MAGNETIC-FIELD INDUCED TRANSITIONS:
THE SEARCH FOR CLOSE DEGENERACIES

Jon Grumer\textsuperscript{a}, Wenxian Li\textsuperscript{b,c}, Roger Hutton\textsuperscript{b,c}, Yaming Zou\textsuperscript{b,c}, Per Jönsson\textsuperscript{d} and
Tomas Brage\textsuperscript{a}

\textsuperscript{a} Division of Mathematical Physics, Department of Physics, Lund University, Sweden
\textsuperscript{b} The Key Laboratory of Applied Ion Beam Physics, Ministry of Education, China
\textsuperscript{c} Shanghai EBIT laboratory, Modern physics institute, Fudan University, Shanghai, China
\textsuperscript{d} Materials Science and Applied Mathematics, Malmö University, Sweden

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 (the Zeeman effect). A more intriguing consequence is that the field will introduce new decay channels through off-diagonal interactions. We call these \textit{magnetic-field induced transitions} (MITs). Such exotic lines 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 of calculations of their rates \cite{1,2} and the possible application as a tool for measuring plasma magnetic fields in cases when conventional methods, such as measurements of Zeeman separation energies, are beyond reach. We are currently developing a module for general atomic systems \cite{3} based on wave-functions and transition matrix elements calculated with the well-established multiconfiguration Dirac-Hartree-Fock program package GRASP2K \cite{4}. The code also supports ions with non-zero nuclear spin (and therefore also pure hyperfine induced transitions) and the aim is to eventually make it available to the general public as an extension module to GRASP2K.

We will give an overview and recent progress in this field and present some new results. One interesting example is our ongoing investigation of \textit{enhanced} MITs appearing due to close degeneracies, and the possible application of these as probes of magnetic fields in solar flares of which no direct measurements yet exists. The origin of these eruptions is connected to regions in the Solar corona with comparatively strong magnetic fields (sunspots) and it is believed that the energy released in a flare has been stored in these fields. It is therefore of great importance to measure the magnetic field strength and we propose a method based on MIT intensities.

References

\cite{1} J Li, J Grumer, W Li, M Andersson, T Brage, R Hutton, P Jönsson, Y Yang and Y Zou, Phys. Rev. A \textbf{88}, 013416, (2013)


\cite{3} J Grumer \textit{et al.} (to be submitted to Comput. Phys. Commun.)