

Astronomical observations indicate that ordinary matter makes up only approximately 15% of the matter in the Universe whereas the remaining 85% is believed to exist in the form of dark matter. The origin of dark matter continues to remain one of the greatest and most perplexing problems in modern astrophysics and physics, especially given the fact that more and more sophisticated experiments are unable to detect dark matter particles.

The recent discoveries of gravitational waves from mergers of massive black holes by LIGO and Virgo detectors have led to suggestions that some of these black holes may be relics of the early Universe (“primordial black holes”) rather than “ordinary” astrophysical black holes and that they can make up a significant fraction of dark matter. Primordial black holes (PBHs) are believed to form in the very early Universe by the collapse of large density fluctuations generated by a period of inflation, although more exotic scenarios were also proposed. Whereas there exists a number of constraints on the mass spectrum of PBHs, two mass-windows are not excluded by the current data, one of which is the 1-100 solar mass range.

Since black holes do not emit any electromagnetic radiation, they evade detection by traditional astrophysical techniques. One method that is particularly suited for finding black holes is gravitational microlensing – microlensing occurs when gravity of a lensing object, irrespective of its brightness, bends and magnifies the light of a distant source. An observer on Earth may detect a transient brightening of the source star. The more massive the lensing object, the longer the microlensing event.

The main goal of the proposed project is to measure the abundance of massive black holes in the Milky Way halo by searching for extremely-long duration gravitational microlensing events toward the Magellanic Clouds in the combined 20-year-long OGLE data set. The proposed project will allow us to directly probe, for the first time, the phase space of those extremely-long timescale events.

Regardless of whether massive black holes make up a significant fraction of dark matter or not, the expected results are likely to have a considerable impact on many fields of modern astronomy, cosmology, and physics. A detection of massive black holes in the Milky Way halo would represent a big breakthrough for science and would change our understanding of the Universe. On the other hand, the expected limits on the abundance of massive black holes are significantly stronger than the existing constraints. The 20-year OGLE data set is unique and it will be very hard for anybody to improve on these results for decades to come.