University of Miami, Physics Department Colloquium

Date: Wednesday, Apr 26, 2023
Time: 4:00 pm – 5:00 pm
Location: Wilder Auditorium – Rm 112, Knight Physics Building

Stress-testing the Cold Dark Matter Paradigm

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Abstract

Observations of structure formation and assembly over a range of physical (Gpc to pc) and temporal (109-103 yr) scales have been successfully accounted for by the concordance cosmological model comprising cold dark matter (CDM) and a cosmological constant. However, tensions have emerged in the several key directions, from: the discordant (now at the 5-sigma level) measurements of the Hubble parameter; discrepant observationally determined values of the growth of structure parameter sigma-8 and most recently from the order of magnitude discrepancy in strong lensing cross-sections on small-scales in galaxy clusters. I will elaborate on this third tension, derived from galaxy-galaxy strong lensing. While several other crises on small-scales in CDM reported in the past stand resolved, this new one intriguingly persists. In this talk, I focus on this new gnawing gap between the observed and theoretically predicted galaxy-galaxy strong lensing cross-sections inferred from the small-scale lensing properties of cluster member galaxies. The implications of this mis-match and potential resolutions, both within the standard cold dark matter paradigm and beyond will be discussed.

Related papers: https://arxiv.org/abs/1702.04348 ; https://arxiv.org/abs/2009.04471 .

Bio

Priya Natarajan is a Professor in the Departments of Astronomy and Physics at Yale. She is also an External PI at Harvard's Black Hole Initiative. Her research work is focused on the study of the dark Universe: dark matter, black holes and dark energy. She has made seminal contributions to two key open problems in astrophysics– our understanding of the nature of dark matter and black hole physics. Her foundational work using gravitational lensing has helped establish substructure – the distribution of dark matter on small-scales – as a critical diagnostic of the nature of dark matter. She has made fundamental contributions to our understanding of the formation, fueling and feedback from supermassive black holes. She proposed the physics for two new channels to form the first black hole seeds and developed the methodological framework linking black holes to their larger scale environments. She is the architect of QUOTAS a platform that co-locates observational and simulation data of high redshift quasars to leverage machine learning methods to explore the underlying connection between the parent dark matter halo, host galaxy and supermassive black hole. Her work has enabled the demographic modeling of black hole populations as a function of cosmic epoch permitting direct comparison with multi-wavelength observations. Recipient of many honors and awards including the Guggenheim and Radcliffe fellowships; fellowship of the APS and RAS she also holds the Sophie & Tycho Brahe Professorship at the University of Copenhagen and an Honorary Professorship for Life at the University of Delhi, India. She also plays a prominent leadership role in the astronomy community including serving as the current Chair of the National Astronomy & Astrophysics Advisory Committee (AAAC) that advises NASA, NSF and DoE; as past Chair of the Division of Astrophysics at the APS and spearheading the first implementation of dual anonymous proposal reviews in the allocation of scarce resources in Astronomy. Her undergraduate degrees are in Physics, Electrical Engineering and Mathematics from MIT. She also holds a master's degree in the history and philosophy of science from MIT's Program in Science, Technology and Society. She completed her PhD from the Institute of Astronomy at the University of Cambridge, where she was the first woman to be elected a fellow of Trinity College in Astrophysics. Deeply interested in interdisciplinary activities, she has collaborated with several prominent artists. More information on her research work, on-going projects and papers can be found at: https://campuspress.yale.edu/priya/ .