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Joint neutron-polarizability extraction and dark-sector search using deuteron photodisintegration

We assess the potential of using deuteron photodisintegration around the neutron quasi-free peak as a dual-purpose experiment to simultaneously constrain neutron polarizabilities and probe physics beyond the Standard Model. Such a combined approach would uniquely tackle two distinct research programs simultaneously: nucleon electromagnetic structure and searches for light new physics.

The neutron electric and magnetic polarizabilities are essential inputs for precision calculations but often dominate theoretical uncertainties. One established method to infer neutron polarizabilities uses deuteron photodisintegration near the neutron quasi-free peak. Here, we explore this reaction, $\gamma d \to e^+e^-pn$, with quasi-free neutron kinematics in the context of a low-energy, high-intensity experiment at MAGIX@MESA. With a projected e^+e^- invariant mass resolution of 0.1 MeV, MAGIX@MESA is expected to offer significantly improved sensitivity over prior efforts (such as MAMI-A2).

In addition, we identify an overlap between kinematic regions relevant for polarizability extraction and for searches of new light bosons in the 10–100 MeV mass range. Given the growing interest in light mediator models—which may give rise to such bosons—we extend our previous work, in which we built a framework to obtain bounds on the coupling of the neutron to a new light boson using deuteron photodisintegration.

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