

STSM Scientific Report Template

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Visited scientist and host institution : Dr. Luca Belluzzi, Istituto Ricerche Solari Locarno (IRSOL)

Dates of STSM : April 6th to May 15th 2015

Explain briefly below how your STSM matched one of these key-points :

1. strengthen current collaborative projects
2. establish new collaborations
3. obtain necessary knowledge for the application of new techniques
4. use host infrastructures that are not available at the home institute.

During my stay at IRSOL I had the opportunity to work more closely with Dr. Luca Belluzzi, who is the co-director of my thesis. It is highly beneficial to be able to work with him in person, given his expertise in radiative transfer in the solar atmosphere in general, and particularly in the subject of partial redistribution in frequencies (PRD).

The main objective of the stay was to finish developing a radiative transfer code for a two-level atom, which considers partial redistribution in frequencies (PRD), in the presence of a deterministic magnetic field of arbitrary intensity; i.e. without considering either the weak magnetic field approximation (neglecting the effect of Zeeman splitting) nor the strong field limit of the Zeeman effect (in which atomic polarization is not considered).

Describe below the activities carried out during the STSM and the main results obtained.

The code is based on the redistribution matrix formalism developed by V. Bommier (1997). During the first few days of the stay, certain theoretic aspects concerning the physics of Raman scattering were addressed, such as the effects of Doppler redistribution together with Raman scattering (as well as a theoretical interpretation of the contribution of each individual transition to the redistribution matrix due to coherent scattering using the metalevel theory).

The RII redistribution matrix was included in a non-LTE code which had been previously developed for treating the limit of complete frequency redistribution (CRD), and which already used the so-called frequency-by-frequency method (a numerical method that allows applying the Jacobi iterative scheme when the source function is frequency-dependent; see Paletou & Auer 1995).

After a debugging phase in which multiple tests were performed in order to find possible sources of errors - such as comparing the zero-field results with those of codes already in existence, taking the limits of CRD and of coherent scattering (CS), or considering an optically thin slab in order to eliminate radiative transfer effects – the code was applied to the Ba II line at 4554 Å and the Sr II line at 4077 Å, the atomic model for which had been developed during my previous stay at IRSOL. Results were obtained for various inclinations and intensities of the magnetic field, and the combined action of the Hanle and Zeeman effects was identified in the corresponding Stokes profiles. In addition, the results were compared to the ones obtained using the weak field approximation. It was found that, while this approximation is a good one in the core of these lines, the depolarization found in the wings in this approximation is considerably overestimated.

In conclusion, the main goal of my STSM at IRSOL has bee successfully achieved. The above-mentioned code has been completed, and it is now producing some very interesting results. From the computational point of view, the next step will be to improve the rate of convergence for strong fields. Theoretically, we need to identify the exact physical mechanisms at the origin of producing peculiar behaviours shown by the calculated Stokes profiles for given magnetic field intensities and geometries.