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Dark Matter Direct Search Rates in Simulations of the Milky Way and Sagittarius Stream

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Abstract:

We analyze self-consistent N-body simulations of the Milky Way disk and the ongoing disruption of the Sagittarius dwarf satellite to study the effect of Sagittarius tidal debris on dark matter detection experiments. In agreement with significant previous work, we reiterate that the standard halo model is insufficient to describe the non-Maxwellian velocity distribution of the Milky Way halo in our equilibrium halo-only and halo/galaxy models, and offer suggestions for correcting for this discrepancy. More importantly, we emphasize that the dark matter component of the leading tidal arm of the Sagittarius dwarf is significantly more extended than the stellar component of the arm, since the dark matter and stellar streams are not necessarily coaxial and may be offset by several kpc at the point at which they impact the Galactic disk. This suggests that the dark matter component of the Sagittarius debris is likely to have a non-negligible influence on dark matter detection experiments even when the stellar debris is centered several kpc from the solar neighborhood. Relative to models without an infalling Sagittarius dwarf, the Sagittarius dark matter debris in our models induces an energy-dependent enhancement of direct search event rates of as much as ˜20 - 45%, an energy-dependent reduction in the amplitude of the annual modulation of the event rate by as much as a factor of two, a shift in the phase of the annual modulation by as much as ˜20 days, and a shift in the recoil energy at which the modulation reverses phase. These influences of Sagittarius are of general interest in the interpretation of dark matter searches, but may be particularly important in the case of relatively light (m_X < 20 GeV) dark matter because the Sagittarius stream impacts the solar system at high speed compared to the primary halo dark matter.

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