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Chasing Scalar Field Dark Matter with Pulsar Experiments

The ultralight scalar field dark matter (also known as fuzzy dark matter), consisting of bosons with extremely low masses of m ~ 10^(−22) eV, is one of the compelling dark matter candidates, which solves some of the problems of the conventional cold dark matter hypothesis. It was shown by Khmelnitsky and Rubakov that fuzzy dark matter in the Milky Way induces oscillating gravitational potentials, leaving characteristic imprints in the time of arrivals of radio pulses from pulsars. The traces of ultralight scalar field dark matter in the Galaxy are searched in the latest Parkes Pulsar Timing Array dataset that contains the times of arrival of 26 pulsars regularly monitored for more than a decade. No statistically significant signal has been detected. Therefore, we set an upper limit on the local dark matter density assuming the fuzzy dark matter hypothesis. Our stringent upper limits are obtained in the low-boson-mass regime: for boson masses m < 10^(−23) eV, our upper limits are below 6 GeV cm^(-3), which is one order of magnitude above the local dark matter density inferred from kinematics of stars in the Milky Way. The prospects of detecting the fuzzy dark matter with future radio astronomical facilities are discussed.

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