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Axion Gegenschein: Dark Counterimages of Bright Radio Sources

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Axion-like particles (ALPs), promising particle candidates of dark matter, can decay into photons through their electromagnetic couplings. However, thanks to their very large lifetime, they are extraordinarily stable. While exposed to ambient radiation of similar frequency as their mass, the decay rate of ALPs into photons is dramatically enhanced resulting in a detectable flux of photons, a phenomenon often termed as the stimulated decay of ALPs.

When photons from radio-bright astrophysical objects such as distant AGNs and SNe remnants pass through the dark matter halo of the Milky Way, they can induce stimulated decay of QCD-scale ALPs each resulting in two photons traveling in directions opposite to one another. While observing in the direction opposite to the source from the observer along the line of sight, photons from stimulated ALP decay appear as radiation that has been backscattered precisely opposite to the incoming wave. We propose a novel detection framework to look for radio emissions from these *counterimages* of the astrophysical source, named *Axion Gegenschein*, analogous to the zodiacal light observed in the antisolar direction.

The detectable radio emission should have the spectrum of a narrow emission line, with a width determined by the axion velocity dispersion. Correspondingly, the counterimage should have the same morphology and dimension as the astrophysical source with a localization in a direction diametrically opposite to it, which constitute a unique signature of decaying ALPs that cannot be mimicked by other astrophysical phenomena. We show the sensitivity of this powerful technique in current and future-generation radio telescopes and discuss the advantages over other probes of radio emission from stimulated ALP decay.

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