Contribution ID: **238** Type: **not specified**

Enhancing CMB acoustic phase shift with dark matter loading

Monday 8 May 2023 15:00 (15 minutes)

The acoustic peaks in the CMB power spectrum contain valuable information for studying particle physics. A shift in the position of these peaks corresponds to a phase shift in the acoustic oscillations of the photon-baryon fluid before recombination, which only corresponds to specific types of dark sector physics. As such, it provides a clean cosmological signature for identifying new physics models. For example, if compared against the lambda-CDM model plus free-streaming radiation, the acoustic peaks shift to shorter wavelength modes if the radiation is self-interacting. The maximum phase shift from scattering radiation is typically considered due to the radiation effect. However, in this talk, I will show that such a phase shift can be significantly enhanced by an observable amount if the dark radiation scatters with a fraction of dark matter (DM). The DM-loading effect further suppresses the dark fluid sound speed, shifting the peaks to even shorter wavelength modes. We use neutrino-DM interactions as an example to show that this DM-loading effect can be well-described by a simplified model consisting of two coupled oscillator equations for the photon and neutrino perturbations. The simplified model provides a semi-analytical approach to understanding the origin of the CMB phase shift.

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Session Classification: Cosmology I