ESPM-16

Radio Imaging of Quasi-periodic Magnetic Reconnection and Electron Acceleration during a Solar Flare

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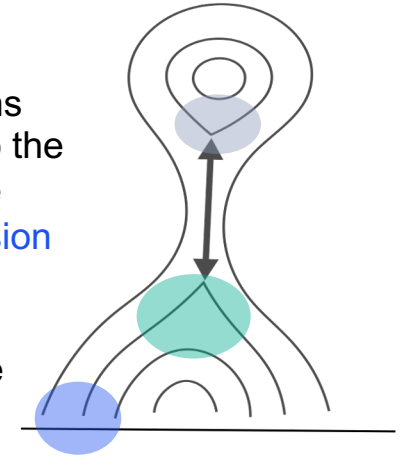
Standard Flare/CME Model

Magnetic reconnection appears in the vertical current sheet between flare loops and erupting CMEs. It converts the magnetic energy into the kinetic energy and internal energy, and efficiently accelerates particles.

- The accelerated electrons propagate downwards to the dense lower atmosphere
  - Produce HXR emission by bremsstrahlung
  - Electrons trapped in magnetic field excite microwave (MW) emission by gyrosynchrotron (GS)
- Sometimes higher HXR/MW sources are reported
  - Interpreted as the results of upward flows



Mechanism

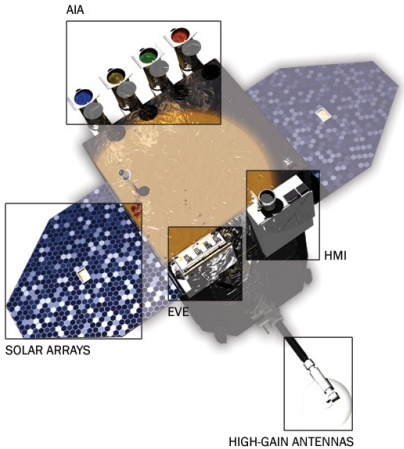
- The **periodic magnetic reconnection**, including those induced by periodic inflows and self-oscillation
- The modulation of MHD waves

Quasi-periodic Pulsations (QPPs)

Observations

SDO/AIA (EUV)

Provide the morphology and evolution information of the flare and the erupting filament, given its high temporal and spatial resolution.



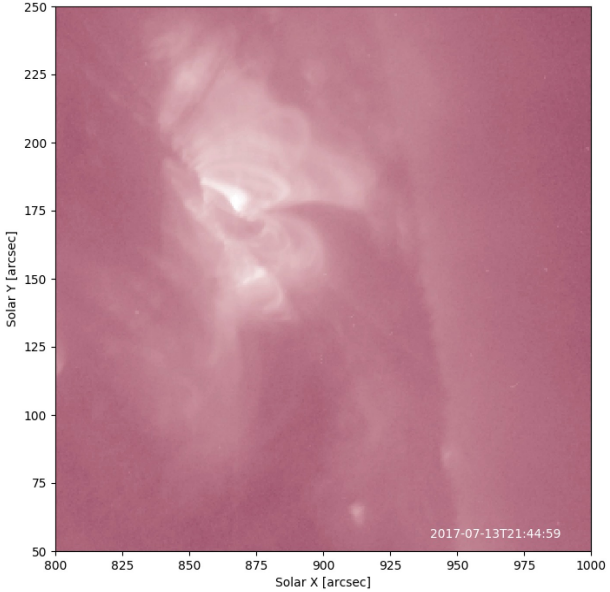
EOVSA (MW)

- Broadband radio spectroscopic imaging
- Angular resolution: 57"/ n_{GHz} × 51"/ n_{GHz}
- Temporal resolution: 1 s
- Frequency range: 3.4 to 17.9 GHz

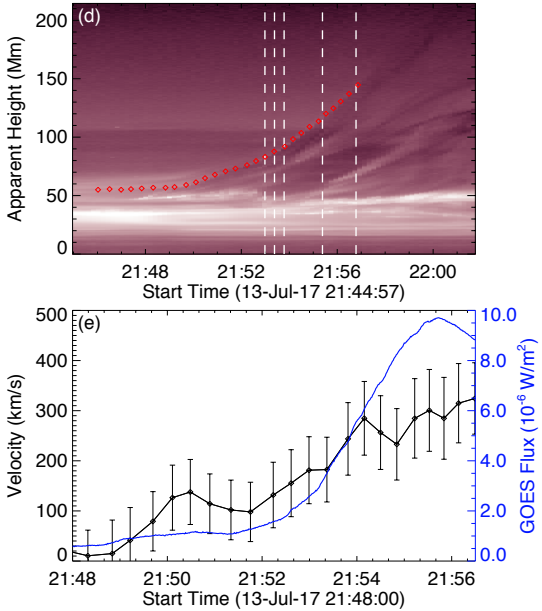
An ideal instrument for investigating QPPs.

Event Overview

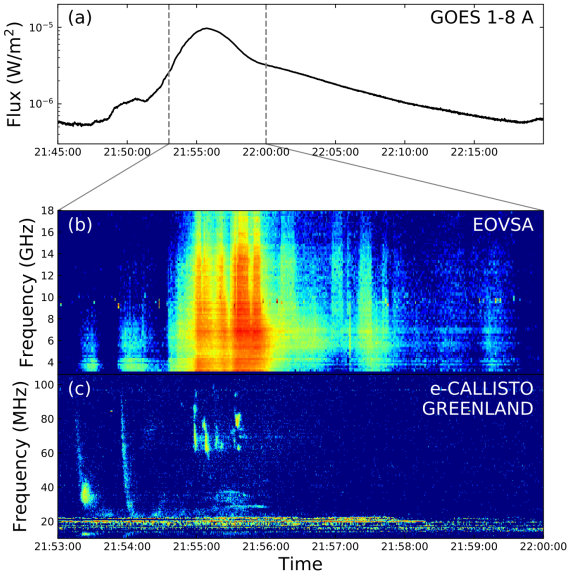
(movie)



An erupting filament. The underlying bright flare loops appear after the filament erupted.

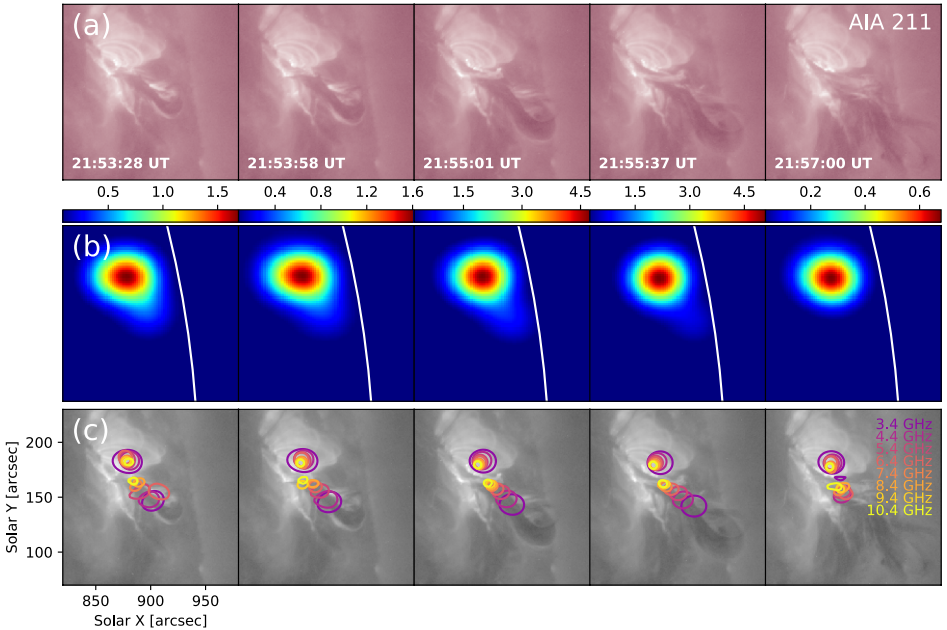


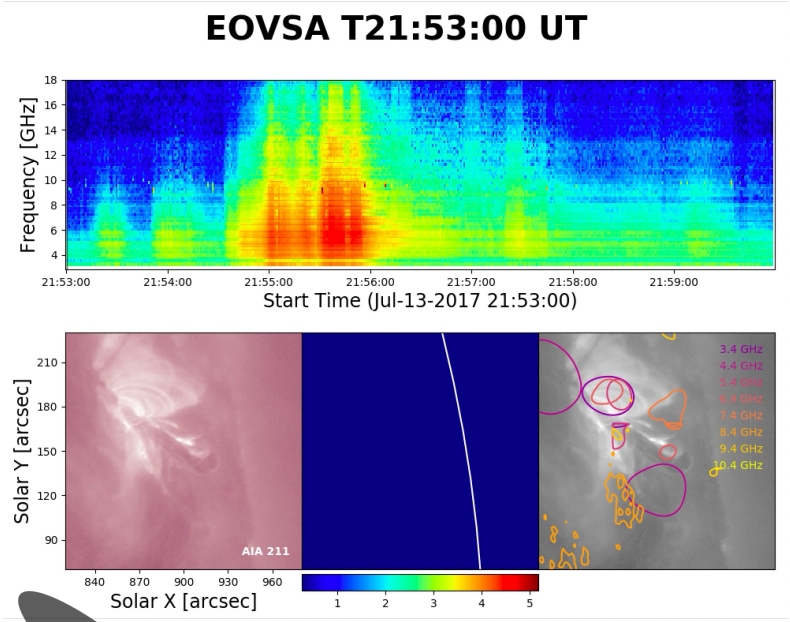
The eruption velocity increases with GOES SXR flux.

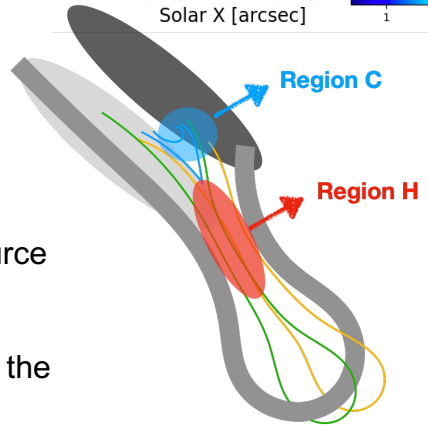


Repeated MW bursts and the radio burst counterparts.

MW Morphology



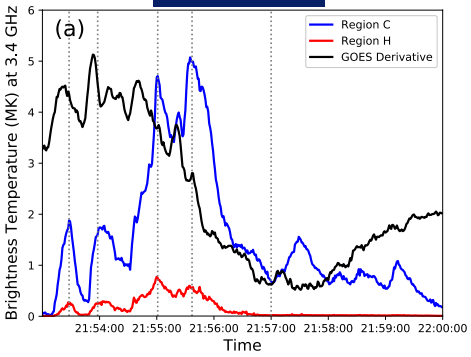




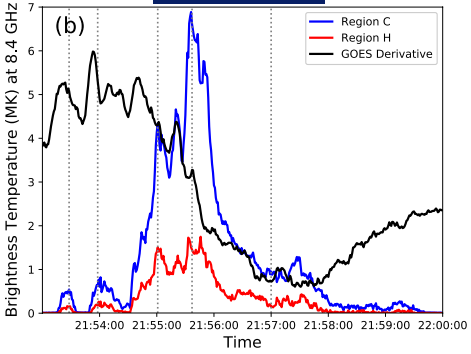
- (e.g. at 3.4 GHz) A strong MW source with a weak secondary source extending to southwest
- The MW morphology remains unchanged at four peak moments
- Almost all bands show secondary sources, which distribute along the current sheet

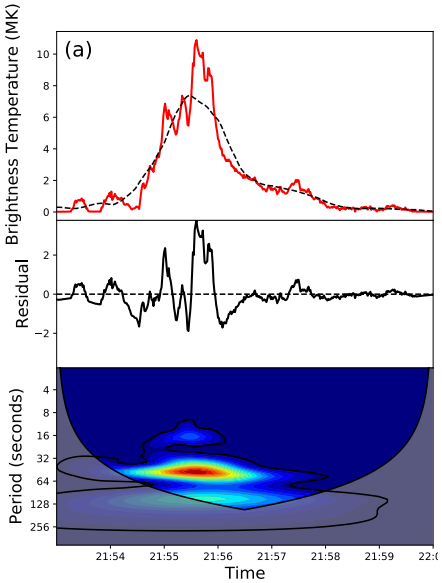
Lightcurves and Periodicity

3.4 GHz

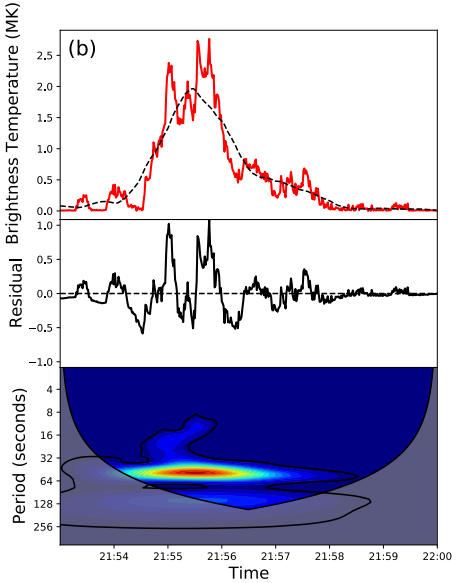


8.4 GHz

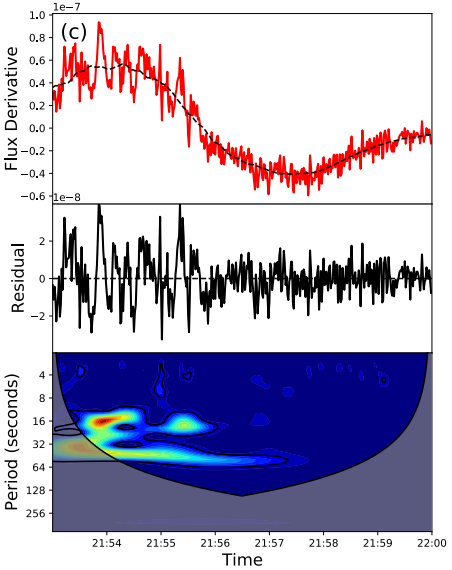




Region C at 8.4 GHz



Region H at 8.4 GHz

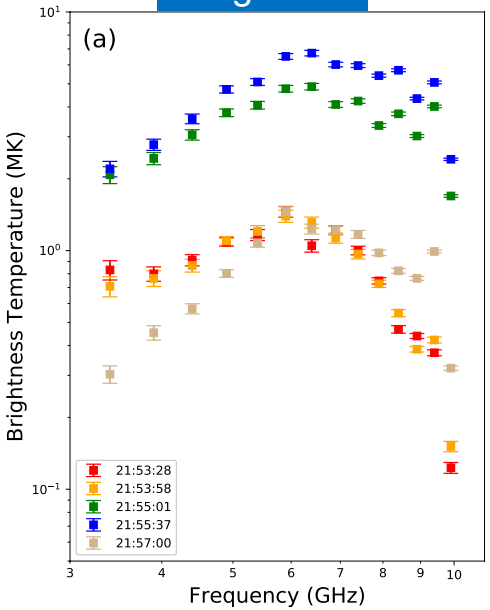


SXR derivative

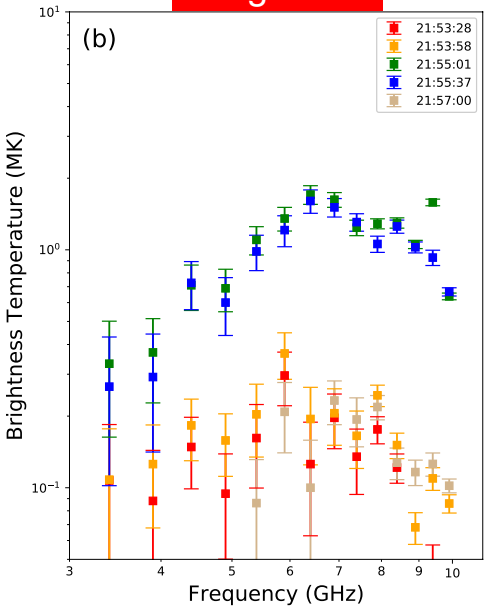
- Similar between the two sources
  - Synchronized intermittent enhancements
  - Seemingly a correlation with SXR derivative
- Periods of ~40 s in all three curves
  - MW periodicity is consistent with that of SXR derivative

MW Spectra

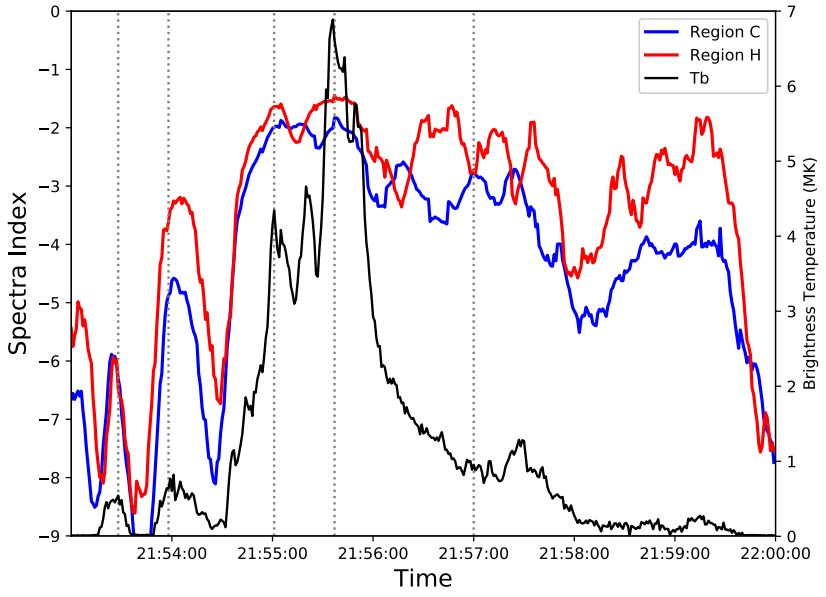
Region C



Region H



(a rough estimation)



- Show the GS characteristics
- The optically thin part:
  - Spectra at ~21:55 UT harder than those at ~21:53 UT
  - Spectra at the above LT region (along the current sheet) harder than near LT region

- Soft-hard-soft during each MW burst
  - The quasi-periodic electron acceleration

Summary and Discussion

- MW double sources are near the LT region and along the current sheet, respectively
- The TB of the two sources varies synchronously
  - modulated by a same process
- The MW periodicity is consistent with that of SXR derivative
  - the non-thermal radiation
- Spectra variation:
  - the intermittent increasement of the non-thermal proportion
  - support that the above LT region is closer to the acceleration site (along the current sheet)
- The EOVSA observation gives the direct position of the QPP. And the sausage mode of MHD wave cannot explain the QPP in MW source along the current sheet.
- **In a word:** the results suggest the quasi-periodic magnetic reconnection and thus the quasi-periodic electron acceleration