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Gravitational Focusing of Dark Matter Streams in Solar Neighborhood and Implications for Detection

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Cosmological models of dark matter in the galaxy reveal more intricate features than a smooth standard Halo model. One of the features is the existence of numerous fine-grained streams at the location of the solar system, where these fine-grained streams have small velocity dispersion owing to the cold non-interacting nature of dark matter. The gravitational focusing of dark matter by the solar system bodies including the Sun and the Moon has been explored previously. These studies have shown that a small modulation in dark matter density would result at Earth's location if velocity profile of dark matter is Maxwellian which is the assumption in the standard Halo model. The semi-analytic models indicate however large density enhancement are possible for streaming dark matter. We developed simulation tools to propagate dark matter particles such as WIMPs or axions from these streams in our neighborhood accounting for cumulative gravitational effect of Sun and Earth, velocity dispersion effects, and multiple streams overlap. We comment on density enhancement and implications for detection. While our tools have been focused on fine grained streams they could be used for any incoming phase space propagation of dark matter particles in solar vicinity.

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