



Contribution ID: 217

Type: **oral**

Indirect DM searches with Gravitational Waves

Thursday, 26 September 2024 17:35 (17 minutes)

LISA, the space-based gravitational wave detector which was recently adopted, is due to fly in the mid 2030s. An entire new frequency range will be opened up for discovering gravitational wave sources, including intermediate and extreme mass ratio black hole binaries which will remain in band for up to weeks, months or even years. This offers an exciting new avenue for fundamental physics discoveries because the environment of the binaries will have an effect on the gravitational waveform over this long period of time, and we will be able to measure the properties of the environments from the gravitational wave observations alone.

I will show that we can hope to measure the parameters of not only baryonic environments such as accretion disks, but also the properties of dark matter spikes or clouds of scalar fields if they are present around the binaries. I will demonstrate that we can distinguish between different environments with a Bayesian model comparison approach and argue the importance of including environmental effects in waveform modelling. I will also address the various modelling and data analysis challenges that require development before LISA flies, and present ideas towards a realistic data analysis solution that relies on simulation based inference.

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Session Classification: Indirect Dark Matter Detection 2