Migdal effect: improving the sensitivity to light dark matter of liquid argon experiments

Speaker: Stefano Piacentini
16th Patras Workshop -
14/06/2021
Authors: G. Grilli di Cortona, A. Messina, S.P.

Sapienza, Università di Roma
INFN Sezione di Roma 1
Dark Matter direct detection

\[ \frac{dR}{dE_r} \propto \frac{\rho_0}{m_N^2} \sigma_0 F^2(E_r) \int_{v_{\text{esc}}} d^3v \frac{f(\bar{v})}{v} \]

\[ v_{\text{min}}(E_r) = \sqrt{\frac{E_r m_e}{2m_N}} \]
The Migdal effect

Standard Nuclear Recoil (NR) assumption:

The electron cloud follows instantaneously the nucleus after the collision.

More realistic picture:

Due to the initial “displacement” between the nucleus and the electron cloud, an atom can emit an electron (Migdal effect).

There is a range of DM masses for which it is easier to detect the electronic energy originating from the Migdal effect processes rather than nuclear recoils, as a consequence of the fact that more energy can be carried off by light or massless particles for a given momentum transfer.
New sensitivity bounds

- We examined the Migdal effect in experiments exploiting LAr detectors.
- We developed a simulated experiments, called TEA-LAB, inspired on DarkSide-50, a double phase TPC direct detection experiment using LAr, and computed the Migdal electron spectra.

G. Grilli di Cortona, A. Messina, S. Piacentini. JHEP 11 (2020) 034
New sensitivity bounds

- We examined the Migdal effect in experiments exploiting LAr detectors
- We developed a simulated experiments, called TEA-LAB, inspired on DarkSide-50, a double phase TPC direct detection experiment using LAr, and computed the Migdal electron spectra
- We showed how it is possible to extend the experimental sensitivity from $m_\chi \geq 1.8 \text{ GeV}/c^2$ down to masses $m_\chi \lesssim 0.1 \text{ GeV}/c^2$

G. Grilli di Cortona, A. Messina, S. Piacentini JHEP 11 (2020) 034
Thanks for the attention.