ISSI Visiting Scientists Programme

THE RHESSI MISSION: X-RAY SPECTRA AND IMAGE ANALYSIS BY MEANS OF INVERSION METHODS.

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Final Report

The key aspect of the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) [6] is its ability to produce X-ray images in different energy bands [4] and so to determine the hard X-ray spectrum at different locations. Instrumentally, RHESSI collimators realize this capability indirectly, inasmuch X-ray images are synthesized by applying back-projection/reconstruction algorithms and X-ray spectroscopy requires spectral deconvolution in order to reduce the detector response. Furthermore, on a more physical level, deconvolved, spatially integrated X-ray spectra must be inverted to reconstruct spatially integrated electron spectra and therefore to gain first insights about the acceleration mechanisms in solar plasma during flares.
This project, funded by ISSI for the period 2005-2006, was focused on the formulation and application of inversion methods [3, 12] for the restoration of mean electron spectra from RHESSI X-ray spectra. The main results of this activity have been the validation and comparison of different regularization methods in the reconstruction of the mean electron spectrum from X-ray data [1, 2, 5, 10] and the implementation of one of these methods into an IDL code which is being integrated in the official Solar SoftWare (SSW) for the mission data analysis and which provides RHESSI (and even non-RHESSI) community of a powerful data analysis tool not previously available. Other results in the framework of this first project have been the study of the influence of albedo [5] and electron-electron bremsstrahlung contribution on X-ray solar spectroscopy and the formulation of a reconstruction method for the differential emission measure from X-ray spectra in a thermal interpretation of the bremsstrahlung emission process [11]. As far as the problem of image reconstruction from raw RHESSI data, our results have been so far exploratory.

Many things have been done in these twelve months. The team has continuously interacted and has reached a correspondingly high level of efficiency, combining highly effective interaction at the Bern meetings with independent research carried out in between these meetings. During the project, the ISSI format, which allows 8-10 researchers with significantly different, but highly complementary, expertise to work together intensively over an extended period of time, and to freely discuss issues of common research interest, has proven very successful in making rapid progress in a number of areas. The ISSI model allows a far more concentrated focus on making progress in areas of common interest than the interaction that would occur at, say, scientific conferences. For this reason, we think that this kind of project built on this synergism and professional camaraderie to produce significant advances crucial to the understanding of solar flare physics.

Our team is composed of scientists in Astronomy, Astrophysics, Mathematics and Computer Science from around the world. All the team members attended at least one meeting and six members over nine attended all the three meetings. Moreover, we had the opportunity to invite Gordon J. Hurford (Space Science Laboratory, University of California at Berkeley) who is the main expert of the imaging problem inside the RHESSI community. As mentioned above, thanks to ISSI this group has reached a high level of collaboration the last year. This is evidenced not only by the visible submission to international journals of several papers coauthored by all or almost all the team members and by the presentation of the obtained results during international conferences, but also through the less visible, but equally valuable, ongoing correspondence and discussion amongst our multi-disciplinary network.

The details of all the work done in the three meetings is described in details in the corresponding reports [7, 8, 9].

References

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