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Revitalising longitudinal plasmon-axion conversion

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In the presence of an external magnetic field, the axion and the photon mix. In particular, the dispersion relation of a longitudinal plasmon always crosses the dispersion relation of the axion (for small axion masses), thus leading to a resonant conversion. While often neglected in the literature, these conversions can dominate axion production or absorption. Using thermal field theory and classical mechanics, we concisely derive the axion emission rate, applying it to astrophysical and laboratory scenarios. For the Sun, depending on the magnetic field profile, plasmon-axion conversion can dominate over Primakoff production at low energies ($\lesssim$200 eV). This both provides a new axion source for future helioscopes and, in the event of discovery, would probe the magnetic field structure of the Sun. Anticipating the detection of solar axions, we determine the potential for the planned next-generation helioscope, the International Axion Observatory (IAXO), to measure or constrain the solar magnetic field. For energy resolutions better than 10 eV, IAXO could access the inner 70% of the Sun and begin to constrain the field at the tachocline: the boundary between the radiative and convective zones. In the case of white dwarfs (WDs), plasmon-axion conversion provides a pure photon coupling probe of the axion, which may contribute significantly for low-mass WDs. Finally, we turn our attention to cryogenic plasmas to search for dark matter axions. Unlike current experiments, which repair the mismatch between axion and photon masses by breaking translational invariance (cavity and dielectric haloscopes), a plasma haloscope enables resonant conversion by matching the axion mass to a plasma frequency.

Abstract Track

Astroparticle physics

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