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Lohengrin —a proposed experiment in the search for dark bremsstrahlung and a portal to the dark sector

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The non-discovery of WIMPs at the LHC and the negative outcome of direct detection experiments have led to a steadily increasing interest in models with light dark matter. Models with a dark matter candidate that has a mass below the Lee-Weinberg bound can predict the right dark matter relic density if a new gauge interaction is introduced in addition to the dark matter candidate. The new gauge boson couples predominantly to the dark matter particle (and possibly other particles), but also acts as a portal to the dark sector in these models thanks to a feeble coupling ε to the standard model.
Dark photons A', massive gauge bosons of a new broken $U(1)_D$ interaction are a prominent example for such a new gauge boson. The dark photon can mix kinetically with the standard model photon, enabling the thermal freeze-out of dark matter particles with masses well below the Lee-Weinberg bound.
Dark photons can be produced in a process called dark bremsstrahlung, for example by shooting a beam of electrons onto a thick target. In this contribution we present the proposal for an experiment at the ELSA accelerator in Bonn that will search for the production of dark bremsstrahlung: the Lohengrin experiment.
A beam of 3.2 GeV electrons is directed onto a tungsten target, placed in a strong magnetic field in the center of a tracking detector that is used for triggering and track reconstruction. Signal events are characterized by a low energy electron and a significant amount of missing momentum and energy in the final state. A fast electromagnetic calorimeter is placed behind the tracking volume to efficiently veto events with standard model bremsstrahlung. A hadron veto is used to discard events with electron-nuclear or photon-nuclear interactions producing neutral hadrons. In order to reach the sensitivity to cosmologically relevant regions in the $m_{A'} - \varepsilon$ parameter space, the key properties of the experiment are 1) a high rate of incoming electrons and 2) a highly efficient background rejection at the order of $10^{(} - 12)$.
We will demonstrate the feasibility of the Lohengrin experiment using next-generation tracking detectors and calorimeters, and will show that the proposed experiment has the potential to conclusively probe the dark photon parameter space for dark photon masses between ~1 MeV and ~50 MeV, an interval that is not currently covered by any existing experiments.

Secondary track

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