HAO Colloquium Series

Speaker: Juan Manuel Borrero, Kiepenheuer Institute of Solar Physics (Freiburg, Germany)

Time: 3:00–4:00 pm

Date: Tuesday, July 22, 2014

Location: CG1 – 2139 Captain Mary (no webcast or recording will be available)

Title: Comparison of inversion codes for polarized line formation in MHD simulations. Milne-Eddington codes

Abstract:

Milne-Eddington (M-E) inversion codes for the radiative transfer equation are the most widely used tools to infer the magnetic field from observations of the polarization signals in photospheric and chromospheric spectral lines. Unfortunately, a comprehensive comparison between the different M-E codes available to the solar physics community is still missing, and so is a physical interpretation of their inferences. In this contribution we offer a comparison between three of those codes (VFISV, ASP/HAO, and HELIX). These codes are used to invert synthetic Stokes profiles that were previously obtained from realistic non-grey 3D MHD numerical simulations. The results of the inversion are compared with each other and with those from the MHD simulations. In the first case, the M-E codes retrieve values for the magnetic field strength, inclination and line-of-sight velocity that agree with each other within \( \sigma B \leq 35 \) (Gauss), \( \sigma \gamma \leq 1.2 \degree \), and \( \sigma v \leq 10 \) m s\(^{-1} \), respectively. Additionally, M-E inversion codes agree with the numerical simulation to a high degree.

**NICOLE:** An Open Source, Massively Parallel Code for Non-LTE Synthesis and Inversion of Spectral Lines and Zeeman-induced Stokes Profiles.

With the advent of a new generation of solar telescopes and instrumentation (DKIST, EST, Solar-C, etc), the interest in the interpretation of chromospheric (spectro-polarimetric) observations has spiked, driving in turn a need for suitable diagnostic tools. In this talk I will describe a new code that has been designed for Stokes NLTE radiative transfer (synthesis and inversion). It has been built from scratch with MPI parallelization implemented right from the beginning, with the idea of applying it on massive datasets. NICOLE is about to be released publicly and considerable effort has been put into making it as user-friendly as possible. We hope that it will become a valuable diagnostic tool for the community. When compared at a fixed optical depth, within \( \sigma B \leq 130 \) (Gauss), \( \sigma \gamma \leq 5 \degree \), and \( \sigma v \leq 320 \) m s\(^{-1} \). Finally, we show that employing generalized response functions to determine the height at which M-E codes measure physical parameters is more meaningful than comparing at a fixed geometrical height or optical depth. In this case the differences between M-E inferences and the 3D MHD simulations decrease to \( \sigma B \leq 90 \) (Gauss), \( \sigma \gamma \leq 3 \degree \), and \( \sigma v \leq 90 \) ms\(^{-1} \).