Miami Physics Conference 2023

Date: Dec 13-19, 2023

Location: LagoMar Resort

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Probing Dark Matter Substructures with Fast Radio Bursts

Abstract

The matter power spectrum is weakly constrained on subgalactic scales while physics beyond the Lambda CDM paradigm can leave unique imprints on small scales, such as an early matter-dominated epoch, and isocurvature fluctuations induced by post-inflationary axions. We propose measuring the Shapiro time delays of Fast Radio Bursts (FRBs) along two sightlines as a new probe to matter power spectrum on scales down to subparsec. There are two scenarios in which observing FRBs from separate sightlines is possible: 1. Repeating FRBs are strongly lensed; 2. Radio telescopes in space are separated by solar system scale. Under the assumption that FRB time delay measurement can achieve sub-nanosecond precision, we show radio dishes separated by 100 AU will probe QCD axion miniclusters or dark matter minihalos from early matter domination with a reheating temperature as large as 100 MeV.