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Searching for dark matter axions via atomic excitations

Axions can be considered as good dark matter candidates. The detection of such light particles can be achieved by observing axion spin induced atomic excitations. The target is in a magnetic field so that the m-degeneracy is removed the energy levels can be suitably adjusted. Using an axion-electron coupling indicated by the limit obtained by the Borexino experiment, which is quite stringent, reasonable axion absorption rates have been obtained for various atomic targets. The obtained results depend, of course, on the atom considered, through the parameters ε (the spin orbit splitting) as well as the δ (the energy splitting due to the magnetic moment interaction). This assumption allows axion masses the tens of μeV within members of the same multiplet, i.e. |J1 M1=-J-1>−>|J1 M1=-J1 +1> and axion masses in the range 1meV-1eV involving transitions of the spin orbit splitting type |J1 M1=-J1>−>|J2 M2=-J-1 +q>, q=-1,0,1 i.e. in all four types of transitions allowed by the angular momentum selection rules. The axion mass that can be detected is very close to the excitation energy involved, which can vary by adjusting the magnetic field. Furthermore, since the axion is absorbed by the atom, the calculated cross section exhibits resonance behavior, which can be exploited by experiments in minimizing any background events.

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