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Direct detection signals of dark matter with magnetic dipole moment

The analysis of direct dark matter (DM) detection data often relies on standard assumptions about the DM interactions with nucleons, namely the so-called spin-independent and spin-dependent interactions. However, other interactions are possible, each giving rise to a different signal. The rate spectrum experiments try to measure can thus be used to gain information about the DM properties. The same is also true for the time dependence of the rate, most notably its annual modulation due to Earth's rotation around the Sun. It is therefore important to have a clear view of what would be the signal produced not only by standard DM candidates, but also by less-standard yet motivated candidates.

A neutral DM particle with a magnetic dipole moment is interesting in this respect, since it has a very different direct detection phenomenology with respect to standard candidates, owing to the peculiar functional form of its differential scattering cross section with nuclei. It could arise as a bound state of charged particles, like the neutron or an atom, or be a fundamental particle which interacts with charged particles, much like a Dirac neutrino. I will analyze in detail the signals expected from this candidate, both the recoil rate and its modulation, and show that they are very different from those expected in the standard scenario. I will also show that, contrary to the common lore, the phase of the modulation depends on the recoil energy as well as on the target material for this candidate. The observation of different modulations by experiments employing different targets would be a strong indication in favour of this type of DM particle.

Experimental Collaboration

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