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Ultralight Dark Matter and Cosmological Condensed Matter Physics

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The identity of dark matter remains a mystery, despite decades of theorizing and detection efforts. This includes the mechanism for its primordial production, its interactions with itself or with visible matter, and the very nature of dark matter, which could range from a Bose-Einstein Condensate to Black Holes. In this talk I will focus on dark matter in the extreme low mass range, which forms a class of models collectively referred to as ultralight dark matter. These models exhibit exciting new phenomena, such as exotic phases of matter (superfluid, superconducting) and vortex formation. They can be tested in a wide array of experimental arenas, ranging from the large scale structure of the universe to particle physics experiments. I will focus on models wherein ultralight dark matter is realized as a composite state in a confining gauge theory, as a quark condensate analogous to Cooper pairs (STUMP dark matter) or as Ultra Light Pion (ULP) dark matter, and discuss model-independent observables of ULDM. Finally, time permitting, I will touch upon the connection of ultralight dark matter to early dark energy and the Hubble tension.

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