Call for applications for a PhD position
Laboratory of Excellence PLAS@PAR

Project title: "Radiation magnetohydrodynamic models and spectral signatures of plasma flows accreting onto young stellar objects"

Project description
Classical T Tauri Stars (CTTSs) are young low-mass (less than 8 solar masses) stars actively accreting mass from a surrounding disk. On the basis of the largely accepted magnetospheric accretion scenario, the accretion process from the disk is regulated by the stellar magnetic field, which is strong enough to disrupt the inner part of the disk at a distance of a few stellar radii (the truncation radius). The field guides the circumstellar material along its flux tubes toward the central protostar, around free-fall velocity (up to a few hundreds km s\(^{-1}\)). The accreting flow terminates in a shock at the stellar surface, which heats the plasma up to temperatures of a few million degrees.

The objective of the PhD project is to shed light on the processes governing the physics of the accreting plasma flows through complete magnetohydrodynamic models. Over the last twenty years, the scientific community has accumulated a wealth of spectra, from medium to high resolution, that primarily cover soft X-ray, UV, and visible domains. These measurements have raised several questions. In particular, the observed X-ray luminosity arising from the post-shock plasma is largely below the predicted value; UV lines exhibit complex profiles suggesting the presence of several plasma components with different downflowing velocities; the influence of the hot post-shock plasma to the upstream flow and the coronal activity is debated. We propose to tackle these problems through two complementary and interdependent directions: 1) the modeling of the structure and dynamics of the post-shock plasma, 2) the calculation of the spectral signatures of this plasma. The originality of our approach is fourfold: extending magnetohydrodynamic (MHD) simulations from 2D \cite{Orlando_2013} to 3D, incorporating radiation in the dynamics and energetics of the flows, calculating self-consistently non local thermodynamic equilibrium (non-LTE) spectral signatures of the 3D structures, answering the need of validation of models by confronting synthesized spectral signatures with observational spectra.

To achieve our objectives, we will use state-of-the-art multi-dimensional MHD, radiation magnetohydrodynamic (RMHD), and radiative transfer codes for astrophysical plasmas:
- PLUTO \cite{Mignone_2007}: it is a modular Godunov-type code intended mainly for astrophysical applications and high Mach number flows in multiple spatial dimensions.
- IRIS \cite{Ibgui_2013}: it is a generic code that fully solves the 3D radiative transfer equation to calculate synthetic spectra.


Requirements for the candidate: Candidates must have a Master degree in physics, astrophysics, or a related field, interest and background in numerical simulation and theory, along with knowledge in magnetohydrodynamics, radiative transfer, and quantitative spectroscopy.

Starting date and location: 1 October 2016
Palermo Observatory, Italy (year 1, and last 6 months of year 3),
University Pierre and Marie Curie, UPMC, Paris, France (year 2, and first 6 months of year 3).

The application should be sent by e-mail to the following contacts:
Salvatore Orlando orlando@astrropa.inaf.it
Laurent Ibgui laurent.ibgui@obspm.fr
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Applications with CV, statement of motivation, copies of degree diplomas and grades, two reference letters, and copies of any previous research-related work. Deadline is May 31st 2016.