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NEW AXION BOUNDS FROM THE WHITE DWARF LUMINOSITY FUNCTION

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Despite its success, the standard model of particle physics has some unsolved issues. Among them, is the CP-problem of Quantum Chromodynamics, i.e. the absence of CP-violation in strong interactions. One elegant solution to the CP-problem is the Peccei-Quinn mechanism. A natural consequence of such mechanism is the existence of a new particle, the axion.

It has been shown that the shape of the luminosity function of white dwarfs (WDLF) is a powerful tool to check for the possible existence of DFSZ-axions. We show that the impact of the axion emission into the neutrino emission cannot be neglected at high luminosities ($M_{\rm Bol} \lesssim 8$) and that the axion emission needs to be incorporated self-consistently into the evolution of the white dwarfs when dealing with axion masses larger than $m_a \cos^2\beta \gtrsim 5$ meV. Globally, our computed WDLFs are in good agreement with those previously computed by Isern et al. (2008).

We have performed χ^2-tests to have a quantitative measure of the agreement between the theoretical WDLFs- computed under the assumptions of different axion masses- and the observed WDLFs of the Galactic disk, see Figure 1. Based on the WDLF presented by Harris et al. (2006), our results indicate that the axion masses larger than $m_a \cos^2\beta \gtrsim 8.5$ meV (11.5 meV), axion electron coupling constant $g_{ae} \gtrsim 2.4 \times 10^{-13}$ (3.2×10^{-13}), can be rejected at more than a 95% (99.7%) confidence level. Additionally, from the WDLF derived by DeGennaro et al. (2008) we can derive a less restringent constraint of $m_a \cos^2\beta \gtrsim 20$ meV at the 95% confidence level.

In all cases, we find that the existence or not of axions with masses $m_a \cos^2\beta \lesssim 6.5$ meV ($g_{ae} \lesssim 1.8 \times 10^{-13}$) cannot be concluded at any significant confidence level from the shape of the WDLF at intermediate luminosities ($7 \leq M_{\rm Bol} \leq 12.5$). Our results indicate a disagreement between the observed

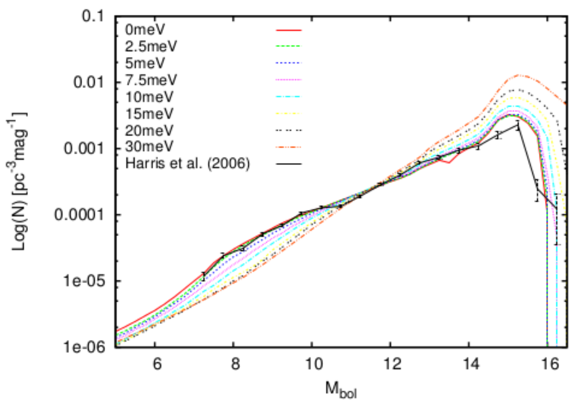

Fig. 1. White dwarf luminosity function constructed for the different axion masses compared with the luminosity function derived by Harris et al. (2006).

WDLF and the cooling speed inferred by asteroseismological tools on G117-B15A and R548.

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