Contribution ID: **8** Type: **Physics Analysis**

Quantum fluctuations masquerade as halos: Bounds on ultra-light dark matter from quadruply-imaged quasars

Monday 15 August 2022 15:12 (12 minutes)

The properties of low mass dark matter halos and subhalos, less than 10ˆ9 solar masses, heavily depend on the particle nature of dark matter. Strong gravitational lensing provides a direct probe of these low mass halos. The relative brightnesses of lensed images (flux ratios) in quadruply-imaged quasars (quads) are sensitive to low-mass dark matter structure, and can be used to constrain dark matter theories. In particular, ultra-light dark matter (ULDM) refers to a class of theories, including ultra-light axions, with a particle mass as light as 10ˆ-22 eV. These particles are so light that quantum mechanical effects can manifest on galactic scales in ULDM theories. First, quantum pressure between the ULDM particles leads to the suppression of small-scale structure. Second, wave-like interference patterns in the density profiles of ULDM halos cause large fluctuations in the dark matter mass density comparable to the de Broglie wavelength of the particle. I will present constraints on ULDM models, from 11 strong lenses, which account for both structure suppression and density fluctuations. I will then show that the fluctuations in ULDM can significantly impact flux ratios in quads, and therefore affect particle mass constraints.

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Session Classification: Session III