

# Electron Impact Excitation of the Fe-peak Ions for Use in Astrophysical Modelling

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The Fe-peak elements are of vital importance since emission lines from these ions are widely observed in the spectra of a vast array of astronomical objects such as H II regions, active galactic nuclei and stellar coronae. To successfully model these astronomical objects requires highly accurate collision strengths for thousands of transitions in each ion. However, obtaining collision strengths for the Fe-peak elements is a complex task due to the presence of an open 3d-shell in the calculations. This gives rise to a plethora of closely coupled channels, typically numbering in the thousands, and results in a highly computationally demanding problem. This issue has necessitated the creation and development of the R-matrix packages Breit-Pauli RMATRIXI and RMATRIXII [1]. These codes facilitate two different approaches. The R-matrix calculation can be performed directly in intermediate coupling using Breit-Pauli RMATRIXI. Alternatively, the results can be obtained in  $LS$  coupling and then transformed into intermediate coupling via a highly efficient energy independent transformation procedure. The Breit-Pauli RMATRIXI and RMATRIXII codes have been successfully utilised to compute the collision strengths for a wide range of Fe-peak elements. Calculations have been performed for Fe II [2], Ni II [3], Cr II [4] and Sc II [5]. There are substantial ongoing calculations for Fe II, Fe III, Mn II, Co II and Ni III with extensive models consisting of 716, 321, 322, 105 and 359 fine structure levels respectively. Results for some of these important ions will be presented at the conference and comparisons made between the two R-matrix approaches.

The atomic data for the aforementioned Fe-peak ions are currently being incorporated into the astrophysical modelling code CLOUDY [6] via the newly created STOUT database. Several ions have already been included in STOUT and results will be presented for the Ni II ion.

## References:

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