Joint Analysis of Solar Type III Radio Bursts with Parker Solar Probe and Solar Orbiter

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Introduction

Solar Type III radio bursts are produced by high-energy electrons accelerated during solar flares. As these electrons travel along open magnetic field lines, they emit radio waves near the electron plasma frequency by interacting with the surrounding solar plasma. These bursts are known for their rapid drift from high to low frequencies.

Why Spectral fluctuations are interesting?

Spectral fluctuations in Type III radio bursts may provide insight into the processes of radio wave generation and the plasma medium they travel through, including local effects such as density fluctuations near the source, or the propagation effect.

Observation and Data Analysis

We analyzed type III solar radio bursts observed by both **Solar Orbiter (SolO)** and **Parker Solar Probe (PSP)** using the following data products:

PSP: Level 3 FIELDS SolO: Level 3 RPW

The data processing steps were as follows:

1. **Type III Burst Detection**
2. **Cross-Spacecraft Event Selection**
   events that were simultaneously observed by both SolO and PSP
3. **Background Subtraction**
   We calculated the average spectrum during burst-free periods
4. **Peak Flux and Fitting**
   For each frequency, we perform Gaussian fitting to determine the **maximum radial flux.**

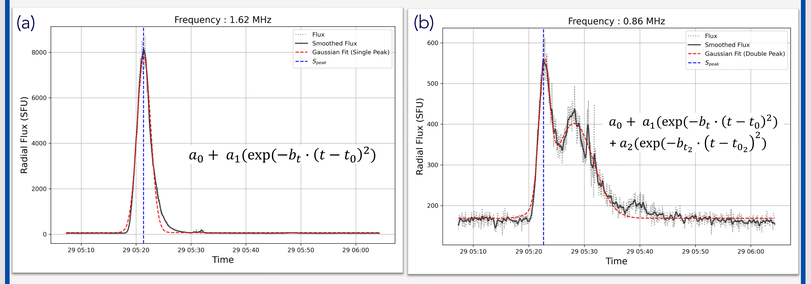

Fig 1. Example of solar type III radial flux measurement at (a) 1.62 MHz, and (b) 0.86 MHz with the Gaussian fitting profile (dashed-red).

Results & Discussions

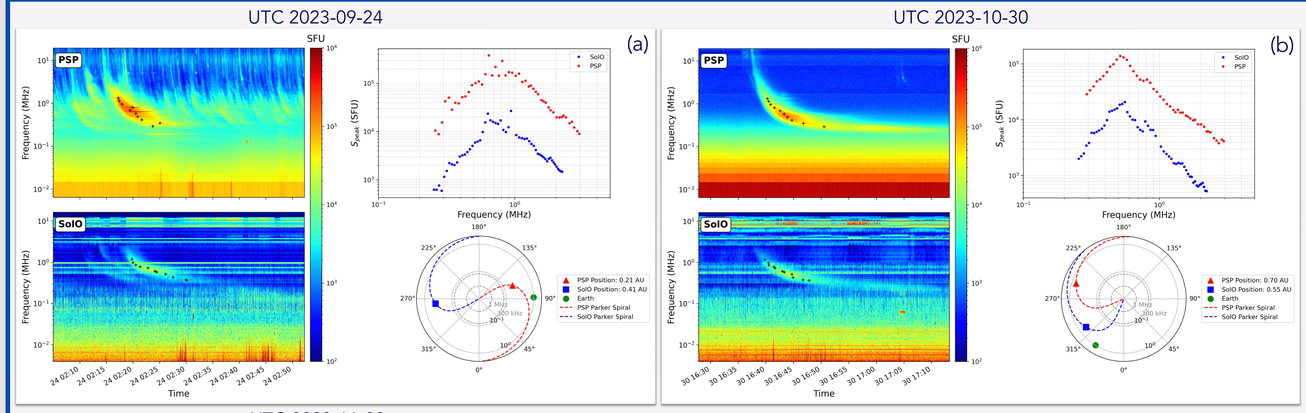

Fig. 2. Overview of three Type III radio burst events observed by PSP and SolO:
(a) 2023 September 24,
(b) 2023 October 30, and
(c) 2023 November 2.
Each panel shows the dynamic spectrum (left), the maximum radial flux as a function of frequency (upper right), and spacecraft positions with Parker spiral lines (lower right).

Our preliminary results indicate that the fluctuations of the maximum type III radio flux appear '**similar**' when observed by both spacecrafts, in despite of their different radial distances and heliolongitudes, suggesting that local effects are responsible for these fluctuations.

Striae (TypeIIIb)

narrowband, fragmented features forming chains of quasi-periodic striae in dynamic spectra, which are indicative of subsecond evolution in the electron distribution. Striae are often associated with **coronal mass ejections (CMEs)** (ChenEA21; ClarksonEA23). These fine spectral structures may hold important clues to the underlying emission mechanisms, analyzing **radio spectral fluctuations** offers a promising approach to investigate them in greater detail.

Ongoing Work

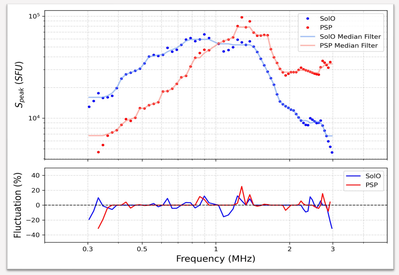

Fig. 3. Maximum radial flux of a Type III radio burst vs. frequency, observed by PSP (red) and SolO (blue). The top panel shows S_{peak} values and the line obtained using a median filter. The bottom panel presents the percentage fluctuation of the signal relative to the median-filtered values.

- Characterizing fluctuation of TypeIII radio spectrum
  - Median/Base line filter
  - Cross-scale correlation

What is the most efficient method for characterizing spectral fluctuations?

- Investigate Striaes
- Collect more samples to enable good statistical analysis.

References

- Reid, H. A. S., & Ratcliffe, H. 2014, Research in Astronomy and Astrophysics, 14, 773
- Chen, L., Ma, B., Wu, D., et al. 2021, The astrophysical journal Letters, 915
- Clarkson, D. L., Kontar, E. P., Vilmer, N., et al. 2023, The Astrophysical Journal, 946, 33
- M. Pulupa, Bale, S. D., Badman, S. T., et al. 2020, The Astrophysical Journal Supplement Series, 246, 49
- Raja, K. S., Maksimovic, M., Kontar, E. P., et al. 2022, The Astrophysical Journal, 58
- Gieseler, J., Dresing, N., Palmroos, C., et al. 2023, Frontiers in Astronomy and Space Sciences, 9

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