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Storage ring as an ALP antenna - an experimental proof of principle

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Axions, or axionlike particles (ALPs), can couple to the spin of nucleons and nuclei, either directly through the axion-wind effect, or indirectly, inducing an oscillating electric dipole moment in nucleons in the process. If ALPs are a part of the cold dark matter in our Galaxy, they can be treated as a classical field. A beam of in-plane polarized hadrons circulating in a storage ring can therefore be used as an ALP antenna. At the resonance between the frequency of an ALP field and the spin-precession frequency of the beam, a buildup of the vertical polarization component should appear as a signal of the ALP presence. As the ALP mass and frequency are unknown, the beam momentum, which is directly related to its spin-precession frequency, needs to be ramped in a search for the resonance crossing. The JEDI collaboration conducted a proof-of-principle experiment demonstrating this new method using the polarized deuteron beam of the COSY synchrotron. An ALP mass range of $0.495 - 0.502\ \mathrm{neV/c^2}$ was scanned. No ALP signal was observed, but a 90% confidence upper limit on the deuteron oscillating electric dipole moment of 6.4×10^{-23} e·cm was obtained. The experimental method was successfully tested through injection into the ring of a fake ALP signal generated using a radio-frequency Wien filter. In my talk, I will discuss the method, necessary preparatory work and developments, the experiment and its subtleties, and the results.

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