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Detection of Fe-57 14.4 keV Axions by Coherent Inverse Primakoff Conversion in Single Crystal Detectors

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Axions can be emitted in the M1 transition of Fe-57 in the Sun. The width of the 14.4 keV axion spectrum is Doppler broadened to about 5 eV (FWHM). The angular size of the region of the Sun responsible for axion production subtends an angle of approximately 0.05 deg., which means the Sun is a nearly monochromatic point source of 14.4 keV axions and ideally suited for coherent Bragg conversion by the inverse Primakoff effect in single crystal detectors.

The region of the sky where the Bragg condition is satisfied for a particular reciprocal vector can be visualized as an annular ring with an angular width on the order of 0.01 deg. whose center is the projection of the reciprocal vector on the sky. It takes the Sun on the order of 10-20 seconds to cross one of these Bragg rings, leading to a very distinctive time-dependent counting rate. Both the flux from the Sun and the cross section for coherent conversion are insensitive to the axion mass so long as the mass of the axion is much less than its energy.

We estimate that with oriented detectors like SuperCDMS and CUORE it will be possible to establish an upper bound on the product of the coupling of axions to nuclei and to photons one or two orders of magnitude better than current limits.

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