

Other science cases

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SKA science cases

- Galaxy evolution, DE (Neutral hydrogen 21-cm), $z < 2$
- Cosmic dawn (Neutral hydrogen 21-cm), $z > 10$
- Strong-field tests of GR with pulsars and BHs. Detect pulsars, map space with pulsars (GW).
- Origins and evolution of cosmic magnetism (Faraday rotation).
- Cradle of life (search for life and planets, thermal emission from dust, SETI)
- “Flexible design to enable exploration of the unknown”

SKA science cases (2009)

Description of Key Science Project	Frequency Range (GHz)						FoV deg ²	Sensitivity m ² /K	Survey Speed deg ² m ⁴ K ⁻²	Resn. mas*	Base-line Km	Dyn. Range Driver	Poln. Driver	
	.1	0.3	1.0	3.0	10	30								
1 The Dark Ages														
1a EoR	—								>~3x10 ⁷		10	✓	✓	
1b First Metals					—		0.003	15,000			50			
1c First Galaxies & BHs			—					20,000			10	4500	✓	✓
2 Galaxy Evolution, Cosmology & Dark Energy														
2a Dark Energy			—						6x10 ⁹		5			
2b Galaxy Evolution	—	—						20,000	1x10 ⁹		10			
2c Local Cosmic Web			—						2x10 ⁷		0.5			
3 Cosmic Magnetism														
3a Rotation Measure Sky			—						2x10 ⁸		10-30		✓	
3b Cosmic Web	—	—							1x10 ⁸		5		✓	
4 GR using Pulsars & Black Holes														
Search			—						1x10 ⁸		< 1			
4a Gravitational Waves		—	—	—			-	>15,000		1	200		✓	
4b BH Spin		—	—	—	—		1	10,000			-		✓	
4c Theories of Gravity		—	—	—	—			>15,000		1	200		✓	
5 Cradle of Life														
5a Proto-planetary Disks					—		0.003	10,000		2	1000			
5b Prebiotic Molecules			—	—	—		0.5-1	10,000		100	60			
5c SETI			—	—	—		1							
6 Exploration of the Unknown	—	—	—	—	—	—	Large	Large	Large					

*milli-arcseconds of angular resolution

SKA specifications



Parameter	Specification
Frequency range	50 MHz (6 m wavelength) to 20 GHz (1.5 cm wavelength)
Sensitivity area / system temperature	5 000 m ² /K (400 μJy in 1 minute) between 70 and 300 MHz
Survey figure-of-merit	$4 \times 10^7 - 2 \times 10^{10} \text{ m}^4 \text{K}^{-2} \text{ deg}^2$ depending on sensor technology and frequency
Field-of-view	200 square degrees between 70 and 300 MHz 1-200 square degrees between 0.3 and 1 GHz 1 square degree maximum between 1 and 10 GHz
Angular resolution	TBD
Instantaneous bandwidth	Band centre \pm 50%
Spectral (frequency) channels	16 384 per band per baseline
Calibrated polarisation purity	10 000:1
Synthesised image dynamic range	>1 000 000
Imaging processor computation	10^{18} operations/second
Final processed data output	10 GB/second

SKA1-LOW: ~250000 dipoles

Cosmic Dawn

Interferometry/correlator

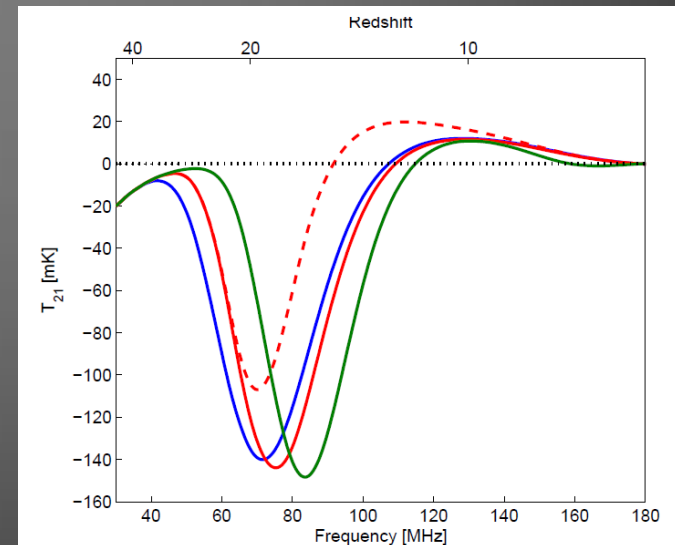
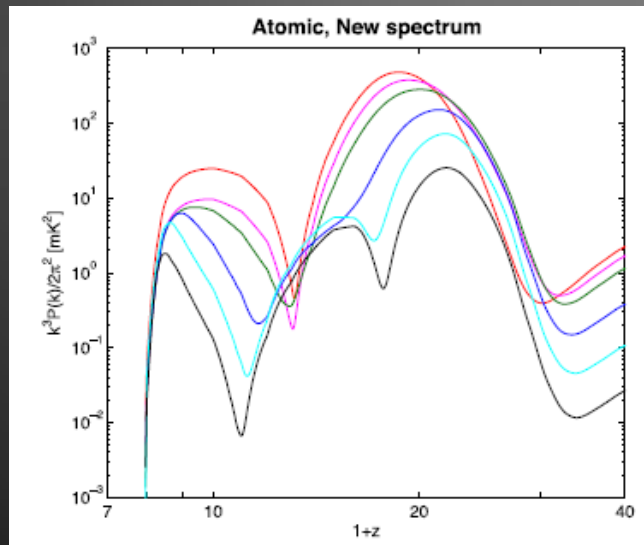
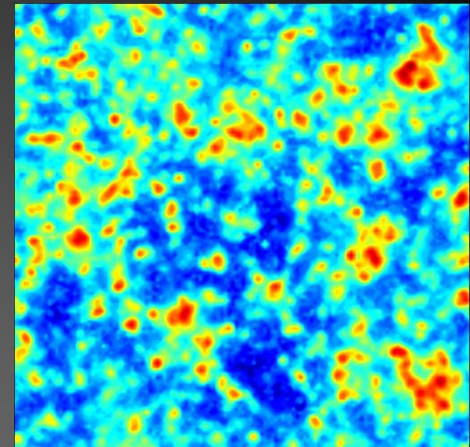
Imaging – large FoV

Power spectrum/global signal

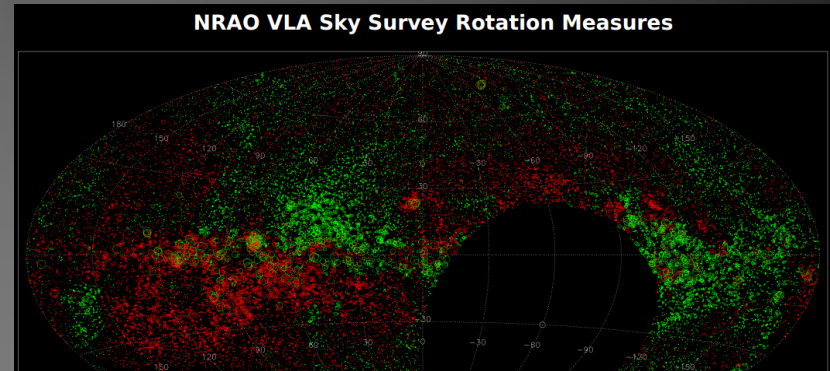
Sampling time ~ 3 sec (ionosphere)

Frequency resolution (kHz): Removing foregrounds, RFI excision and precise noise characterization

(talks by F. Combes and XiangPing Wu)



Cosmic Magnetism



Requirements

- Large frequency range
- Multichannel spectro-polarimetry

Cosmic magnetism needs a frequency range as large as possible.

Instrument	Frequency Range MHz	$\Delta\lambda^2$	λ^2_{\min}	$\delta\Phi$ rad/m ²	$L\Phi_{\max}$ rad/m ²
SKA1-low	50-350	35.2	0.73	0.1	4.3

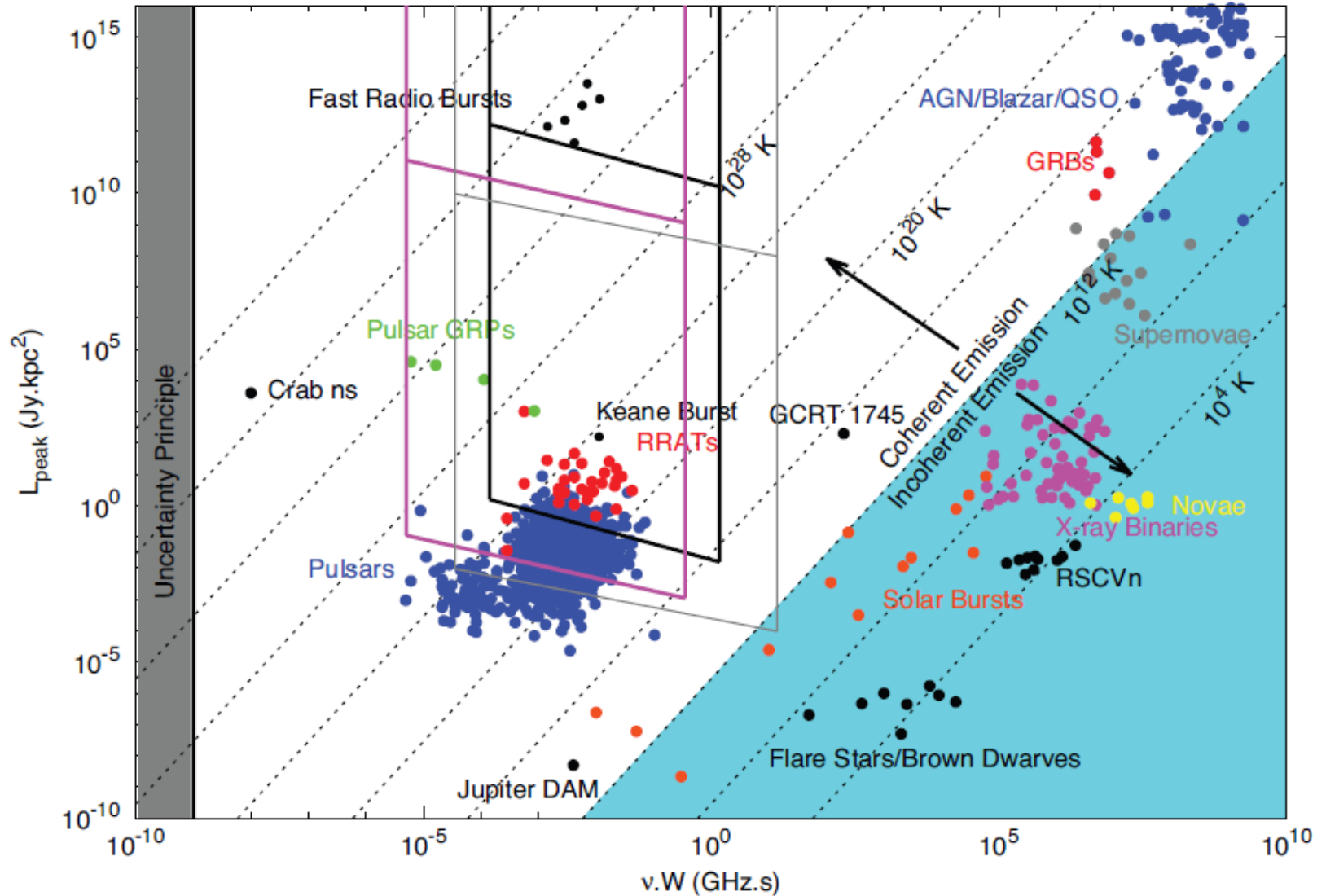
$$\delta\phi \simeq \frac{2\sqrt{3}}{\Delta\lambda^2}$$

Resolution in
Faraday depth space

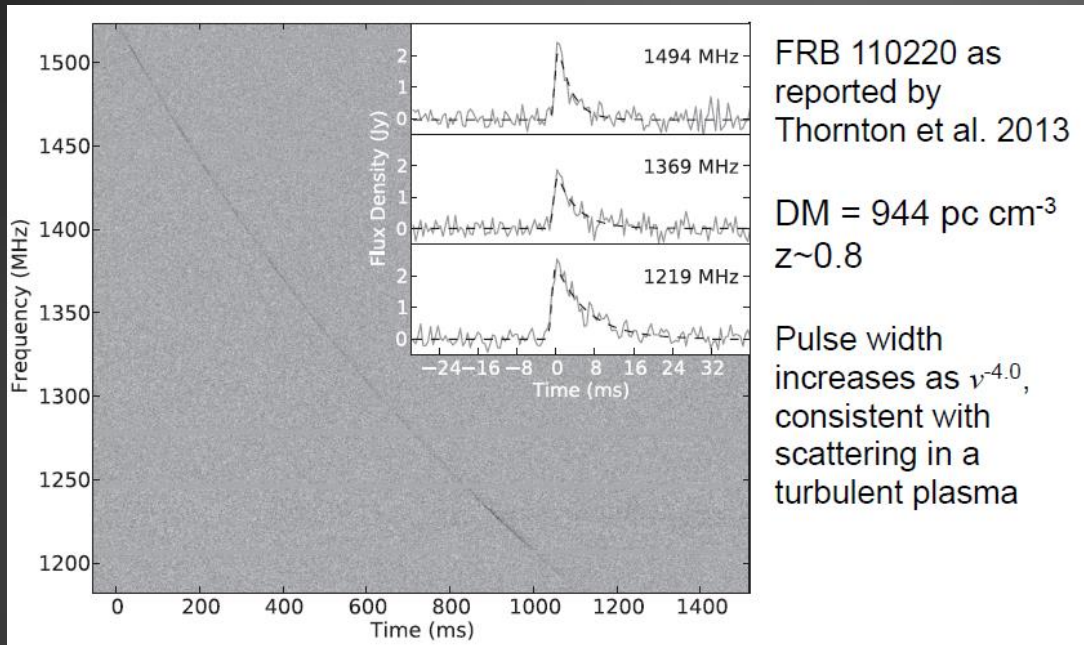
$$L_{\phi, \max} \simeq \frac{\pi}{\lambda_{\min}^2}$$

Maximum observable
Faraday depth width

The Transients Radio Sky



Fast Radio Bursts



- Bright ($> 1 \text{ Jy ms}$)
- Common ($10^4 \text{ sky}^{-1} \text{ day}^{-1}$)
- Millisecond durations
- Required: 0.1-0.5'' localization to determine sources ($z > 1$)