Magnetic Field Induced Transitions

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Unexpected transitions should not be thought of in the same way as forbidden transitions. While forbidden transitions are quite well understood, the unexpected ones are induced via unexpected mixing of energy levels through e.g. nuclear spin, so called hyperfine induced transitions (HITs) [1], or external magnetic fields, labelled magnetic-field induced transitions (MITs) [2]. In this paper we will concentrate on MITs and the possible use of these spectral lines to measure magnetic field strengths. The first MIT was observed by Beiersdorfer *et al.*[3] using the Electron Beam Ion Trap, EBIT, at the Lawrence Livermore National Laboratory. This MIT occurred in Ne-like Argon and was the strictly forbidden, under single photon emission, $2p^6\ {}^1S_0 - 2p^5 3s\ {}^3P_0$ transition. This transition cannot occur without either an external magnetic field or a non-zero nuclear spin. The transition is caused by mixing of the ${}^3P_0$ level with the ${}^3P_1$ and ${}^1P_1$ levels where both of the mixing levels have allowed transitions to the ${}^1S_0$ ground state. However due to the separation of the energy levels of relevance here this MIT requires a field on the order of several Tesla. Through careful studies of the atomic structure of Cl-like ions we have identified an MIT that is sensitive to magnetic fields of the order of 0.1 – 0.2 T, i.e. similar in magnitude to the expected size of the fields in the active solar corona [4].The MIT is found in Fe^{9+}, which has an high abundancy in the solar corona. Hence this opens up a possible measurement of the active corona magnetic field where there are currently no such measurements. In this case the mixing levels are the $3p^4 3d\ {}^4D^{7/2}$ and ${}^4D_{5/2}$ levels where the ${}^4D_{5/2}$ has an allowed transition to the ground state. The ${}^4D_{7/2}$ level is sensitive to even relatively small magnetic field due to the close degeneracy of the mixing ${}^4D_{5/2}$ level, only 3.5 cm^{-1} [5].

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