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Constraining Self-interacting Scalar Field Dark Matter with Strong Gravitational Lensing

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The most widely accepted model to describe our Universe is the Cold Dark Matter model (CDM), where the WIMPs scenario is favored for theoretical and experimental reasons. However, despite many experiments, WIMPs have still not been detected. Moreover, as observations and simulations at galactic scales have improved, several challenges remain such as the core-cusp problem and the missing satellite problem.

These tensions could be signs of new physics needed to better understand our Universe. In this context, alternative scenarios have emerged including the hypothesis that DM could be a scalar field (SFDM) with masses ranging from 10^(-22) eV to eV.

This ultra-light mass corresponds to a de Broglie wavelength on the parcsec or kiloparsec scale. Consequently, at scales much smaller than this wavelength, the field exhibits wave-like behavior. These dynamics will result in a different density distribution of dark matter compared to the Navarro-Frenk-White (NFW) profile that typically characterizes CDM halos.

In this talk, I will discuss the use of strong gravitational lensing within galaxy clusters to test SFDM models, in particular the self-interacting model. Gravitational lensing is a powerful technique for investigating mass distribution in dense regions like galaxy clusters. By analyzing gravitational lensing effects, we can place constraints on the parameter space of the model such as the scalar field mass and interaction strengths. Moreover, I will discuss the impact of the baryons in these configurations.

Through a combination of theoretical and numerical calculations and observational data analysis, we investigate how SFDM modifies gravitational lensing patterns compared to the CDM model. Our findings provide valuable insights into the alignment of SFDM with observational data, thereby enhancing our understanding of the mysterious properties of dark matter.

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