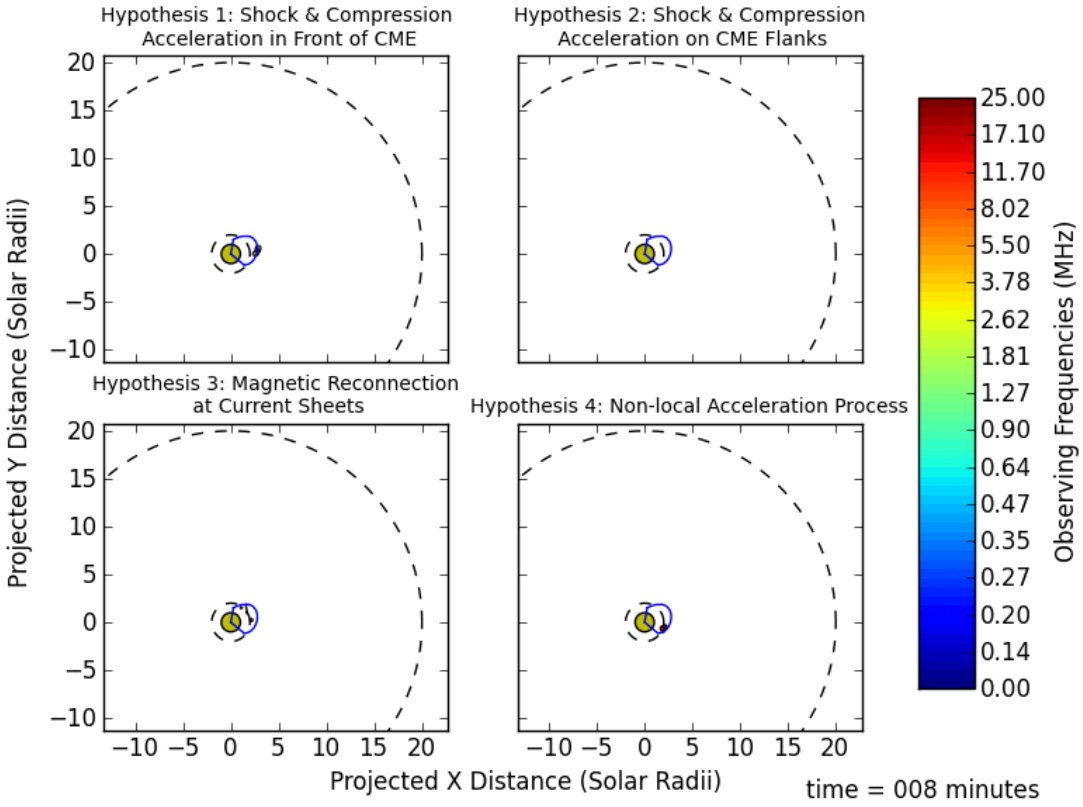
SunRISE Recovered Radio Emission

SunRISE
Sun Radio Interferometer
Space Experiment



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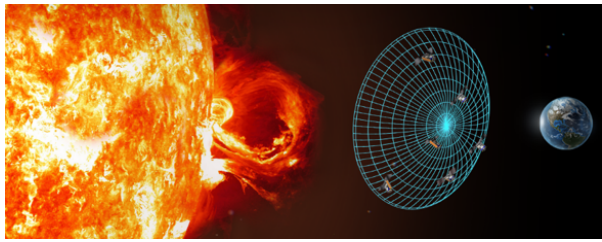
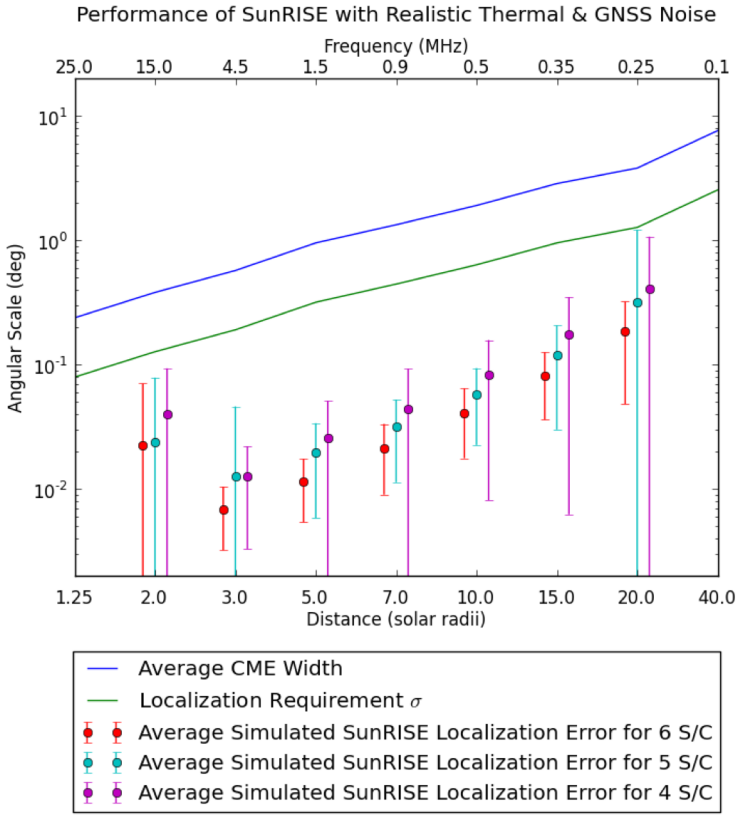


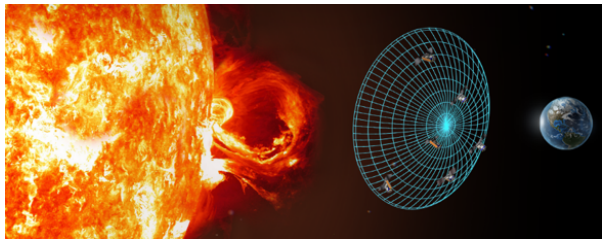
Localization Resolution

SunRISE
Sun Radio Interferometer Space Experiment

- Localization resolution determined by array configuration and frequency.

- SunRISE localization resolution ranges from 0.01 – 0.1 degrees (or 0.6 – 6 arcseconds)





Orbiting Arrays are Irregular

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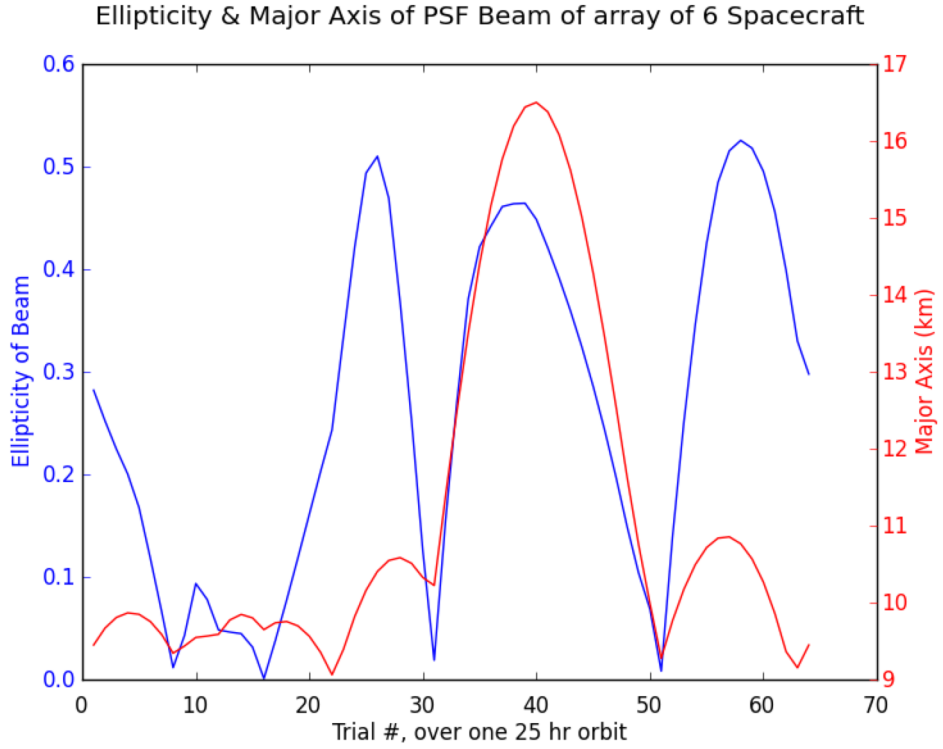
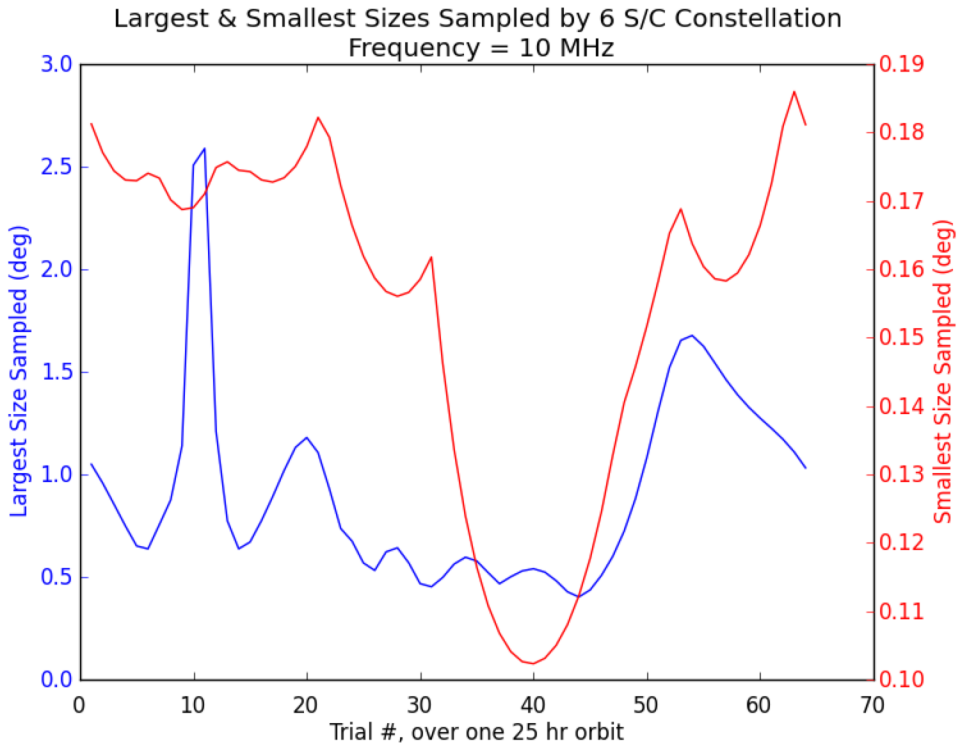
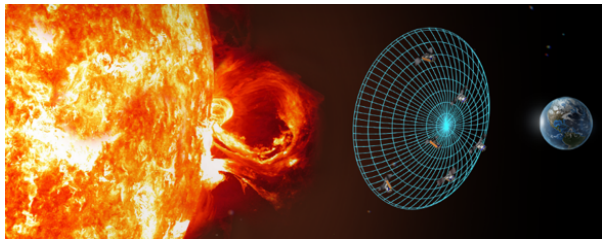






Additional Science

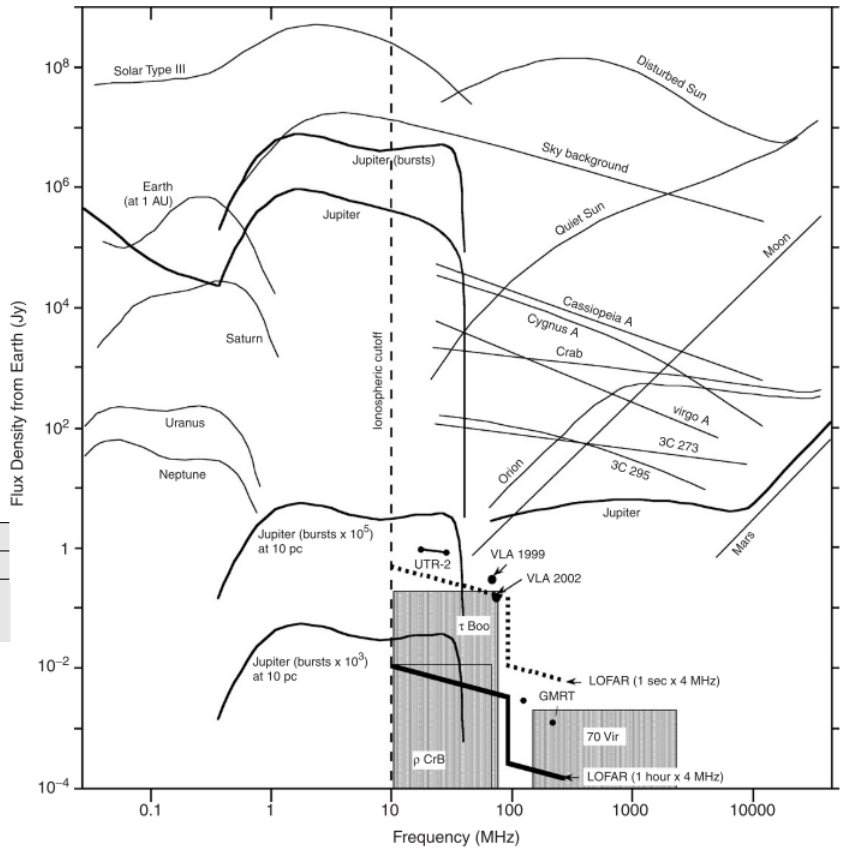
SunRISE
Sun Radio Interferometer Space Experiment

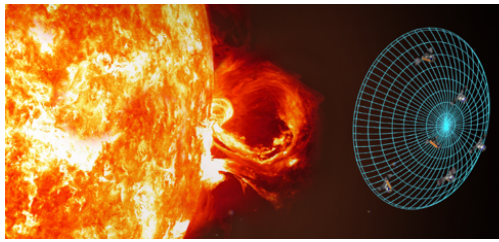
- SunRISE might be first array that can make basic images at low Frequencies below Ionospheric cutoff
- New Window into the universe, plenty to look at
- Astronomy review papers have detailed requirements for every possible source

Topic	Our Sections	*Requirements*					
		Frequency/MHz	Resolution ϑ	Baselines/km	Expected signal[a]	N(Antennas)	t_{exp} (5-σ)
Transients	3.4						
Solar and planetary bursts	3.4.1	0.1–30	degrees	0.5–200	MJy	1–100	min–h
Extrasolar planets	3.4.2	0.5–30	$\lesssim 1'$	$\gtrsim 35$–1000	1–10 mJy	$10^4 - 10^{5}$[f]	15 min

S. Jester, H. Falcke / New Astronomy Reviews 53 (2009) 1–26

P. Zarka / Planetary and Space Science 55 (2007) 598–617





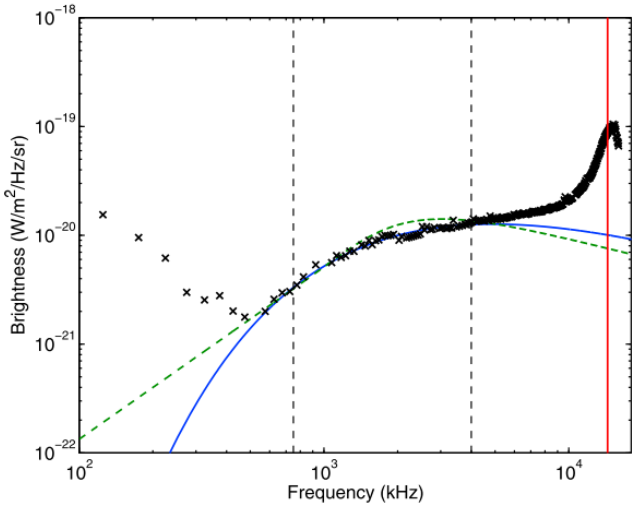
Calibrating with Galactic Brightness

SunRISE
Sun Radio Interferometer Space Experiment

- Mirror galactic calibration of STEREO antenna from Zaslavsky et al 2011
- Must understand Antenna and Stray impedance, goes into Γ^2

$$V_r^2 = V_{noise}^2 + \Gamma^2 V_{QTN}^2 + \frac{4\pi}{3} Z_0 \Gamma^2 l_{eff}^2 B_f .$$

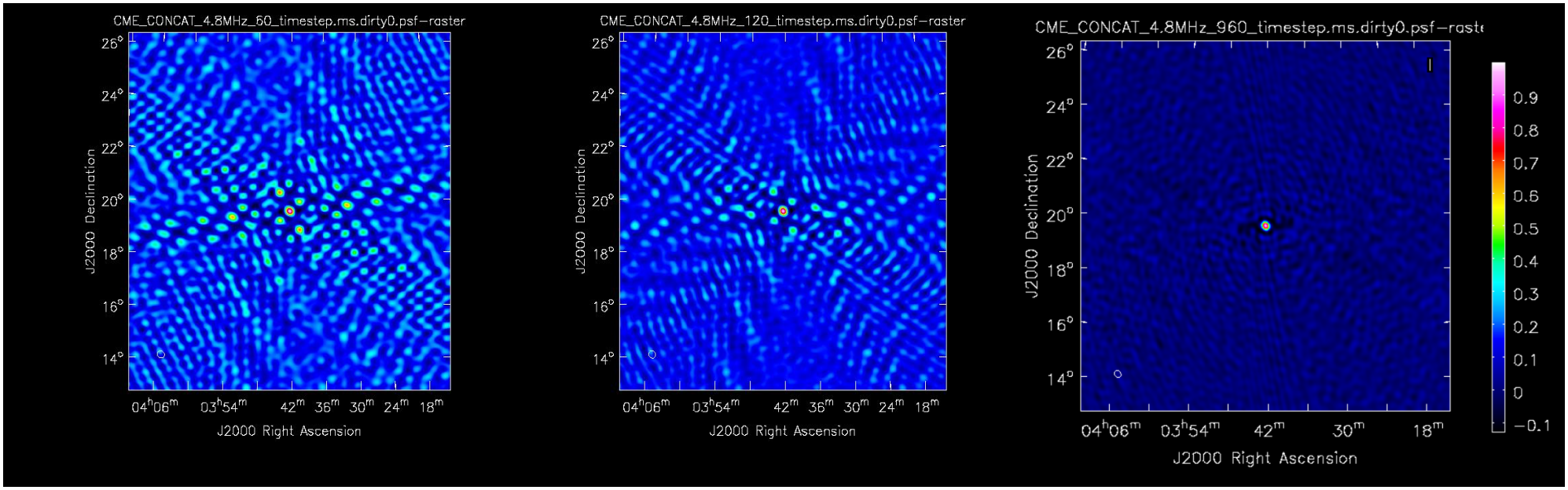
- Choose middle range where galactic noise is dominant (Quasi Thermal Plasma Noise dominates at lowest freqs, short antenna approx. fails at higher freqs)
- Subtract off constant antenna noise to solve for effective antenna length
- Compare calibrated data (crosses) with Galactic brightness models Novacco and Brown [1978] (blue solid line) and Cane [1979] (green dashed line)



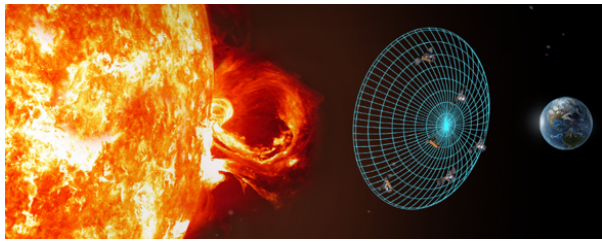
Zaslavsky et al. RADIO SCIENCE, VOL. 46, RS2008, doi:10.1029/2010RS004464, 2011

SunRISE Integration over time

SunRISE
Sun Radio Interferometer Space Experiment



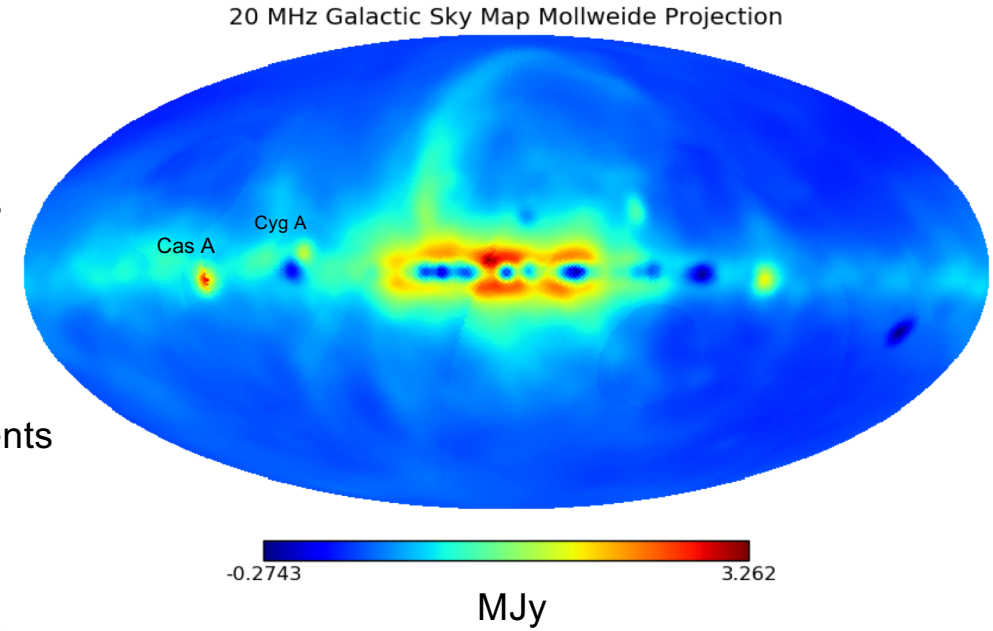
PSFs at 5 MHz after 1, 2 and 24 hours of integration. All images share the same color scale, normalized to 1.0.



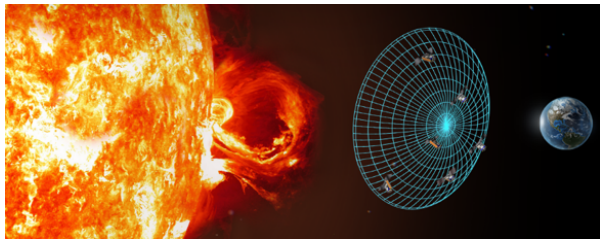
Preliminary All Sky Mapping

SunRISE
Sun Radio Interferometer Space Experiment

- Will have 1 year's worth of data to sift through
- Choose least bright periods to create constant Sky Maps
- For given area of sky, use SPICE to compute times when it is unobscured by Earth, Sun, Jupiter, etc.
- Can subtract constant sky model to look for weak transients
- Working on simulated SunRISE Global Sky Map



Created with gsm2016 Principal Component Analysis
Zheng et al. MNRAS 464, 3486–3497 (2017)



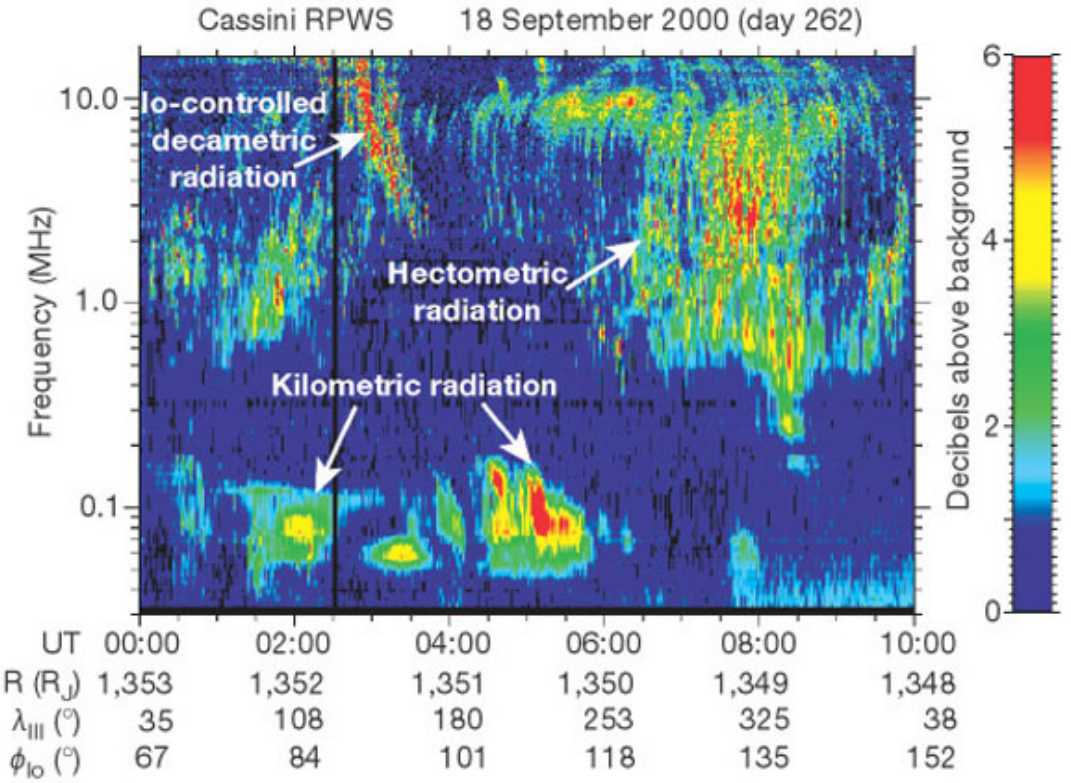
Looking for Planetary Emission

SunRISE
Sun Radio Interferometer Space Experiment

May subtract out constant sky model to look for weaker transients

A Jovian Io burst (strongest and most predictable) will typically dwell on a frequency for > 1 hour.

Processing of searching for Jovian Emission mirrors that of extrasolar planetary emission



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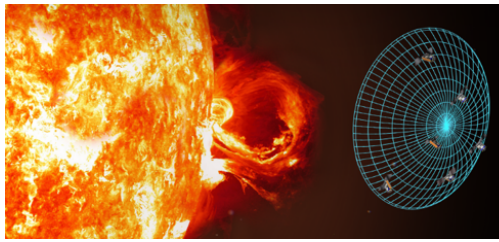


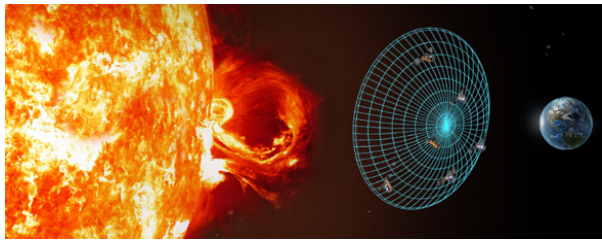
Calibration / Validation with Jovian Bursts

SunRISE
Sun Radio Interferometer Space Experiment

Jupiter's Io Decametric Radiation as a Calibration Source

Property	Range	Notes
Frequency	$0.3\ \mathrm{MHz} - 35\ \mathrm{MHz}$	Significant overlap with SunRISE band.
Occurrence	~every couple of days	Predictable occurrence based on Io orbital phase and Jupiter's longitudinal phase.
Duration	~ 2 hours	Equivalent ~72,000 snapshots with SunRISE
Flux Density	$10^{-20}\ to\ 10^{-19}\ \mathrm{W\ m^{-2}\ Hz^{-1}}$	Flux is variable but strong when active. Stereo/Waves sees them regularly.
Structure	Point source	Source size < 400 km at 4.4 AU from VLBI measurements.

NOTE: These data are gathered while in science mode. It does not interfere with regular operations.



Summary

SunRISE
Sun Radio Interferometer Space Experiment

- SunRISE, designed for Solar Radio Bursts, can see the entire Low Frequency Sky over 12 month mission
- SunRISE could make first maps of the Sky at these Frequencies
- Could do preliminary Galactic foreground subtraction
- SunRISE can localize individual radio sources
- Data Processing mirrors that of a larger array that could detect Extrasolar Planetary Emission
- Space Based Interferometry will be huge, SunRISE could be the pathfinder