

What the Faintest Galaxies in the Universe Tell Us About Dark Matter

Dr. Stacey Kim

Carnegie Theoretical Astrophysics Center

Friday, September 12, 2025, 3:30pm

Abstract: In the next 10 years, all-sky surveys such as Rubin and Roman will discover some of the faintest, least luminous galaxies in the universe. These "dwarf" galaxies are believed to be key to unlocking one of the biggest outstanding questions in astrophysics today: the identity of dark matter. The faintest dwarf galaxies are increasingly dominated by dark matter, and thus such galaxies are heavily shaped by the growth and evolution of their dark matter content. I show that in EDGE, one of the most realistic, high resolution, cosmological hydrodynamic simulation suite of dwarf galaxies to date, key galaxy properties such as stellar mass, size, and metallicity, are affected by halos' growth histories. This implies that dark matter models that predict that halos grow differently from the canonical cold dark matter model may be better constrained by including these effects. As an example, I show how dwarf galaxies in the new EDGE warm dark matter (WDM) simulations are not just less abundant but---as WDM halos form later, they are also fainter and larger, implying that constraints based on luminosity functions may have been overestimated. Ultimately, the most powerful constraints may come from jointly constraining multiple dwarf properties affected by dark matter growth histories: I show that constraints based on the Milky Way satellite galaxies can be tightened by considering not just their abundance but also their kinematics. To end, I preview some exciting new results from EDGE that indicate that the faintest dwarf galaxies may share properties of faint globular clusters. Rubin and Roman will be able to detect hundreds of such faint dwarfs, which will revolutionize dwarf-based dark matter constraints.