothy Groves and Fabian Pease for stimulating discussions.

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