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Daniel Gilman (UCLA): Probing dark matter with flux ratios from multiply imaged quasars

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The properties of the dark matter particle(s), including its mass and self interactions, affect the abundance and density profiles of dark matter substructure with viral masses below 10ˆ9 solar masses. When these halos impinge on the multiple images in strong gravitational lenses, they perturb image magnifications significantly. To connect this observable to populations of dark matter halos and subhalos, we present a statistical method that relies on forward modeling image magnifications in strong lenses to measure the subhalo mass function. We apply this technique to a warm dark matter scenario, in which free streaming suppresses the subhalo mass function below a characteristic scale that depends on the dark matter particle mass. With our method, we project 2 sigma lower bounds on the mass of thermal relic particles, and quantify the modeling and observation precision required to perform the measurement. A sample of 180 systems with 4% uncertainties on image fluxes constrains the thermal relic mass to > 4.5 keV for projected mass fractions in substructure at the Einstein radius of 0.4%. With a higher mass fraction of 2%, the bound on the free streaming scale improves to 6.5 keV with only 80 lenses. In the coming years, data from strong lenses will push tests of the fundamental predictions of cold dark matter to increasingly small scales.

Presenter: GILMAN, Daniel (UCLA)

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