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Combining SunRISE and Lunar Surface Interferometer Observations of Solar Radio Bursts

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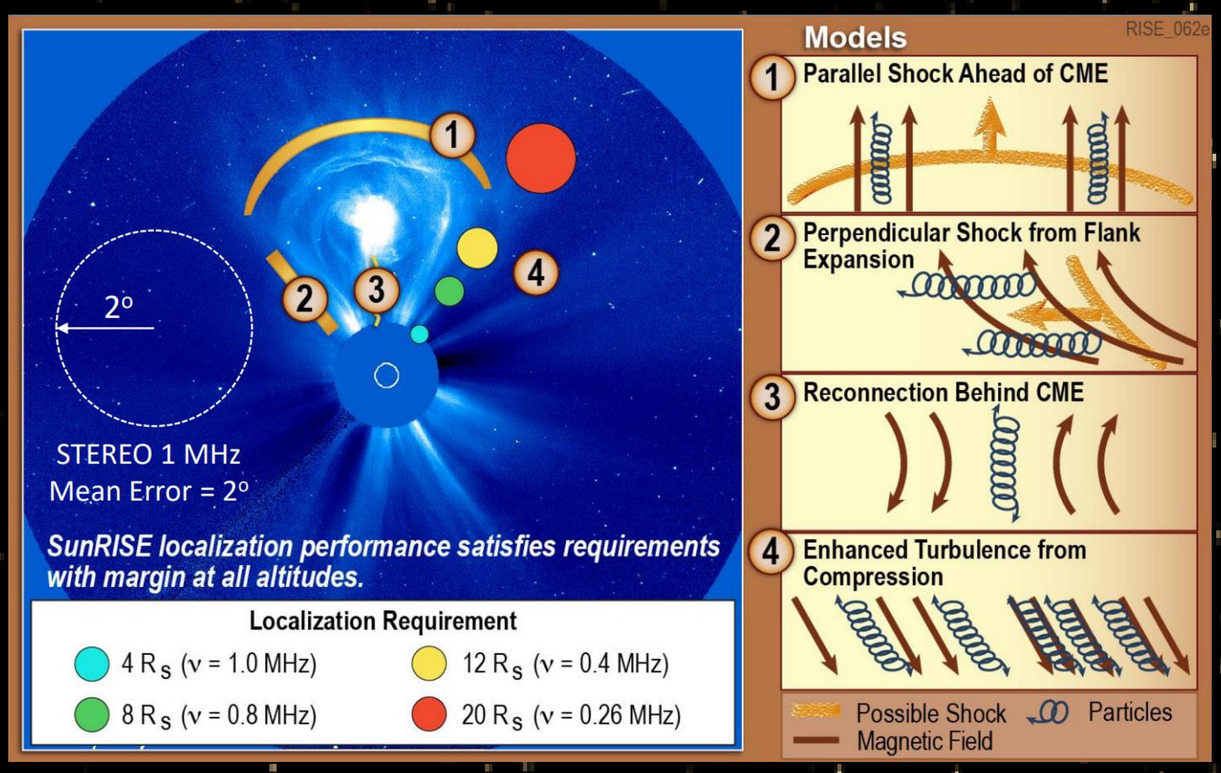
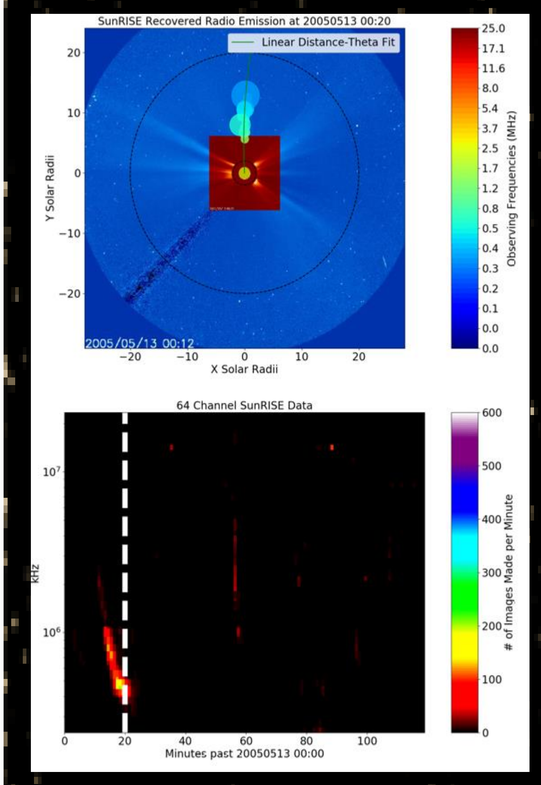
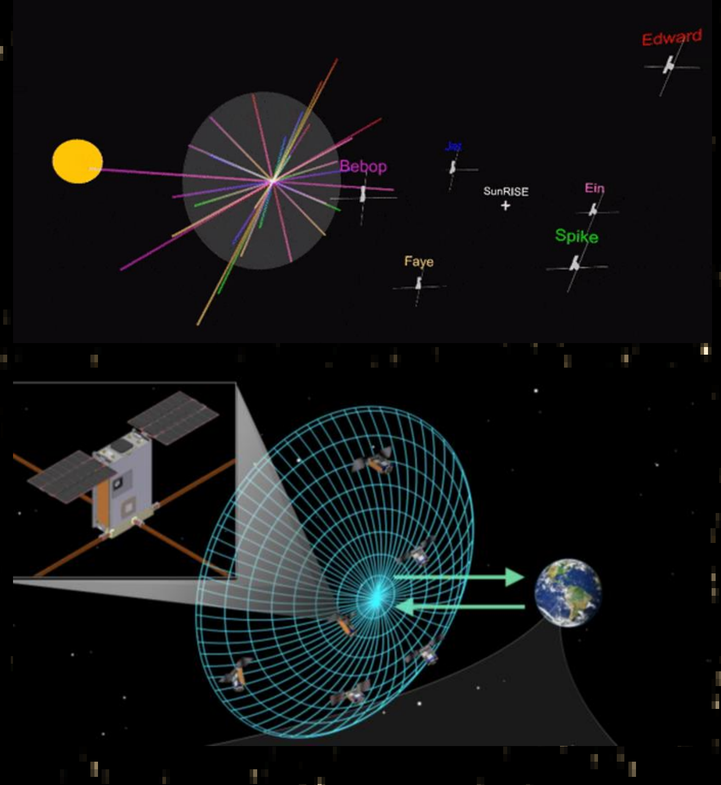
SunRISE Details:

- 6 element Earth Orbiting Interferometer
- Provides Order of Magnitude improvements of solar type II & III burst localization from 2-20 solar radii, 0.1 – 25 MHz
- Will answer basic physical questions on particle acceleration around CMEs and solar magnetic connectivity
- 1 – 10 km separations, best for localizing compact sources
- Struggles with diffuse radio sources that compact ~100m lunar arrays could better capture.
- Combining observations with lunar arrays would improve characterization of burst scattering up to **1000x**



Above: Summary plot of SunRISE capabilities in the context of localizing solar type II radio bursts around Coronal Mass Ejections (CMEs). SunRISE will obtain the localization (colored circles) to resolve which model is operative. An example of past localization quality is shown in the dashed white circle, showing the 2 degree mean error at 1 MHz attained with a single STEREO spacecraft using goniopolarimetric localization techniques [2].



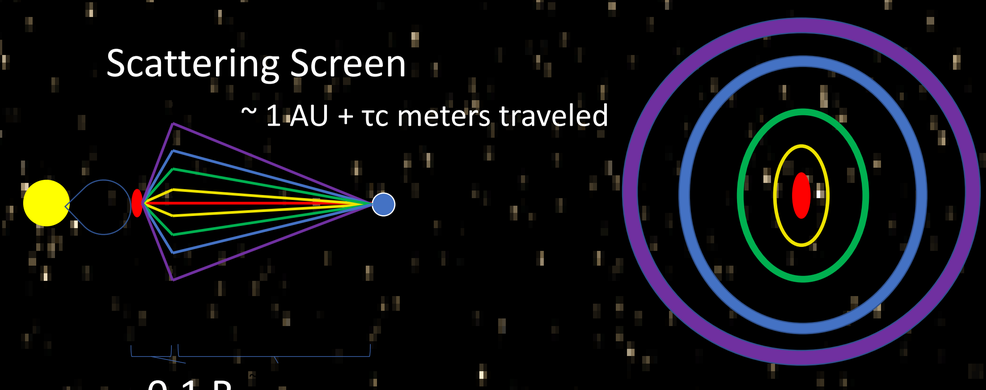


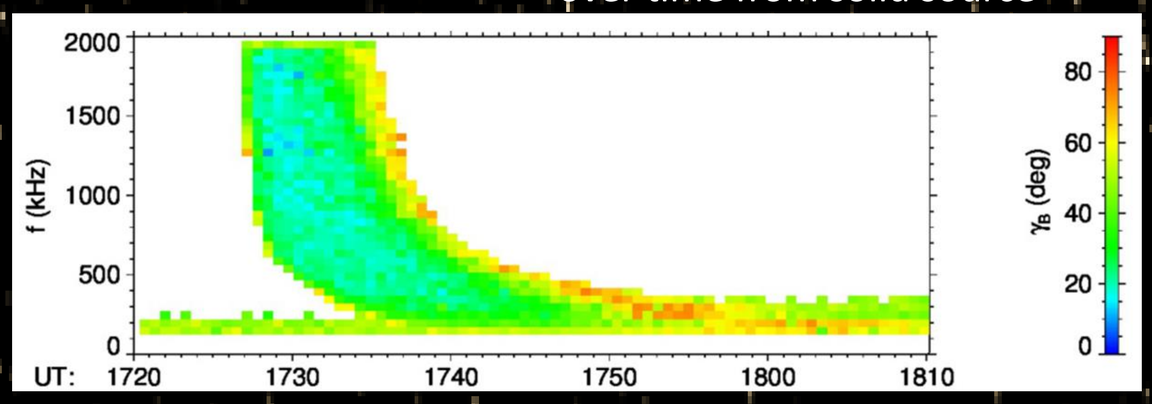
Above: Example of SunRISE observations of a type III burst with localizations over frequency and time overplotted on LASCO C2 & C3 coronagraphs. The response function is dependent on the orbital configuration of the array. The longer separations yield higher resolution images of the bursts, but are not as sensitive to larger, scattered bursts in the sky.

Scattering Details:

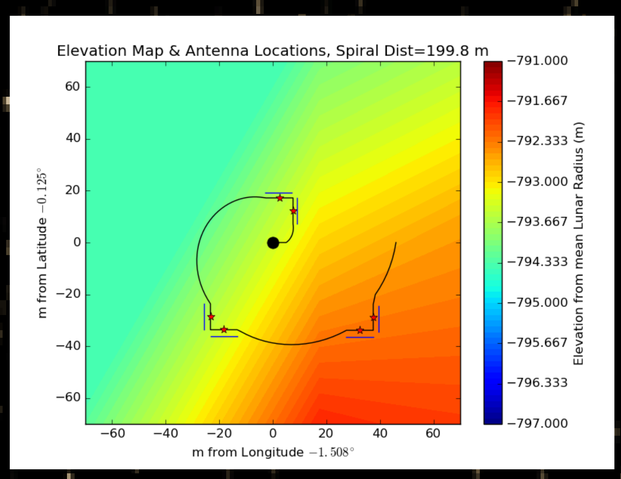
- Recent Parker Solar Probe observations [6] (below) confirm a brief period of 10-20 seconds where a leading edge of circularly polarized emission of radio bursts before scattering takes over and broadens the source to 10-30 degrees in the sky

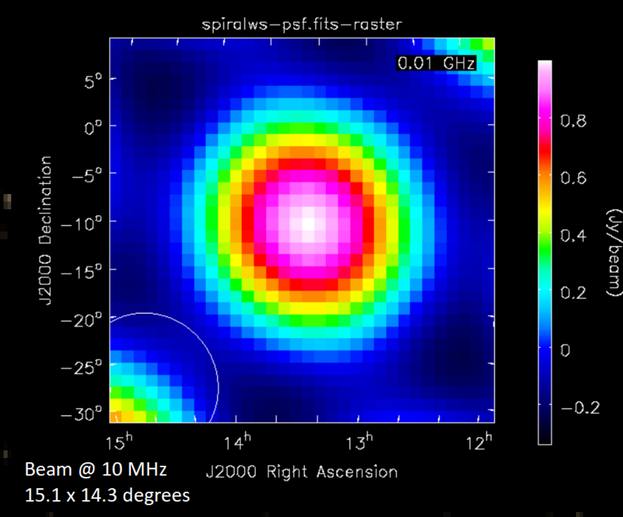
Below: Toy model as to how solar radio emission scatters over time, with a compact source broadening over time. Shorter Baselines are then needed to detect the emission.





Above: STEREO/WAVES fits [5] of a scattered type III radio burst that quickly grows to 10-30 degree sizes in the sky.
Below: Compact Lunar array with ~100 m separations that could observe scattered bursts **1000x better** in the correlated data than SunRISE alone. Combining Observations would yield a 15 degree aperture that could better characterize the scattering of these bursts over time.





Beam @ 10 MHz
15.1 x 14.3 degrees

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References

[1] Thompson, Moran, Swenson 2007 *Astronomy and Astrophysics Library* [2] Krupar et al, 2012, *JGR Space Physics*, 117, 6. [3] Barker et al. 2016 *Icarus* 273 , 346 - 355. [4] Acton, C. H. 1996 *Planetary and Space Science* 44, 65-70. [5] Krupar et al. 2014 *Solar Physics* 289, 4633–4652. [6] Pulupa et al. 2020 *ApJ Supplements* 249:49.

Acknowledgments

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