

# EXPLORE 2022 Workshop: Astrophysical Laboratories of Fundamental Physics



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## EXPLORE project: "Probing Dark Matter with Gravitational Waves" (Dark Matter Team)

*Tuesday 29 March 2022 16:15 (1 hour)*

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On Sep 14, 2015, a dramatic event has taken place. LIGO has detected the first gravitational waves of a binary black hole merger and thus started the era of gravitational wave astronomy.

Seeing the universe with these new eyes opens up countless possibilities to test our theories and make new detections. One of the most intriguing detections would be dark matter!

Massive black holes at the centers of clusters or galaxies are surrounded by gigantic dark matter halos. Near these black holes, the dark matter density can be extremely high and form a so-called dark matter density spike. Due to its extremely high density, the dark matter density spike creates a violent environment around the black hole. If the black hole then merges with a smaller companion object, the presence of the dark matter density spike will drastically affect the binary merger dynamics. In particular, it will leave an imprint on the emitted gravitational wave signal. If we detect such a signal, we can thus probe the nature of dark matter with gravitational waves!

Main tasks: 1. Model the profile of the dark matter density spike around the black hole for different dark matter models (cold dark matter, self-interacting dark matter) in Newtonian gravity and then include relativistic effects. (Dark Matter Group)

2. Model the merger dynamics and the gravitational wave signal including post-Newtonian corrections. (Gravity Group)

3. Compute the gravitational wave signal for different dark matter models, check its detectability with current and future gravitational wave detectors (LIGO, LISA) and constrain the particle nature of dark matter with gravitational waves. (Gravity Group)

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