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The axion dark matter search at CAPP: a comprehensive approach

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Axions are the result of a dynamic field, similar to Higgs field, invented to solve the so-called Strong CP-problem, i.e., why the electric dipole moment (EDM) of the neutron and proton has not been observed so far even though the theory of QCD requires otherwise. Axions as dark matter can be thought of as an oscillatory field interacting extremely weakly with normal matter other than gravitationally. The oscillation frequency is unknown, it can be anywhere between f = 200MHz to 200GHz and it's expected to be a very narrow line, about df/f=10^-6. A very strong magnetic field can be used to convert part of that field into a very weak electric field oscillating at the same frequency as the axion field. In the coming years we plan to develop our experimental sensitivity to either observe or refute the axions as a viable dark matter candidate. That approach includes the development of ultra strong magnets, high quality resonators in the presence of strong B-fields, new resonator geometries, low noise cryo-amplifiers and new techniques of detecting axions. In addition, using the strong CAST LHC dipole field we will be able to search for dark matter axions in the 4 to 6 GHz range in the immediate future.

Another related subject, through the strong CP-problem, is the search for the EDM of the proton, improving the present sensitivity by more than three orders of magnitude. Usually the study of EDM involves the application of strong electric fields and neutral systems were thought to be easier to work with at first. Recently it became clear that charged particles in all-electric storage rings can be used, instead, for sensitive EDM searches by using techniques similar to the muon g-2 experiment. The high sensitivity study of the proton EDM is possible due to the high intensity polarized proton beams readily available today, making possible to reach 103 TeV in New Physics scale.

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