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Would we notice if dark matter just disappeared?

Tuesday, 26 June • 12 PM - 1 PM

MSI Conference Room • 3550 University

In the cosmological concordance model, dark matter is assumed to be cold, non-interacting and covariantly conserved, implying that its density decreases linearly with the volume of the expanding universe. The arguably least testable deviation from this simple picture would be that a small fraction of dark matter was, at any time, converted to an invisible form of radiation. I will discuss how cosmic microwave and large-scale structure observations can test such a scenario in a model-independent way, thus putting a conservative bound on how much dark matter could have disappeared at any point during the cosmological evolution. For late conversion times, but still before the onset of structure formation, such a 'disappearance' of a few percent of the dark matter would even mitigate a well-known discrepancy between these datasets. There is a variety of scenarios that can be mapped to this general idea, such as decaying dark matter or merging primordial black holes. In the second part of the talk, I will discuss yet another concrete particle physics realization, featuring a second era of dark matter annihilation after thermal freeze-out. As a bonus, this model naturally allows for velocity-dependent dark matter self-interactions strong enough to address the small-scale problems of structure formation.

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