Contribution ID: **142** Type: **not specified**

Detecting Gravitational Wave Anisotropies from Supermassive Black Hole Binaries

Thursday 26 September 2024 16:30 (16 minutes)

Anisotropies play a central role in distinguishing between cosmological and astrophysical sources of the GWB, as detectable anisotropies are expected for a GWB from a population of supermassive black hole binaries (SMBHBs) but not for cosmological sources. A search for anisotropies in the NANOGrav 15-year dataset resulted in a null detection. We show that this null detection is not yet in tension with an SMBHB-generated background by calculating the detection probabilities for anisotropies for present and future PTAs. We find that a PTA with the noise characteristics of the NANOGrav 15-year dataset had only a ~6.5% probability for detecting anisotropies, whereas this probability might increase to ~16% for the IPTA DR3. We also identify SMBHB populations that are more likely to produce detectable levels of anisotropies. This information could be used together with the spectral properties of the GWB to characterize the SMBHB population.

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Session Classification: Parallel Thursday Cosmo 3

Track Classification: Cosmology & Astroparticle Physics