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Axion Photon Mixing Dark Matter Conversion: A Torsion-mass Model Constrained by the Barbero-immirzi Parameter

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DESCRIPTION

The search for dark matter, an elusive form of matter that does not emit, absorb, or reflect light, has been one of the most pressing challenges in modern astrophysics. While its existence is inferred from gravitational effects on visible matter, dark matter itself has yet to be directly detected. Several theoretical models aim to explain dark matter, with one promising approach involving axions, hypothetical particles proposed as candidates for dark matter. These ultra-light particles could potentially be detected through their interaction with photons in the presence of strong magnetic fields. A recent development in this area of research introduces the concept of axion-photon-mixing dark matter conversion, which is mediated by torsion mass, constrained by the Barbero-Immirzi parameter. This framework provides a novel way of understanding how axions might interact with electromagnetic fields and could lead to new insights in the hunt for dark matter. Axions, predicted by the Peccei-Quinn theory as a solution to the strong CP problem in quantum chromodynamics (QCD), are incredibly light particles with extremely weak interactions with normal matter. Due to these properties, axions have long been considered a viable candidate for dark matter. These particles are theorized to be produced in the early universe and are abundant in today's cosmos, making them a central focus in dark matter research. Axion-photon mixing is a crucial mechanism that has been proposed to explain how axions could be detected indirectly. When axions interact with photons in the presence of a strong magnetic field, they can oscillate between axion and photon states. This interaction allows axions to convert into photons, which could then be observed as a signature of axion dark matter. In the context of torsion mass, the theory adds another layer of complexity by incorporating aspects of quantum gravity. Torsion is a geometric property of spacetime in certain extensions of general relativity, where the curvature of spacetime is modified by the presence of spin or angular momentum. In such theories, the torsion field can influence the behavior of fundamental particles, including axions. The torsion mass concept, applied to axion-photon mixing, suggests that the conversion between axions and photons is mediated by torsion, modifying the strength and nature of the interaction between these particles. The Barbero-Immirzi parameter, a dimensionless constant introduced in the context of loop quantum gravity, plays a pivotal role in constraining this theory. The parameter is related to the quantization of spacetime and is crucial for understanding the relationship between geometry, gravity, and quantum mechanics. In the case of axion-photon-mixing mediated by torsion, the Barbero-Immirzi parameter effectively constrains the allowed interactions by limiting the torsion mass and, consequently, the axion-photon conversion process. By understanding the values and limits of the Barbero-Immirzi parameter, researchers can refine the theoretical models that predict how axions might interact with photons in the presence of torsion fields. This, in turn, could help constrain the potential observational signatures of axion dark matter. The implications of this framework for dark matter detection are profound. Traditional methods for detecting dark matter involve looking for direct interactions between dark matter particles and ordinary matter or the effects of dark matter on gravitational systems. However, axion-photon mixing offers an alternative approach by searching for the conversion of axions into detectable photons, which could be observed using sensitive instruments such as microwave cavities, resonators, or even telescopes capable of detecting specific photon frequencies.

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CONFLICT OF INTEREST

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