

A Visit to the Nearest Dark Matter Clump

We move from an era of discovering new phenomena to characterizing them in ever greater detail as our knowledge of the Universe grows. But with the increasing cost and complexity of instruments, the power of Earth-based and orbital instruments may soon reach technological limits. We can overcome these bounds with “ground truth” from a visit to astrophysical systems, as we have done with the planets; but the parsec-scale gulf to the nearest stars remains daunting. Yet Proxima Centauri is not the nearest interesting exosolar site. Under our current understanding, the dark matter that makes up most of the Galaxy's mass is clumped into subhalos, some with masses as small as Earth or Jupiter. The nearest clump is only ~ 0.1 pc (~ 10000 AU) away. A probe to this clump will be a natural, timely stepping stone between planetary and true interstellar missions, bringing many benefits.

If dark matter is weakly interacting, there is a good chance that we will detect it indirectly or directly in the next ten years. Characterizing it will then be a major goal of the next few decades. Dark matter clumps could be found in the 2020s by *Fermi*, the CTA, SKA, or other instruments, and cataloged by them or their successors in the 2030s. By then, the LHC may discover WIMPs, followed by studies at the ILC. Understanding these clumps would advance theories of early cosmological structure formation, relevant after JWST and 21 cm line experiments; understanding how the dynamics of dark matter clumps within the Galaxy in fine detail; particle physics; and for interpreting direct detection experiments.

Launching a pre-interstellar probe in the 2040s will be very challenging but rewarding. To reach the clump within a century, the probe must attain speeds >1000 km/s ($>0.003c$) using new forms of propulsion. Aside from direct measurement of its mass profile and detection of its annihilation radiation, the probe can do astronomy only possible beyond Solar System foregrounds, including studies of interstellar cosmic rays and the infrared backgrounds. Finally, a pre-interstellar mission will inspire people everywhere.