Coronal magnetic-field measurements based on accidental degeneracy of quantum states

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Magnetic fields play a crucial role in numerous astrophysical and experimental plasma, such as solar protuberances, tokamaks, ion traps and storage rings. It is well-known that external fields affects ions by breaking the spherical symmetry, resulting in non-degenerate magnetic sublevels. A more intriguing consequence is that the field may introduce new exotic radiative decay channels through mixing of quantum states. We call these Magnetic-field Induced Transitions (MITs) and their rates are proportional to the strength of the magnetic field. This exotic class of radiation could have a significant impact on the spectrum under investigation, especially for systems containing close degeneracies or when otherwise strictly forbidden one-photon channels are opened up. These transitions have attracted new attention recently due to the development of accurate and systematic methods for calculations of their rates \cite{1,2,3} and the possible application as a tool for measuring plasma magnetic fields in cases when conventional methods are beyond reach (e.g. the Solar corona). We are currently developing a general method to determine MIT rates \cite{4} based on wave-functions and transition properties calculated with the well-established relativistic multiconfiguration Dirac-Hartree-Fock program package GRASP2K \cite{5}.

In order to do space-weather forecasts it is necessary to follow the evolution of solar events, such as flares. This requires continuous observations of the magnetic fields which fuels much of the solar activity. We have recently found a unique MIT candidate \cite{6} applicable to measurements of these fields. The plot to the right shows how two quantum mechanical states in Cl-like ions undergo energy inversion along an isoelectronic sequence (see caption for details), uncovering an accidental degeneracy in Fe\textsuperscript{9+} - an ion with a high abundance in astrophysical plasma that also happens to fulfil the requirements for production of an enhanced MIT with a pronounced magnetic-field response. In this talk we will outline this novel method in some detail and explain how it can be applied in measurements of fields in the solar corona. Finally we will discuss the remaining challenges and the way forward.

\begin{thebibliography}{9}
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