Cosmological Evolution of Perturbations in a Model of Superfluid Dark Matter

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The standard LCDM (Lambda-Cold Dark Matter) model of cosmology provides an excellent fit to the observational data of the cosmic microwave background (CMB) as measured by Planck. The growth of large scale structures, galaxy clustering, lensing observations can be explained remarkably well under the scheme of LCDM model. This, along with the simplicity of the model, makes it, by far, the most well accepted model of cosmology. However, certain problems arise when we probe small scales such as individual galaxies or clusters. For example, the Baryonic Tully-Fisher relation and the corresponding tight correlation between the mass and dispersion velocity at the high-mass end, the "cusp-core" problem and "too big to fail" problem cannot be addressed satisfactorily using the usual CDM model. On the other hand, certain modified gravity theories such as MOND (MOdified Newtonian Dynamics) can address these issues at the galactic scales while failing to reproduce observational results at the cosmological scales. This has led to a new idea that CDM might undergo a phase transition depending on the ambient temperature forming superfluids, which can then explain the very different behaviours at small and large scales. In this work, we consider a particular dark matter superfluid theory proposed in [1] which has been shown to mimic MOND at galactic scales due to the strong phononic interactions in the superfluid state. We study, in particular, the background cosmology and the evolution of perturbations in this model. In this talk, I will briefly discuss the results we have obtained and describe how the perturbation growth rate is very different than LCDM suggesting a better modelling of the theory.

References

[1] L. Berezhiani and J. Khoury, *Phys. Rev.* D **92**, 103510 (2015).

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