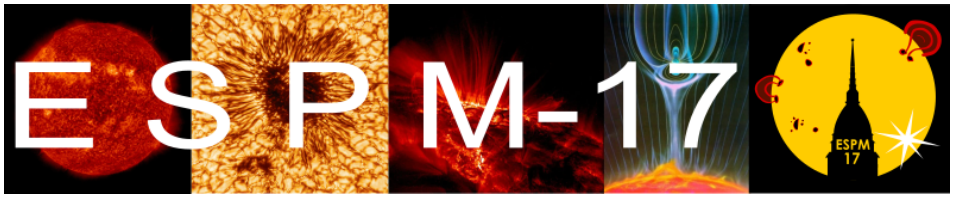

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Jacobian-Free Newton-Krylov method for multilevel NLTE radiative transfer problems

The calculation of the emerging radiation from a model atmosphere requires knowledge of the emissivity and absorption
coefficients, which are proportional to the atomic level population densities of the levels involved in each transition. Due to the
intricate interdependency of the radiation field and the physical state of the atoms, iterative methods are required in order to calculate
the atomic level population densities. A variety of different methods have been proposed to solve this problem, which is known as the
Non-Local Thermodynamical Equilibrium (NLTE) problem.

In this study we have developed a Jacobian-Free Newton-Krylov method (JFNK) to solve multi-level NLTE radiative transfer problems. Using the Rybicki & Hummer (1992) method as a reference, our results show that our JFNK solver can achieve up to a factor two speed up when using local approximate operators / preconditioner, while also achieving a lower residual error in the statistical equilibrium equations. Another advantage of this method is that the addition of charge conservation and partial redistribution effects should be straight forward.

Our method can help accelerating the calculation of the emerging spectra from numerical models and also the reconstruction of chromospheric datasets through NLTE inversions.

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