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Dark Matter in the Local Universe With DESI-II and S5

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Spectroscopic observations with wide field, extremely sensitive facilities like DESI-II and S5 can constrain the particle properties of dark matter through observations of the smallest cosmic structures in the Milky Way and local universe. The mass, interaction cross-section and other properties of dark matter help set the important physical scales in these systems. The mass spectrum and minimum mass of dark matter halos too small to host stars and galaxies can be inferred by the gaps and other perturbations these halos create when they encounter the ordered streams of stars from tidally disrupted Milky Way star clusters. The shape and symmetry properties of our Milky Way Galaxy's extended dark matter halo are also shaped by the properties of the dark matter particle, and can be mapped using the most distant stars in our Galaxy. The central mass density of the dark matter halos that host low-mass dwarf galaxies provide some of the best constraints on different dark matter candidates. All these observations require precise redshifts (velocities) for many stars in structures that span tens or even hundreds of degrees on the sky. Sensitive, wide-field spectroscopic facilities like DESI-II and S5 can map streams across hundreds of degrees to look for gaps and other perturbations. Their field of view is comparable to the sizes of Milky Way dwarf galaxies, making it possible to measure hundreds and even thousands of stars in these dwarfs to map the mass-density profiles of their dark matter halos and compare with predictions. Dedicated surveys of dwarf galaxies and stellar streams in the Milky Way are among the most promising ways to test the predictions from different dark matter candidates, and are complementary to searches with accelerators.

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