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Gravitational focusing of Wave Dark Matter

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A massive astrophysical object deforms the local distribution of dark matter, resulting in a local overdensity of dark matter. This phenomenon is often referred to as gravitational focusing. In
the solar system, the gravitational focusing due to the Sun induces modulations of dark matter signals on terrestrial experiments. We consider the gravitational focusing of light bosonic dark matter with a mass of less than about 10 eV. The wave nature of such dark matter candidates leads to unique signatures in the local overdensity and in the spectrum, both of which can be experimentally relevant. We provide a formalism that captures both the gravitational focusing and the stochasticity of wave dark matter, paying particular attention to the similarity and difference to particle dark matter. Distinctive patterns in the density contrast and spectrum are observed
when the de Broglie wavelength of dark matter becomes comparable or less than the size of the system and/or when the velocity dispersion of dark matter is sufficiently small. While gravitational focusing effects generally remain at a few percent level for a relaxed halo dark matter component, they could be much larger for dark matter substructures. With a few well-motivated dark matter substructures, we investigate how each substructure responds to the gravitational potential of the
Sun. The limit at which wave dark matter behaves similar to particle dark matter is also discussed.

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