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Quantum measurement and fuzzy dark matter ADAM HELFER, Univ of Missouri - Columbia — It has been suggested that dark matter is a superfluid of particles of mass $\sim 10^{-22}$ eV. It has generally been assumed that a classical effective non-relativistic treatment is adequate. However, the Compton wavelength would be ~ 1 pc, and this macroscopic scale raises foundational issues. It has been known for decades that conventional quantum measurement theory is not compatible with conservation laws, but also that the problems may be insignificant if, as is usually the case in laboratories, the measuring apparatus is much larger than the system probed. Because of fuzzy dark matter's large Compton scale, it is possible to invert this ratio. I describe a thought-experiment using a modest apparatus to measure the matter's stress–energy on parsec scales, and show that conventional quantum theory gives unphysical results. It predicts the measurement itself would excite the particles to relativistic energies, a substantial violation of energy conservation. (In fact, they would escape the Galaxy.) This means the conventional quantum theory supposed to underly the effective classical treatment of fuzzy dark matter is unsatisfactory. But more broadly, it points to a new perspective from which to view foundational issues in quantum measurement.

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