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Origin of the two shock waves associated with the September 27/28, 2012 event

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Coronal mass ejections and flares are solar eruptive phenomena responsible for space weather activities near Earth. They can accelerate particles, and generate shock waves which are a threat to our technologies at Earth and in space. Therefore, predicting shock arrival at Earth has been an important goal for space weather. Space based radio observations provide the unique opportunity to track shock waves in the inner heliosphere.
We present the study of CME/flare event on September 27/28, 2012. The GOES C3.1 flare that originated from NOAA AR 1577 was associated with a full-halo CME (first seen in SOHO/LASCO C2 field of view at 23:47) and white light shock wave observed by all three spacecraft STEREO A, STEREO B, and SOHO. The associated radio event shows a group of type III bursts and two somewhat unusual type II bursts with significantly different starting frequencies. To understand the origin of the two shock waves we performed multi-wavelength study, and perform radio triangulation to get their source position in the 3D space. For the radio triangulation study, we used goniopolarimetric measurements from STEREO/WAVES and WIND/WAVES instruments. We also did data-driven modelling of the CME propagation using EUHFORIA cone model (EUropean Heliospheric FORecasting Information Asset) and validate the results by comparison with in-situ data.
Results of this study indicate that, although temporal association between the shock and the CME is good, the low frequency type II burst occurs significantly higher in the solar corona than the associated CME and has therefore unclear origin. To understand the origin of the low frequency type II burst we studied preceding event at 10:20 UT (STEREO A/COR2) on September 27, 2012. The radio triangulation study shows that the type II source positions are in the southern solar hemisphere and thus may be associated to the type II emissions in the radio event succeeding it. We therefore discuss different possibilities for the origin of two type II bursts.