

When stars dim into axions: A time-domain window on new physics

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Magnetic white dwarfs may reveal axions through a simple astrophysical scenario: photons leaving the stellar surface can convert into axions while traversing the star's intense magnetic field. As the star rotates, the changing magnetic geometry can imprint a periodic, energy-dependent modulation on the observed light. Precision photometry can therefore turn rotating magnetic stars into laboratories for fundamental physics.

Using the magnetic white dwarfs PG 1015+014 and RE J0317-853 as case studies, we show how this scenario can be tested with TESS light curves and achieve competitive sensitivity to sub- μeV axions. Intrinsic stellar variability can mimic parts of the signal, making a realistic understanding of the stellar light curves essential. More broadly, observations of multiple magnetic white dwarfs could identify axion-induced modulation through its correlations with magnetic-field geometry, wavelength, and rotation phase, opening a new time-domain window on weakly coupled particles.

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