The Dark that Shapes the Light
H.G.M. Silverwood

Evidence from cosmology shows that the matter content of the Universe is dominated by dark matter (DM), an as yet unknown particle arising from new physics. This thesis is based upon three research papers that further the search for this elusive particle.

In Chapter 1 we review the cosmology and particle physics of DM, focusing on the weakly interacting massive particle (WIMP) paradigm, and introduce direct and indirect methods for detecting WIMP DM. Chapter 2 investigates the complementarity between direct detection and indirect detection via solar capture and annihilation, with a combined analysis of data from both methods allowing degeneracies in the DM parameter space to be broken.

In Chapter 3 we calculate the projected sensitivity of the Cherenkov Telescope Array (CTA) to gamma-rays from DM annihilating in the galactic centre, the first such calculation to include the sensitivity degradation from the gamma-ray galactic diffuse emission (GDE) and systematic uncertainties in CTA's performance. We also show how the impact of the GDE can be ameliorated by the use of a morphological analysis.

Both direct detection and indirect detection via solar capture and annihilation are dependent on the local DM density, and determining this quantity and its uncertainty is crucial for interpreting results from these experiments. In Chapter 4 we introduce and test a new method for determining the local DM density from the vertical motions of stars in the Milky Way disc, and explore the impacts of the so-called tilt term and a dark disc.