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Thermal effects on dark matter particle production

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Particles properties in an ambient medium are very different from those in vacuum. Their masses and lifetimes change, and new processes even become possible. For example, in the Standard Model, photons in a plasma (plasmons) acquire an effective mass and can decay into neutrinos, a process forbidden in vacuum. These kinds of thermal effects are especially relevant for dark matter phenomenology, since dark matter production always happens inside a medium of particles, or even from this medium. Examples of these environments include the early universe and the inside of stars. Yet, many calculations of dark matter production still rely on a vacuum-based treatment, and miss key in-medium effects.

In this talk, I will present a systematic formalism to quantify the thermal corrections to particle dynamics. Using this approach, I will demonstrate how qualitatively new amplitudes that have no vacuum analog arise in a medium, and how such amplitudes can significantly impact dark matter production. I will show how these effects can alter dark matter predictions in ways that have been mostly overlooked, and why they are essential for accurate dark matter phenomenology.

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