

# The Solar Sources of GeV Gamma-Rays

26 February – 2 March @Snellius

## Science:

Ion acceleration in solar flares is incompletely understood and  $\sim$ GeV gamma-radiation sometimes persisting for hours after these events poses new challenges to theory. The aim of this workshop was to bring together people with expertise on data analysis and interpretation of the observations from Fermi-LAT, AMS-02 and Pamela together to work in unison with experts in solar, space, and plasma physics to find answers to the following questions:

- Why do superficially similar flares differ so greatly in ion acceleration?
- How important are ions in the overall flare energy budget?
- What role does the coronal mass ejection (CME) play in the acceleration of ions?
- Why, in some events, does GeV energy continuum persist for hours after all other emissions of the flare appear to have ceased?
- What are the UV/optical/IR/radio counterparts of the gamma-ray and particle sources?

From a pair of Workshops at ISSI, Bern had come a preliminary classification of  $\sim$ GeV events in terms of their relationship to the established picture of flare development (impulsive and gradual phases, etc.). Such a classification would relate the gamma-radiation to existing physical pictures of what is happening in the various phase of flare development. Our discussions at the Lorentz center workshop sharpened these ideas considerably, as well as assembling a large, coherent set of data from cutting-edge experiments with which to validate them. These data, together with detailed notes from the Lorentz center workshop, summaries of findings, etc. have been shared amongst the participants via Google Drive to be a resource for collaborative working and preparation of papers. A publication describing this classification scheme and summarising properties of the individual events is in the works; the scheme and the underlying ideas, and the paper, will be tangible outcomes of the Workshop. Several subsequent publications have also been planned, presenting and interpreting aspects of individual events in detail.

One potential scientific breakthrough that we found during our workshop at the Lorentz center was identifying the signature of CME-CME interactions in radio and coronagraph images for the Fermi-LAT long-duration gamma-ray flares. These signatures often occur close to the onset time of gamma-rays detected in the LAT, so they could indicate that such interaction plays a crucial role in the hours-long emission detected by the LAT.

## Organization/Format:

The Workshop spent the first day and a half on introductory presentations covering instruments, simulation tools and theory. The remaining time of the workshop was dedicated to hands-on working sessions, where the participants split up into topic specific groups, analyzing the available data and considering particular events in great detail. This format proved to be very fruitful leading to lively discussions, many new ideas and a wealth of data. Personally, I would suggest this format to colleagues and would be interested in having more workshops with this format. The Lorentz Center structures and facilities were ideal for this type of organization and the administration was very helpful prior/during and after the workshop.

## Organizers

Christina Cohen (Caltech, United States)

Alexander MacKinnon (University of Glasgow, Scotland)

Melissa Pesce-Rollings (INFN-Pisa, Italy)