Paris-Sud / CSC program 2014

PhD project proposal form

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Discipline

Earth & Universe Sciences

Doctoral School

288 - Waves and Matter

Thesis subject title **Prominence plasma diagnostics from the IRIS/NASA mission data**

- **Laboratory name** **Institut d'Astrophysique Spatiale**
  - **Laboratory web site** **http://www.ias.fr/**

- **PhD supervisor (contact person)**
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  - **Position** **Directeur de Recherche Emerite & Chargé de Recherche CNRS**
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- **Thesis proposal (max 1500 words)**

The NASA IRIS spacecraft launched on 27 June 2013 provides a wealth of imaging and spectroscopic data concerning the solar atmosphere with excellent spatial and spectral resolutions and a unique cadence (about 1 sec.). The thesis directors are Associated Scientists and consequently have a unique access to the data (and the relevant information). Since June, a lot of prominence observations have been performed and some of them pre-analyzed, particularly in the Mg II doublet at 280 nm.

Prominences are a fascinating structure in the solar atmosphere. They are made of cool plasma (10 000 K) "suspended" in the hot corona (one million K). The plasma is partly ionized (but not fully), the plasma parameter β is close to 1 and the magnetic field (essentially horizontal) is supposed to maintain, through its tension, the plasma against the solar gravity. Until now, many thermodynamic parameters (including the ionization degree) are only known within an order of magnitude. The overall objective of the proposed thesis is to drastically reduce this large range of values which impedes a reliable mhd modelling.

The bulk of the thesis consists in analyzing the data concerning different prominences (in the usual classification), taking into account ancillary observations from other S/C (SDO, Hinode et STEREO) and from ground-based Observatories (Big Bear, Iles Canaries, Pic-du-Midi, ..). The proposed work involves the search of relevant space and ground-based data up to the characterisation of the plasma through the interpretation of spectra. Along this lengthy process, it also involves instrumental corrections, photometric calibration and search for context imaging.

Since the Mg II doublet is an optically thick line formed in Non-Local Thermodynamic Equilibrium (NLTE), the derivation of physical properties of the plasma is non-trivial. It relies upon complex NLTE codes that are available in I.A.S. and also in Ondrejov Observatory with which we have a strong collaboration (see Heinzel, Vial, Anzer 2013, submitted). The thesis will also rely upon the use of such codes for modelling solar prominences.

Overall, the thesis will provide the opportunity of learning various techniques of solar spatial spectroscopy and NLTE radiative transfer.

Short bibliography :

Vial, J.-C. : 1982, Optically thick Lines in a Quiescent Prominence : Profiles of Lalpha, Lbeta (HI), h and k (Mg II), K and H (Ca II) Lines with the OSO-8 L.P.S.P. Instrument, Astrophys. J., 253,330

Vial, J.-C. : 1982, Two-Dimensional non-LTE Transfert Computations of Resonance Lines in quiescent Prominences, Astrophys. J., 254, 780

N. Labrosse, P. Heinzel, J.-C. Vial, et al., 2010, Physics of Solar Prominences: I—Spectral Diagnostics and Non-LTE Modelling, Space Science Reviews, 151, 243

P. Heinzel, J.-C. Vial, and U. Anzer, 2013, On the formation of MgII h and k lines in solar prominences, submitted to A & A

- **Publications of the laboratory in the field (max 5)**

Koleva, K.; Madjarska, M. S.; Duchlev, P.; Schrijver, C. J.; **Vial, J.-C.; Buchlin, E.**; Dechev, M., 2012, *Kinematics and helicity evolution of a loop-like eruptive prominence*, Astronomy & Astrophysics, 540, 127

1.

Vial, J.-C.; Olivier, K.; Philippon, A. A, et al., 2012, *High spatial resolution VAULT H-Lyα observations and multiwavelength analysis of an active region filament*, Astronomy & Astrophysics, 541, 108

2.

Gunár, S.; Parenti, S.; Anzer, U.; Heinzel, P.; **Vial, J.-C**. 2011, *Synthetic differential emission measure curves of prominence fine structures. II. The SoHO/SUMER prominence of 8 June 2004,*

3.

N. Labrosse, P. Heinzel, **J.-C. Vial,** T. Kucera, S. Parenti, S. Gunár, B. Schmieder and G. Kilper, 2010**,** *Physics of Solar Prominences: I—Spectral Diagnostics and Non-LTE Modelling*, Space Science Reviews, 151, 243

4.

J.-C. Vial, H. Ebadi, and A. Ajabshirizadeh, 2007, *The Lyα and Lyβ profiles in solar prominences and the issue of the fine structure*, Solar Physics, 246, 327

5.

- **Specific requirements to apply, if any**
  This thesis is shared between Jean-Claude Vial and Eric Buchlin who already shared the thesis of Céline Boutry.
  As far as the background of the PhD student is concerned, a solid formation in physics is a requisite. An interest in astrophysics and numerical analysis is welcome.