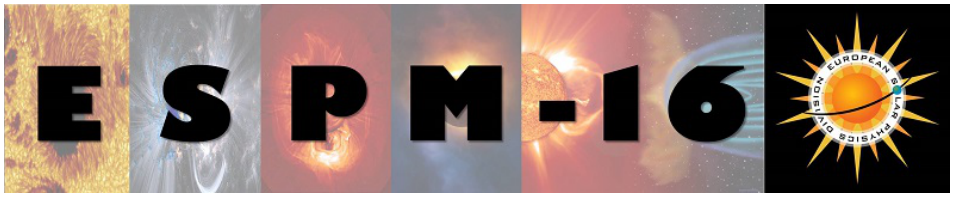

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How wrong are the results of inverting Fe I lines when NLTE and 3D radiative transfer effects are ignored?

Monday, 6 September 2021 16:48 (13 minutes)

The Fe I 6301.5 Å and 6302.5 Å lines are widely used to probe the solar photosphere. They are known to be affected by the non-local thermodynamic equilibrium (NLTE) conditions due to the ultraviolet overionisation of iron atoms in the solar atmosphere. This leads to deviations in their level populations based on Saha-Boltzmann statistics. When inverting their Stokes profiles to determine atmospheric parameters, the NLTE effects are often neglected and other quantities are tweaked to compensate for deviations from the LTE. In this work, we discuss how the routinely employed LTE inversion introduces errors in the derived atmospheric quantities. We show that when the NLTE effects are neglected, these errors can be as high as 13% in temperature, and in line-of-sight velocity and magnetic field strength the errors can even exceed 50%. Errors are found at the sites of granules, intergranular lanes, magnetic elements, and basically in every region with strong vertical gradients in the atmosphere. Similarly, strong horizontal gradients in temperature introduces 3D effects in these lines. We find that errors due to neglecting the 3D effects are more localised and are lower than 5% in temperature, and lower than 20% in both velocity and magnetic field strength. The NLTE and 3D effects are found to persist when the Stokes profiles are spatially and spectrally degraded to the resolution of the SST or DKIST. Our findings have wide-ranging consequences since many results derived in solar physics are based on inversions of these Fe I lines carried out in LTE.

Student poster?

Primary author: Dr SMITHA, H N (Max Planck Institute for Solar System Resesarch)

Co-authors: Dr HOLZREUTER, R. (Max Planck Institute for Solar System Research); Dr VAN NOORT, M. (Max Planck Institute for Solar System Research); Prof. SOLANKI, S. K. (Max Planck Institute for Solar System Research)

Presenter: Dr SMITHA, H N (Max Planck Institute for Solar System Resesarch)

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