Abstracts for Wednesday 27th May

Understanding CME and Associated Shocks in the Solar Corona by Merging Multi Wavelength Observations

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Coronal Mass Ejections (CMEs) are large-scale energetic eruptions in the solar corona. Their association with other manifestations of solar activity (e.g., Flares, EUV waves) has being studied extensively, but to date some questions remain unanswered on the role of CMEs in driving coronal shocks and associated radio emission.

To understand the nature of the shock and its association with CMEs, Flares, and EUV waves, we present a detailed case study of the coronal magnetic topology and the complex morphological features in the radio bursts spectra. The study was performed joining the information from high-cadence radio spectra and radio-heliograph imaging with the EUV and white light observations. The event studied is the CME observed on 06 November 2013, its radio signature was registered at frequencies where the radio imaging with the NRH was possible.

We were able to study the complex magnetic topology and relate it to the CME onset and associated radio emission. We showed that the active region (AR) includes fan-field lines originating from a coronal null point with the presence of a small magnetic loop in the proximity of the AR.

Relating the coronal magnetic topology to the EUV and radio observations we found that the electron beams responsible for the multiple dm-type III radio emission were originated from the same region as the EUV eruption.

In addition, we were able to identify step by step the origin of the spectral fragmentation of the coronal type II burst in relationship with the CME evolution, resolving the location of the type II splitted bands.

Observational properties of decameter type IV burst oscillations

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Oscillations of decameter type IV bursts were registered during observations of solar radio emission by UTR-2, URAN-2 and NDA in 2011-2012. Large majority of these bursts were accompanied by coronal mass ejections (CMEs), which were observed by SOHO and STEREO in the visible light. Only in some cases decameter type IV bursts were not associated with CMEs. The largest periods of oscillations T were some tens of minutes. There were some modes of long periods of oscillations simultaneously. Periods of oscillations in flux and in polarization profiles were closed. Detailed properties of oscillations at different frequencies were analyzed on the example of two type IV bursts. One of them was observed on April 7, 2011 when a CME happened. Another one (August 1, 2011) was registered without any CME. The 7 April type IV burst had period which was changing from 35 to 45 minutes. Interesting feature of these oscillations is decreasing periods with time. Connection of type IV burst oscillations with oscillations of magnetic loops and CMEs at corresponding altitudes are discussed.

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Solar Microwave Drifting Pulsation Structures This work statistically investigated the characteristic of DPS from the observation. The results showed that: (1) DPSs happened more frequently at decimeter (0.8-2 GHz) than centimeter (2-5 GHz). (2) The special DPSs are all associated with SXR flares; about 80 percent of them are associated with CME. While the isolated or simple DPS are poorly associated with CME. (3) Some DPSs have harmonic structure.

A relation between microwave bursts and the fluences of near-Earth protons

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The correspondence between strong high-frequency radio bursts and near-Earth proton enhancements has been known since 1970-s. This fact was initially interpreted in terms of the proton acceleration in solar flares. Kahler (1982) explained this association by the ‚Big Flare Syndrome‚ (BFS), i.e., a general correspondence between the energy release in an eruptive flare and its various manifestations. The responsibility for the proton acceleration was assigned exceptionally to CME-driven bow shocks. They are believed to develop at considerable distances from the Sun well after the flare, when the CME and flare become independent. The domination of this concept diminished the interest to the microwave bursts for space weather forecasting.

However, recent studies show that shocks appear considerably back in time, when the early CME genesis in the low corona is closely related to the rising flare. This circumstance implies the existence of a much more significant correspondence between the products of the flares, CMEs, and shocks, than the BFS predicts, irrespective of their particular source. A scattered correlation was found indeed between the peak values of the near-Earth proton enhancements and microwave bursts recorded during 1990-2012 with the Nobeyama Radio Polarimeters at a high frequency of 35 GHz, where the correspondence was expected to be most pronounced (PASJ 2013, 65, SP1, S4).

Based on this finding, one might expect a higher correlation between the proton fluences, fp, and the corresponding integrals of microwave time profiles, Imw. We have analyzed this relation for the proton events with E > 100 MeV occurring during the daytime in Nobeyama and the 35 GHz bursts. The analysis included 55 events from 1996 to 2012, for which both GOES proton records and CME catalogs were available. By discarding occulted far-side events, two clusters show up: (i) events with a power-law tendency, fp ~ I35^1.5 (70%), and (ii) events without proton enhancements (30%). The correlation coefficient between the logarithms is 0.7 for events (i), and reaches 0.84 without four challenging events revealed in the mentioned paper. All of the proton enhancements occurred after CME-associated solar events. The role of CMEs is ambiguous. On the one hand, shocks very rarely occur without CMEs. On the other hand, CMEs open closed magnetic structures, thus favoring escape of flare-accelerated particles from an active region. Our results are promising for a prompt diagnostics of proton enhancements but do not help in understanding their origin, still complicating the shock vs. flare-acceleration issue and causing pessimism about the considerations of the relative timing.

The Upgraded Siberian Solar Radio Telescope

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In the report a brief review of the upgraded Siberian Solar Radio Telescope (SSRT) is represented. The new instrument ‚Siberian Radioheliograph (SRH) ‚Äì is a T-shaped array radiointerferometer designed for multifrequency operation at the range 4 - 8 GHz. The SRH has 96 antennas that are mounted on stations of West, East and South arrays of SSRT. Each antenna signal is transmitted to a control building by an analog optical fiber. The brightness temperature sensitivity is expected to be about 100 K. The spatial resolution is up to 13 arcseconds at 8 GHz. The instrument hardware can be divided into the following parts: analog broadband front-ends, analog back-ends, digital receivers and a correlator. The structure of each part is briefly described. The current state of the SRH development and the near future plans are discussed.

Development of the New Solar Meter-Wave Spectropolarimeter (SSMD)

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In this report, we discuss the development of the new solar radio spectrometer, working in 50-500 MHz frequency range. This range is very important for radio astronomical researches, due to occurrence of various physical phenomena in it. The new instrument will expand the frequency range of the 2-24 GHz spectrometer, which is a part of SSRT complex, situated in Eastern Siberia, Russia. The new spectrometer is developed on the basis of the FX correlator architecture with an implementation of real-time pipeline Fast Fourier Transform (FFT) engine as a main block of the digital part of the radiometer scheme. Our aim is to design the radiometer, receiving signals of horizontal and vertical polarization components and giving out the full set of Stokes parameters. These parameters completely describe the polarization state of the solar radio emission.

Imaging Low Frequency Type III Radio Bursts with LOFAR

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The Sun is an active source of radio emission which is often associated with energetic phenomena such as solar flares and coronal mass ejections (CMEs). At low radio frequencies (<100 MHz), the Sun has not been studied extensively due to instrumental limitations of previous radio telescopes. With the recent commissioning of LOFAR, the low frequency Sun can now be studied with unprecedented spectral, spatial and temporal resolution. Here we report the results of several LOFAR observations that used 126 simultaneous beams sampling the Sun at up to 5 solar radii and covering the full spectral range of the low band antennas (LBAs; 10-90 MHz). In particular, we report on the spatial characteristics of a multitude of type III radio bursts. The observations show that these bursts occurred at altitudes in excess of values predicted by 1D electron density models of the solar corona and, for the first time, this was found to be associated with the expanding flank of a CME.