Fragmented radio emission reveals a shock passing through solar active region loops

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Solar radio type II bursts (i.e., bursts with frequency-drifting emission lanes, observed in dynamic radio spectra) are rarely seen at frequencies higher than a few hundred MHz. The mechanism behind the type II bursts is generally assumed to be a propagating shock which creates electron beams that excite Langmuir waves, which in turn convert into radio waves at the local plasma frequency and its second harmonic [1].

The exact relationship between solar flares, shocks, and coronal transients is still not well understood, and it is of interest to know how shocks are initiated and under which conditions radio type II bursts can be excited. In particular, how are high-frequency, fragmented type II bursts created? Are there differences in shock acceleration or in the surrounding medium that can explain the differences to the “typical” metric type IIs?

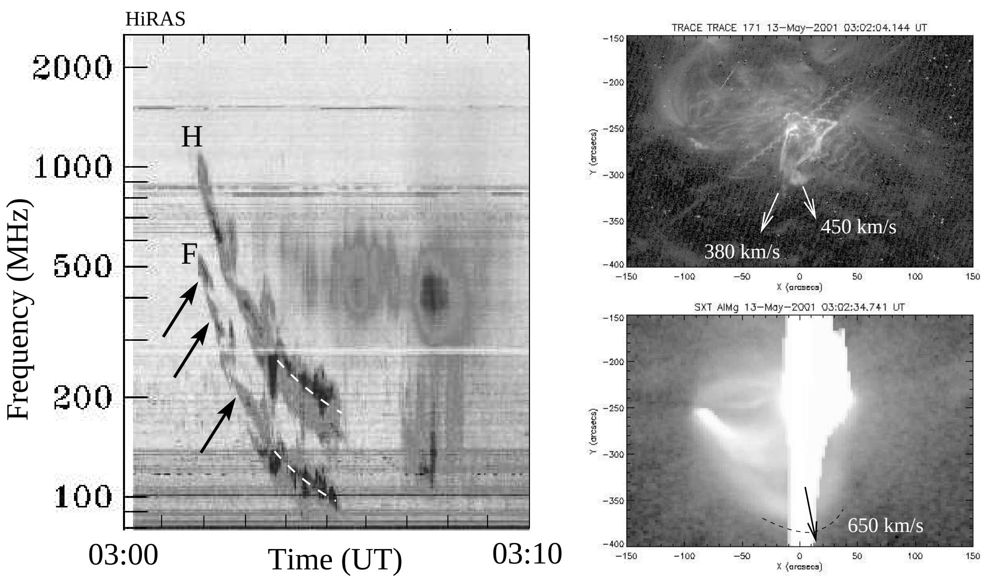

Figure 1: HiRAS dynamic spectrum on 13 May 2001 (left). ’F’ notes emission at the fundamental and ’H’ at the second harmonic plasma frequency. Arrows point to the fragmented emission bands and dashed white lines outline the later-appearing “regular” type II burst lanes. EUV and soft X-ray observations (TRACE and Yohkoh satellites) of the erupting region are shown on the right, see details in [2].

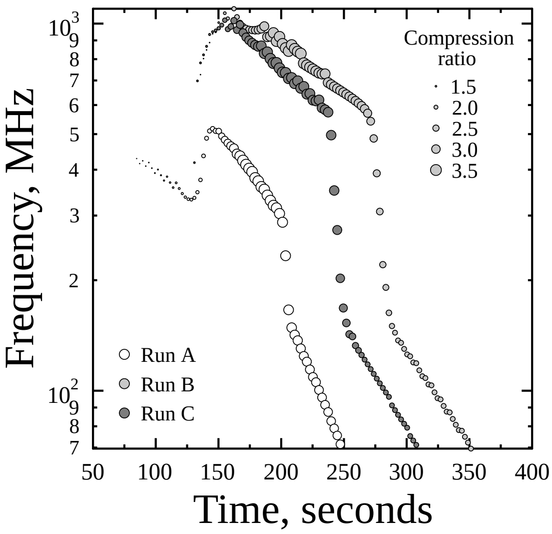

Figure 2: Radio track of the three different simulation runs. The size of the marker indicates the compression ratio of the shock.

METHOD and ANALYSIS

We have analysed one unusual metric type II event in detail, with comparison to white-light, EUV, and X-ray observations. The radio dynamic spectrum and the eruption region are shown in Fig. 1. We then utilized numerical MHD simulations to study the shock structure induced by a coronal mass ejection (CME), in a model corona including dense loops. The details of the model are presented in [3]. Fig. 2 shows the radio emission produced by a shock (with three different simulation runs), assuming that the emission is produced immediately in front of the CME leading edge shock. The emission lanes show a frequency drop in accordance with the exponentially decreasing density of the ambient corona.

RESULTS

Our simulations show that the fragmented part of the type II burst can be formed when a coronal shock driven by a CME passes through a system of dense loops overlying the active region [2]. To produce fragmented emission, the conditions for plasma emission have to be more favourable inside the loop than in the interloop area. The obvious hypothesis, consistent with our simulation model, is that the shock strength decreases significantly in the space between the denser loops. The later, more typical type II burst appears when the shock exits the dense loop system and finally, outside the active region, the type II burst dies out when the changing geometry no longer favours the electron shock-acceleration.

References

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[2] S. Pohjolainen, J. Pomoell, and R. Vainio, "CME liftoff with high-frequency fragmented type II burst emission" *Astron. Astrophys.*, in press, 2008.

[3] J. Pomoell, R. Vainio, and R. Kissman, "MHD modeling of coronal large-amplitude waves related to CME lift-off" *Solar Phys.*, in press, 2008.