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

Speaker: Stefano Piacentini 16th Patras Workshop - 14/06/2021

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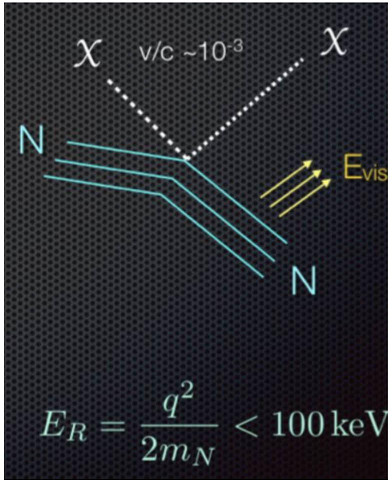
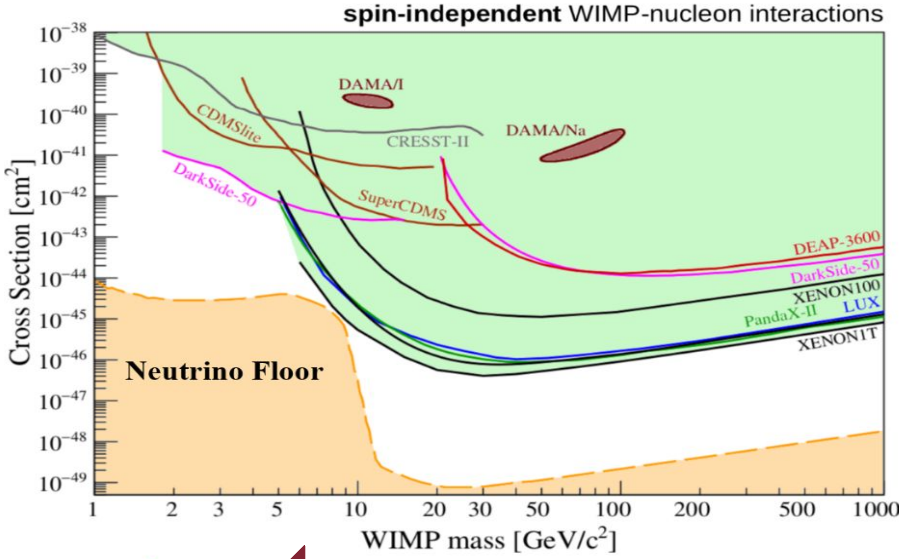
Dark Matter direct detection





Exposure

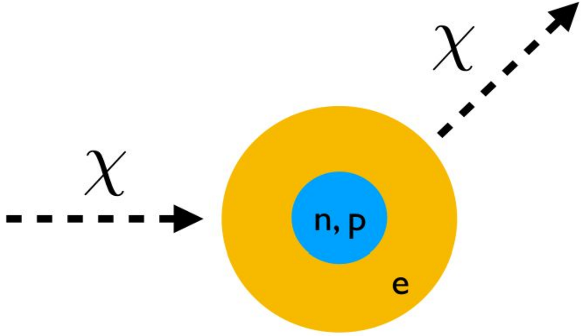
Threshold

$$\frac{dR}{dE_r} \propto \frac{\rho_0}{m_\chi \mu^2}\sigma_0 F^2(E_r)\int_{v_{min}(E_r)=\sqrt{\frac{E_r m_N}{2\mu^2}}}^{v_{esc}} d^3v\,\frac{f(\bar{v})}{v}$$

The Migdal effect

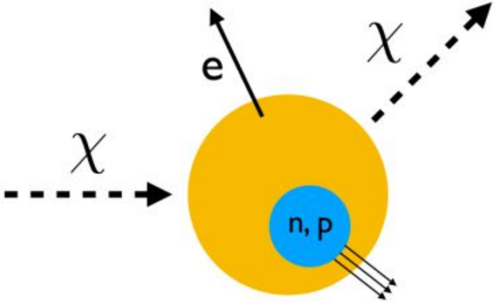
Standard Nuclear Recoil (NR) assumption:

The electron cloud follows instantaneously the nucleus after the collision



More realistic picture:

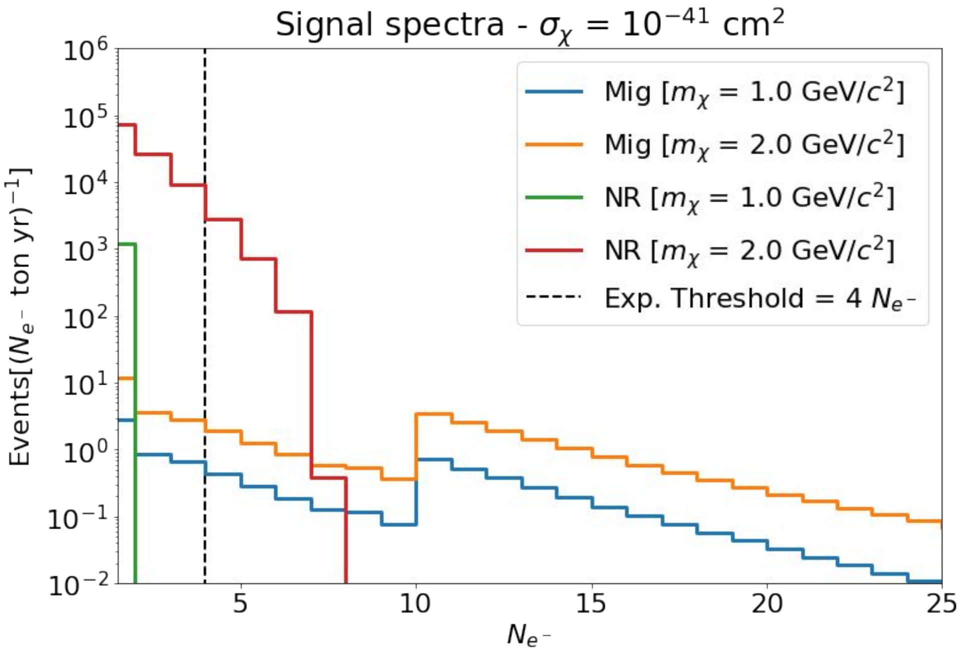
Due to the initial “displacement” between the nucleus and the electron cloud, an atom can emit an electron (**Migdal effect**)



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**



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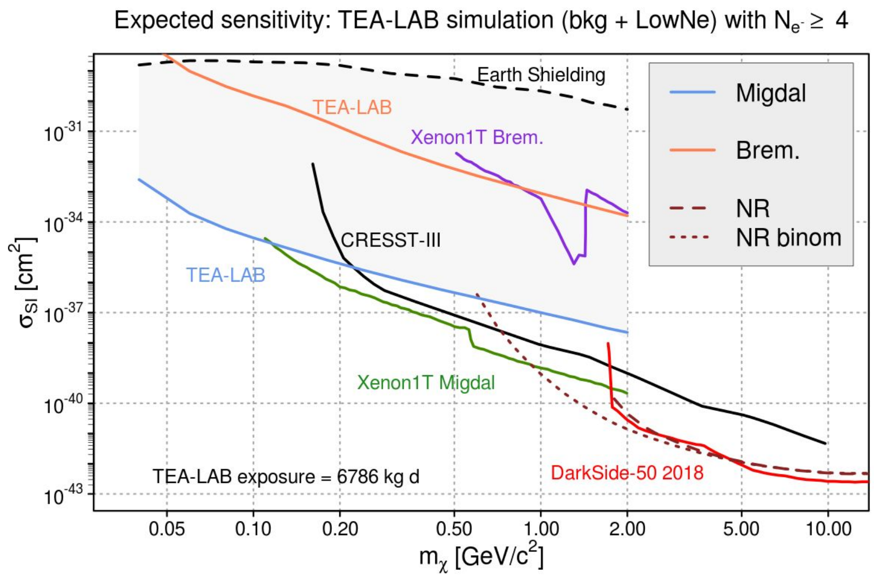
- We showed how it is possible to **extend the experimental sensitivity** from $m_\chi \geq 1.8$ GeV/c^2 down to masses **$m_\chi \lesssim 0.1$ GeV/c^2**



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Thanks for the attention.