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“Searches for light bosonic dark matter”

If the dark matter is made up of a bosonic particle, it can be ultralight, with a mass potentially much below that of ordinary particles. Moduli fields, whose values could set couplings and masses of known particles, are good candidates for such light dark matter. Their abundance in our Universe would manifest itself as tiny fractional oscillations of Standard Model parameters, such as the electron mass or the fine-structure constant, in turn modulating length and time scales of atoms. Rods and clocks, used for gedanken experiments in the development of relativity theory, have since transformed into actual precision instruments. The size of acoustic resonators and the frequency of atomic transitions can now be measured to 1 part in $10^{24}$ and $10^{18}$, respectively, and thus constitute sensitive probes of moduli over a mass range of $10^{-22}$ eV to $10^{-6}$ eV.

In addition, I will present a proposal for another class of bosonic dark matter detectors based on resonant absorption onto a gas of small polyatomic molecules. Bosonic DM acts on the molecules as a narrow-band perturbation, like an intense but weakly coupled laser. The excited molecules emit the absorbed energy into fluorescence photons that are picked up by sensitive photodetectors with low dark count rates. This setup is sensitive to any DM candidate that couples to electrons, photons, and nuclei, and may improve on current searches by several orders of magnitude in coupling for DM masses between 0.2 eV and 20 eV. This type of detector has excellent intrinsic energy resolution, along with several control variables---pressure, temperature, external electromagnetic fields, molecular species/isotopes---that allow for powerful background rejection methods as well as precision studies of a potential DM signal. The proposed experiment does not require usage of novel exotic materials or futuristic technologies, relying instead on the well-established field of molecular spectroscopy, and on recent advances in single-photon detection. Cooperative radiation effects, which arise due to the large spatial coherence of the nonrelativistic DM field in certain detector geometries, can tightly focus the DM-induced emission photons in a direction that depends on the DM's velocity, permitting a detailed reconstruction of the full 3D velocity distribution in our Galactic neighborhood, as well as further background rejection.