

JOINT TUFTS/MIT COSMOLOGY SEMINAR

Rethinking Cosmological Inference: From Pulsar Timing Arrays to Weak Lensing

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IAS

Extracting information from cosmological observations requires both careful scrutiny of modeling assumptions and powerful inference methods. I will explore these complementary challenges through a reanalysis of pulsar timing array data and field-level inference from weak gravitational lensing.

In the first part, I will discuss the nanohertz gravitational-wave background (GWB) inferred by pulsar timing arrays, which opens a new window on supermassive black hole binary (SMBHB) populations and potentially the early universe. The inferred GWB amplitude exceeds most predictions based on SMBHBs, motivating explanations involving cosmological sources such as cosmic strings and phase transitions. Using NANOGrav 15-year data, I will show that this excess arises largely from a prior volume effect associated with assumptions about pulsar noise. Revisiting these assumptions yields an inferred GWB consistent with SMBHB predictions and weakens the preference for early-universe sources.

In the second part, I will present a simulation-based inference framework that uses generative models incorporating physical symmetries and multi-scale structure to perform field-level weak lensing analysis. This approach extracts 3–5 times as much information as traditional two-point analyses, while enabling diagnostics of model misspecification. I will discuss our ongoing application to the Hyper Suprime-Cam survey, as well as the FAIR Universe weak lensing data challenge.

Tuesday, September 29, 2026, 2:30 pm

Cosman Seminar Room

Center for Theoretical Physics

Building 6C, Room 6C-442

Massachusetts Institute of Technology