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## TALK: Thermal Axion and Dark Radiation

*Monday, June 24, 2024 10:00 AM (45 minutes)*

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We provide a comprehensive analysis of thermal axion production in the early universe, focusing on the KSVZ and DFSZ models. We extend our calculations to incorporate multiple mass thresholds, including the QCD phase transition, and provide a continuous production rate across these regimes. Employing updated cosmological data, we refine constraints on axion mass and examine the implications for dark radiation quantified as an effective number of additional neutrino species ( $\Delta N_{\text{eff}}$ ). Our rigorous approach revisits traditional approximations in axion production, highlighting the importance of precise calculations in anticipation of future CMB surveys and large scale structure observations. Also, we examine the validity of different computational approaches for the calculation of effective number of additional neutrino species.

**Presenter:** HAJKARIM, Fazlollah (University of Oklahoma)