The particle nature of dark matter is one of the most intriguing puzzles of our time. It is therefore important to identify cosmological and astrophysical processes where the particle interactions of dark matter are of relevance. The wealth of knowledge which is and will soon be available from cosmological surveys will reveal new information about the dark sector. In the first part of this talk, I will discuss how we can use observations of the Cosmic Microwave Background and the large-scale structure of the universe to improve our understanding of the particle nature of dark matter. I will review my work aimed at identifying cosmological processes in which the particle interactions of dark matter are of relevance and show how we can use current and future cosmological data to probe these interactions both at large and small scales. In the second part of the talk, I will present a new and promising technique based on gravitational lensing to probe sub-galactic scales where possible clues about dark matter physics could be hidden.