Special P/SS Department Colloquium

Approaches to Interactive 3D Modeling and Forward-Fitting Diagnostics Using Imaging Spectroscopy Data

Monday, March 17, 2014
Crawford 220
4:00 - 5:00pm

Meet and Greet
OPS 405
3:00 – 4:00pm

Dr. Gregory D. Fleishman
Center for Solar and Terrestrial Research (CSTR), New Jersey Institute of Technology

Obtaining new knowledge in modern astrophysics and space sciences relies, to a great extent, on spectral data recorded with high spatial resolution, commonly called the imaging spectroscopy. This is particularly true for the solar physics because many dynamic phenomena at the Sun, due to its proximity to the observer, can be spatially resolved and studied in detail. A great challenge in understanding such spatially resolved data is that they give a 2D projection of the actual 3D volume, thus, recovering this 3D structure requires additional efforts and novel approach to the analysis of this corresponding big data volume. To be specific, this talk will be guided by anticipated microwave spectropolarimetry data from a new community facility—the Expanded Owens Valley Solar Array (EOVSA), which we have built over the past three years, and which is now at the commissioning stage. EOVSA is a unique, state-of-the-art instrument that incorporates innovative hardware and software technology developed for a much bigger future instrument, FASR. EOVSA, located at Caltech's Owens Valley Radio Observatory, is the only solar-dedicated radio interferometer array in the United States. Given its unprecedented spatial, temporal, and spectral resolution, EOVSA will provide the most comprehensive physics-based radio spectral measurements of solar and space-weather phenomena to date. To properly and fully convert these measurements into new fundamental solar physics knowledge is a great challenge, which calls for an innovative approach to analyze the data, derive the science data products, and serve the community with these data and data products. In this talk I will describe modeling efforts allowing fast interactive building realistic 3D models of active regions and solar flares. A modeling tool, GX Simulator, developed for this purpose is capable of creating a 3D magnetic data cube from extrapolating the photospheric magnetic measurements into the coronal volume, populating this data cube with thermal plasma distribution, creation of isolated flux tubes and populating them with the thermal plasma and nonthermal particle distributions, many kinds of analysis and manipulation, and, eventually, computation of emission using specifically developed fast computing codes. As a result, a set of realistic multi-frequency images is obtained on the time scale of one minute. Such 3D models, although can be viewed as a final product, can then be used as the input for further analysis. For example, the images can be folded through a given instrument response function and then restored using an imaging algorithm (e.g., CLEAN) to represent a realistic model of what this instrument can actually observe. I will present and discuss the a novel forward fitting approach to the source parameter diagnostics based on such realistic (folded) imaging data and demonstrate that such approach is capable of reliable diagnostics of magnetic field and fast electron 2D distributions along the flaring loop. Finally, I will briefly discuss the perspective for developing a more ambitious 3D diagnostics based on 2D input data obtained from various instruments.