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Primordial Black Holes: From formation to detection

Tuesday, May 21, 2024 3:00 PM (1 hour)

I will present recent work on the formation of primordial black hole dark matter and the resultant gravitational wave (GW) signal, in which my collaborators and I performed an MCMC analysis of a simple—yet generic—multifield inflation model characterized by two scalar fields coupled to each other and non-minimally coupled to gravity. The model was fit to the Planck 2018 CMB data. In particular, model parameters are constrained by data on the amplitude of the primordial power spectrum of scalar curvature perturbations on CMB scales , the spectral index , and the ratio of power in tensor to scalar modes , with a prior that the primordial power spectrum should also lead to primordial black hole (PBH) production sufficient to account for the observed dark matter (DM) abundance., the spectral index , and the ratio of power in tensor to scalar modes , with a prior that the primordial power spectrum should also lead to primordial black hole (PBH) production sufficient to account for the observed dark matter (DM) abundance.

I will discuss why such a class of multifield models is well-motivated and derives from natural high-energy ingredients, and what the parameter space can teach us about the genericness PBH formation from inflation.

I will then transition to the natural follow-up question: how might we detect such PBHs, if they do indeed constitute an O(1) fraction of the DM? I will show that, if PBHs lie within this mass range and make up most or all of the dark matter, the PBH abundance would be large enough for at least one object to cross through the inner Solar System per decade. Since Solar System ephemerides are modeled and measured to extremely high precision, such close encounters could produce detectable perturbations to orbital trajectories with characteristic features. Using a suite of simple Solar System simulations, I will make the case that the abundance of asteroid-mass PBHs can be probed by existing and near-term data, potentially furnishing us with a new direct probe of PBH dark matter.

Presenter: GELLER, Sarah (Santa Cruz Institute for Particle Physics, UC)