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Dependence of accessible dark matter annihilation cross-sections on the density profiles of dwarf spheroidal galaxies with the Cherenkov Telescope Array

Dwarf spheroidal galaxies are excellent targets in gamma-ray searches for dark matter. We consider dark matter searches in dwarf spheroidal galaxies (dSphs) with the Cherenkov Telescope Array (CTA). The aim of this work is to reveal a quantitative and precise dependence of the accessible dark matter annihilation cross-sections on the dark matter density profiles of dSphs and on the distance to them. In most data analyses, researchers have assumed point-like signals from dSphs because it is difficult to resolve the expected emission profiles with current gamma-ray observatories. In future however, CTA will be able to resolve the peak emission profiles in dSphs. We take several variations of the dark matter density profile of Draco dSph as examples and analyze the simulated observations of with CTA. We derive the accessible region of the dark matter annihilation cross-section with each dark matter density profile. The accessible region of the annihilation cross-section can differ by a factor of 10 among plausible profiles. We also examine the dependence on the distance to the target dSphs by assuming the same profiles of dSphs at different distances. Closer targets are better due to the higher J-factor, while their spatial extension significantly degrades our reach to the annihilation cross-section compared to the value expected from a simple distance-scaling of the J-factor. Spatial extension of the source affects the probable parameter region in energy-dependent ways. In some gamma-ray energy ranges, this behaviour becomes moderately dependent on the properties of the observation facility.

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