The SKA and its pathfinders in the next decade: synergies with the TMT

Luigi Strano Science+

Kristine Spekkens

TMT Science Forum, 17 July 2014

ROYAL MILITARY COLLEGE

Queen's UNIVERSITY

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Outline:

- The road to the SKA: pathfinders, SKA1, SKA2
- SKA and pathfinder science and the TMT
- SKA science: where will we be in 2025?

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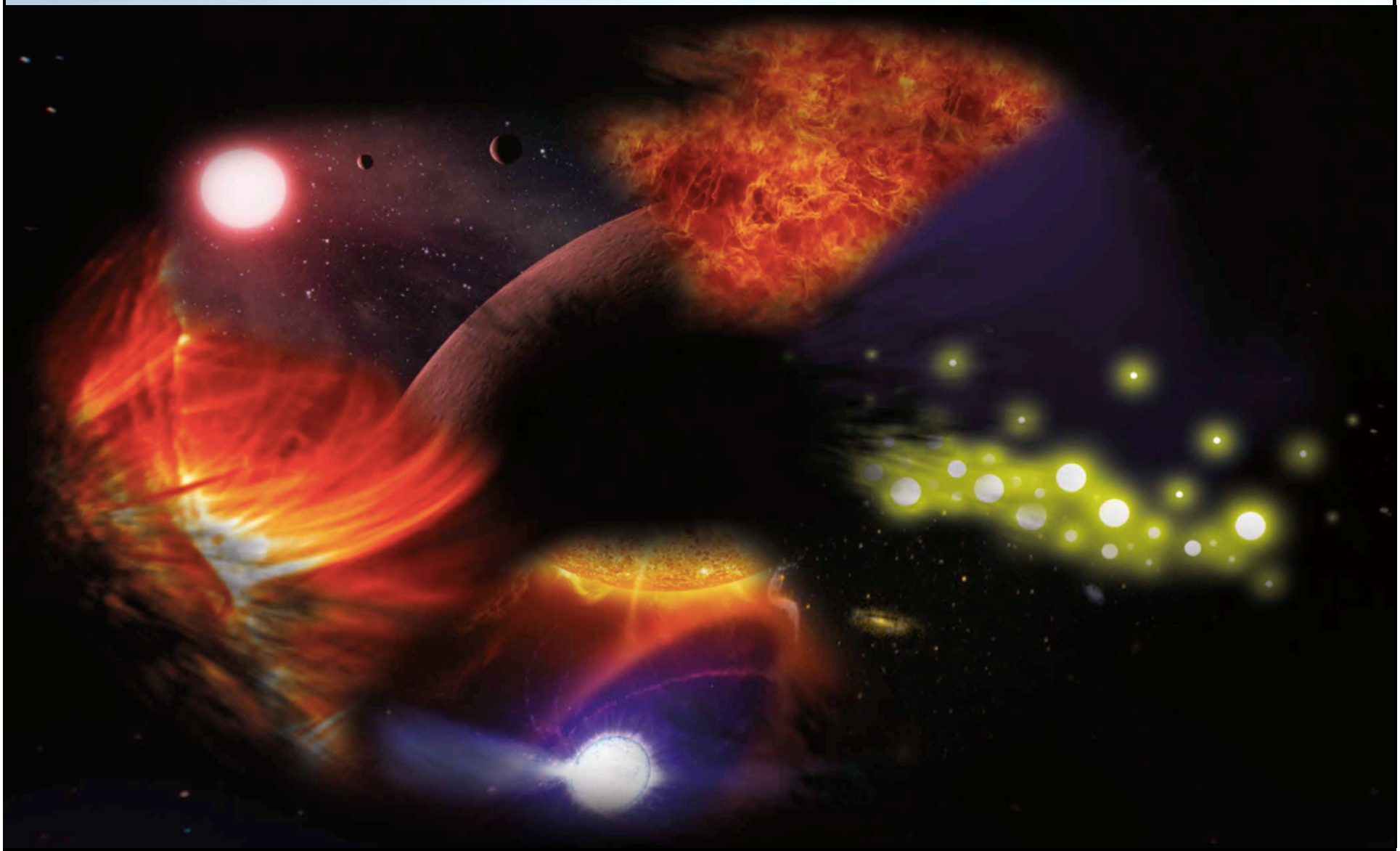
The SKA vision

1 km^2 area; 0.1-20 GHz; $\Delta\nu \approx \nu$; full pol; $\theta \leq 0.1''/\nu$; FOV≈100deg^2

The SKA vision



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The Dark Ages

→ HI tomography of reionization, $6 < z < 20$
→ Detect 21cm forest, first stars, black holes

Galaxy Evolution

→ Billion galaxy HI surveys, $z < 7$
→ 10B galaxy cosmic shear survey, $z < 10$

Cosmic Magnetism

→ Characterize galaxy/cluster B-fields for $z \leq 5$
→ Measure structure of the IGM B-field

Strong-Field Gravity

→ Gravity tests with Galactic/Sgr A* pulsars
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→ Terrestrial planets: $\theta \approx 0.15$ AU at 150 pc
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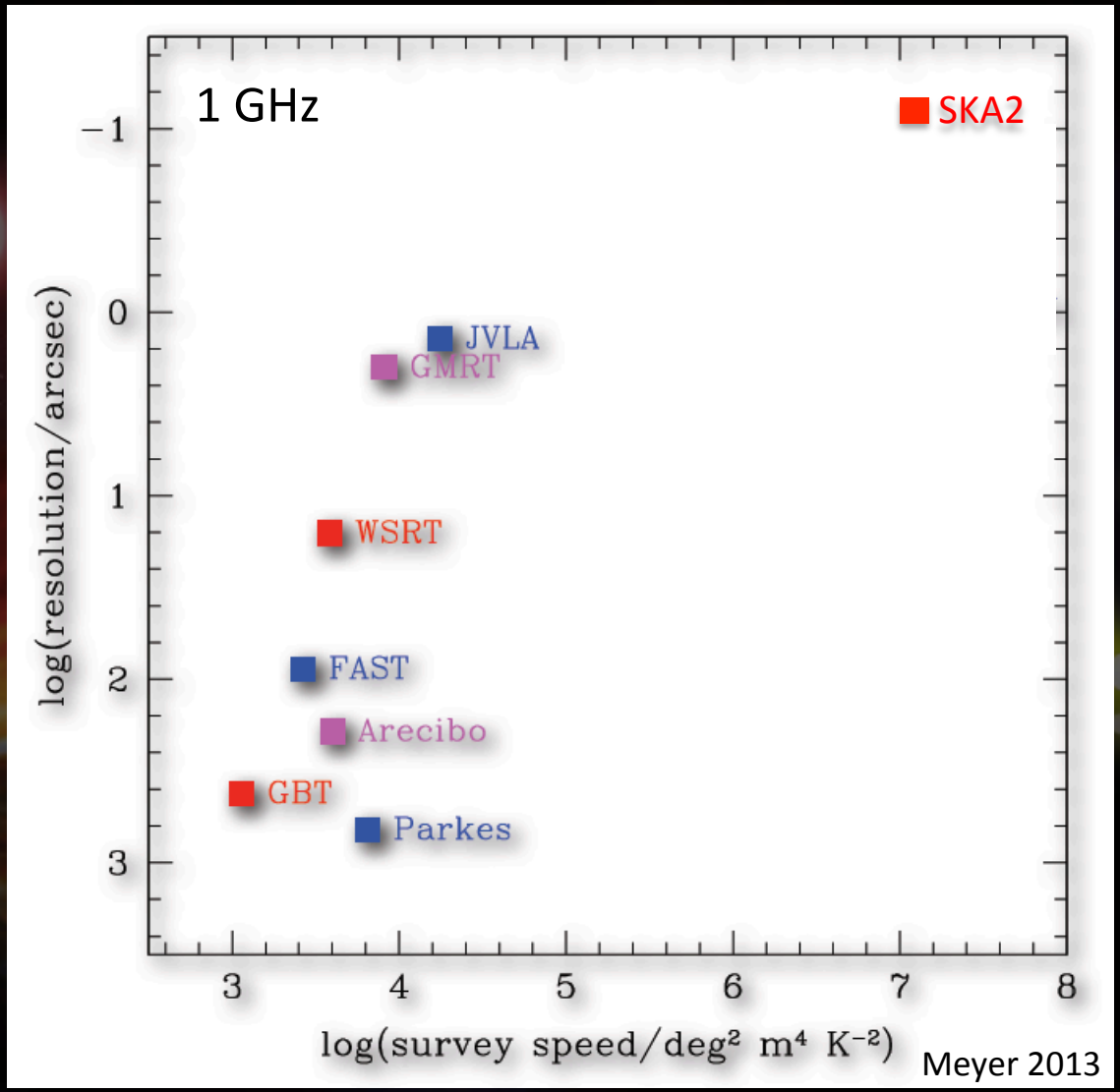
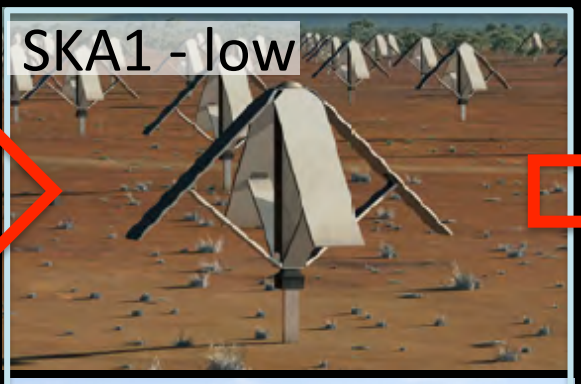
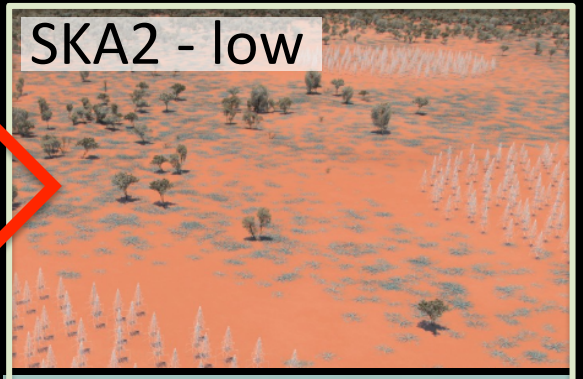
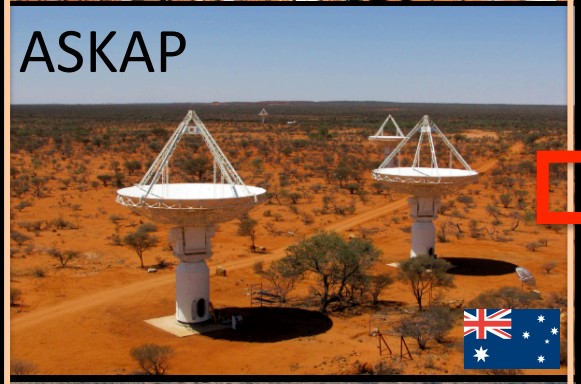
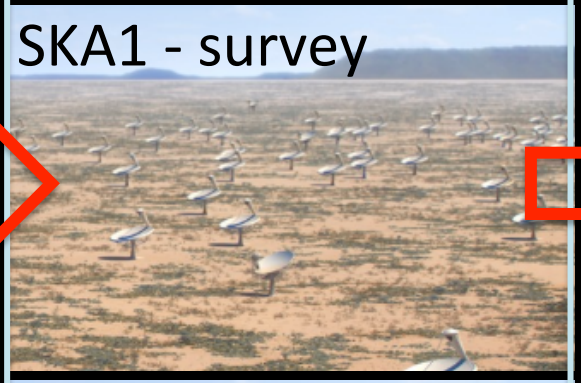
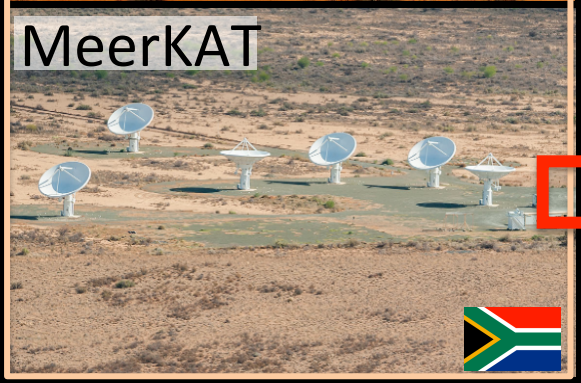
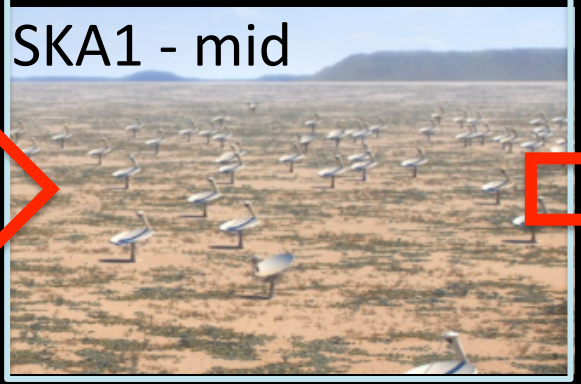
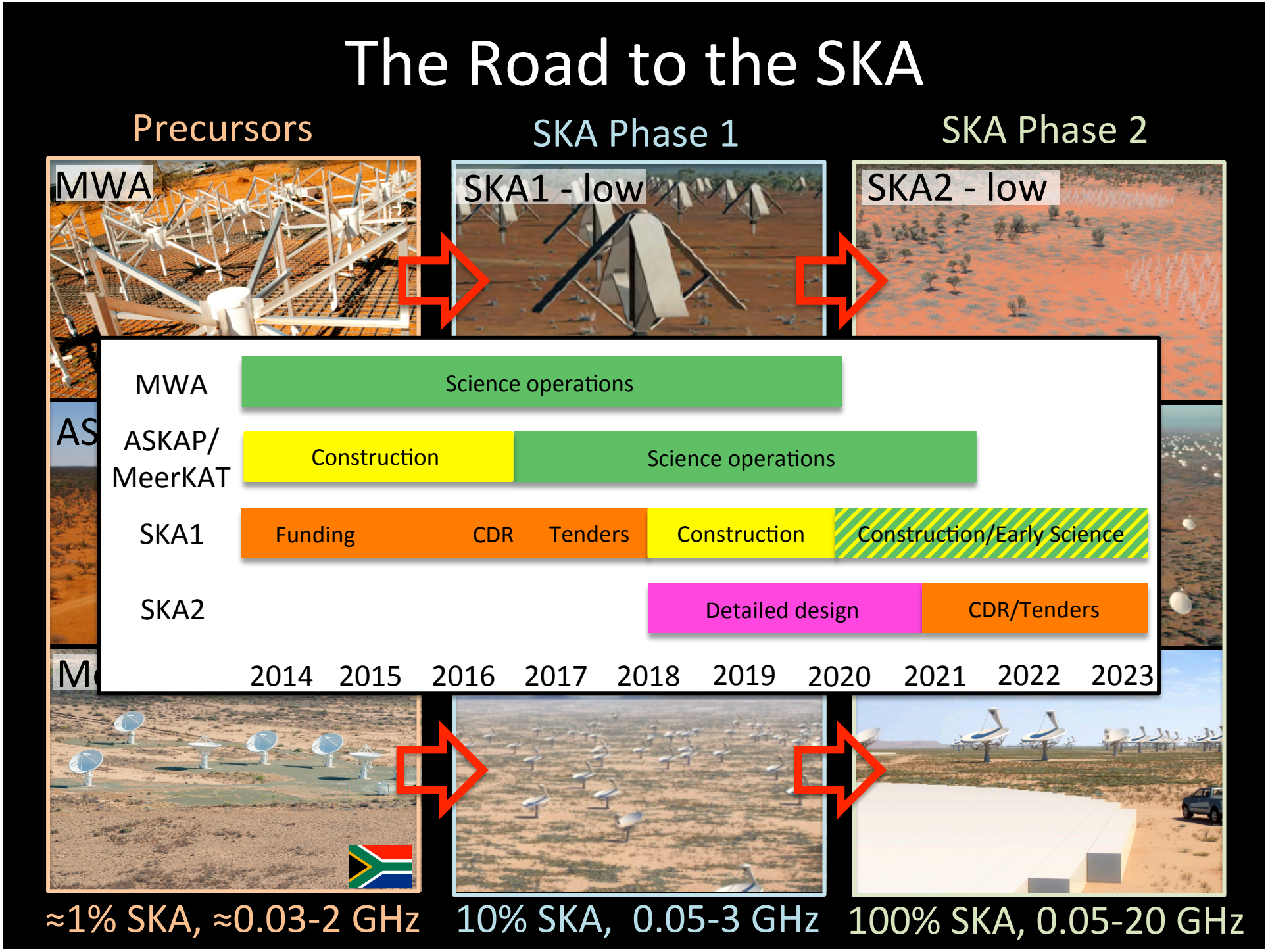


1 km² area; 0.1-20 GHz; $\Delta\nu \approx \nu$; full pol; $\theta \leq 0.1''/\nu$; FOV≈100deg²

The Road to the SKA

Precursors	SKA Phase 1	SKA Phase 2
MWA 	SKA1 - low 	SKA2 - low 
ASKAP 	SKA1 - survey 	SKA2 - survey 
MeerKAT 	SKA1 - mid 	SKA2 - mid 
≈1% SKA, ≈0.03-2 GHz	10% SKA, 0.05-3 GHz	100% SKA, 0.05-20 GHz

The Road to the SKA



The SKA vision – post-2030

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Galaxy Evolution

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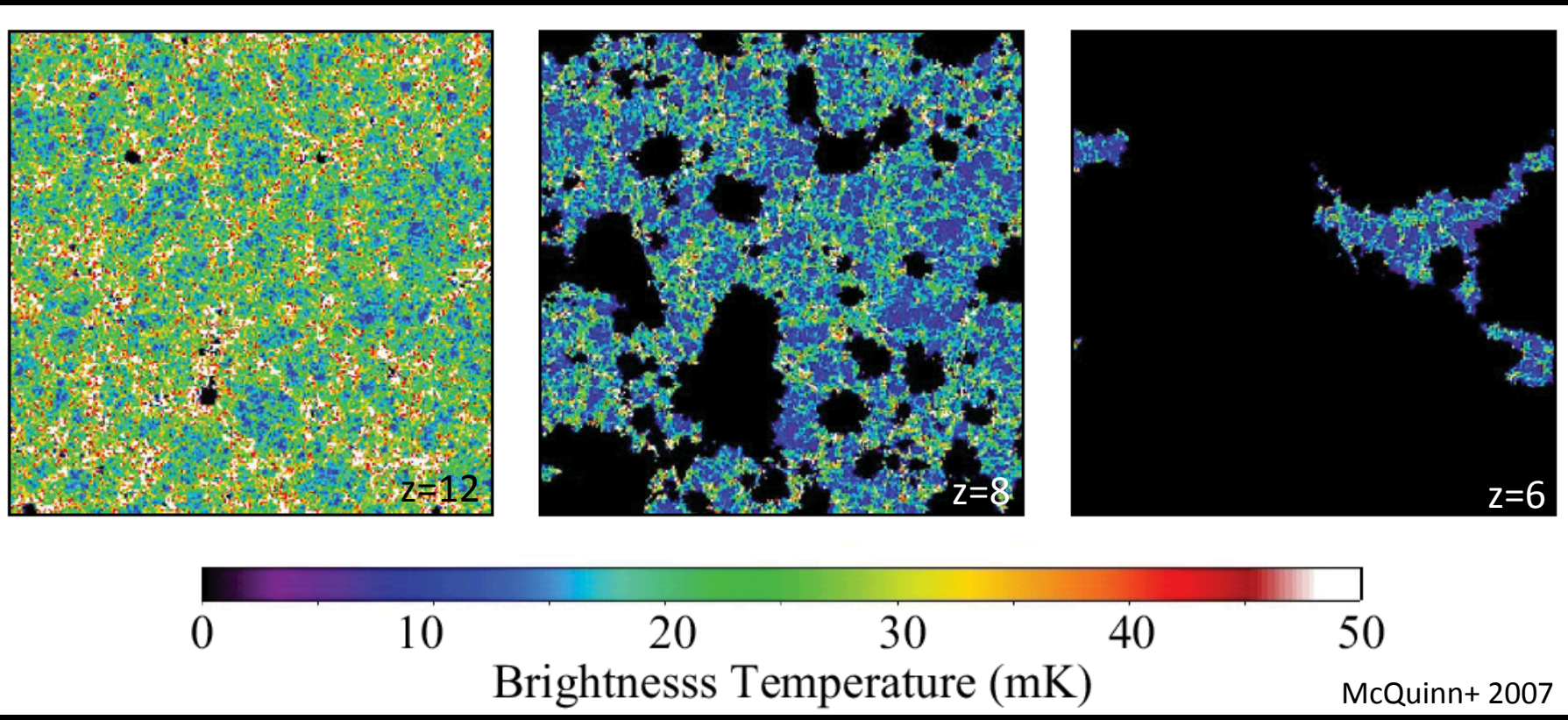
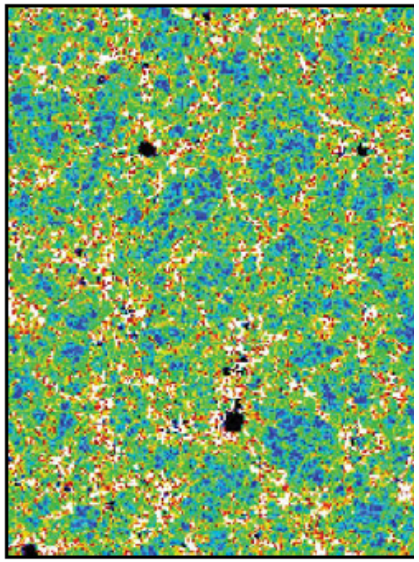
What will we learn from pathfinders + SKA1 (≤ 2025)?

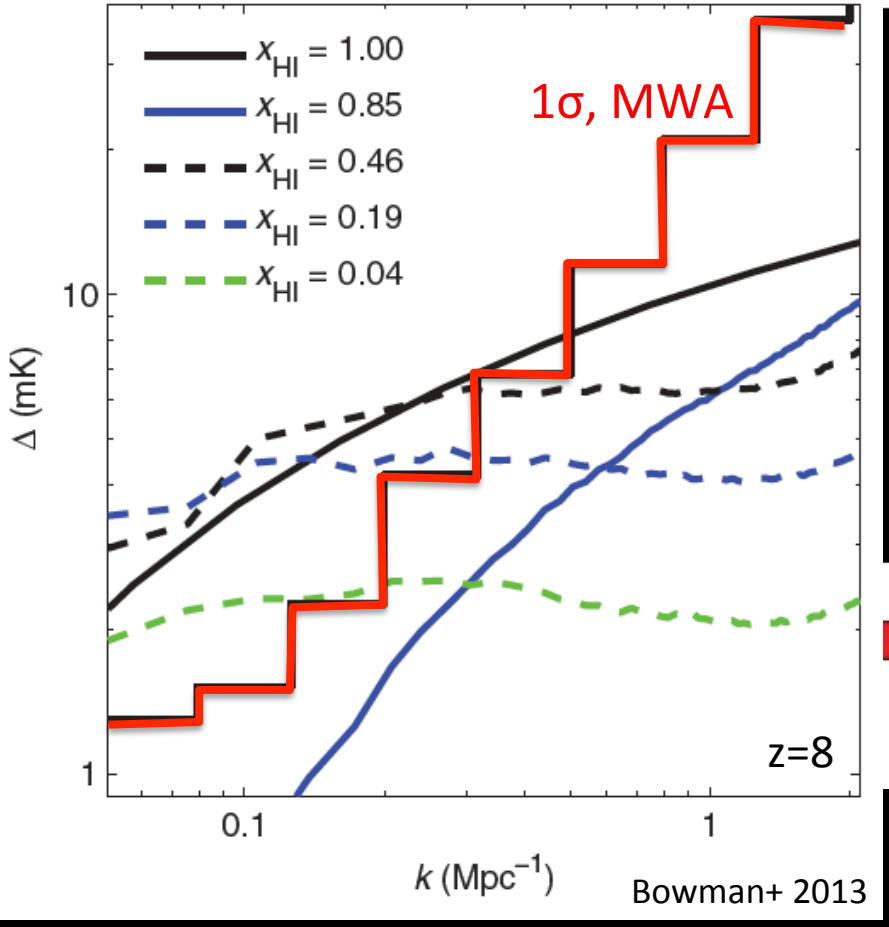
The Dark Ages and Reionization



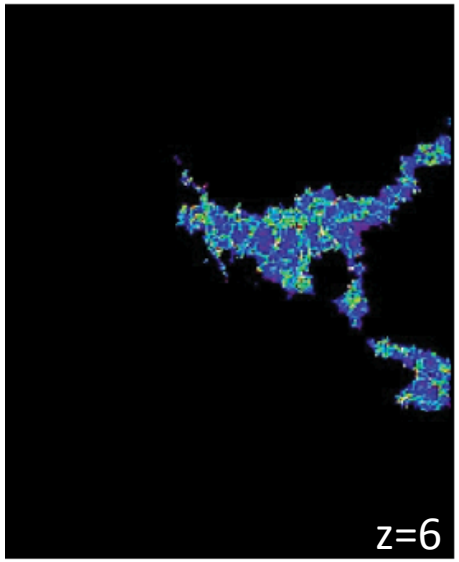
SKA2: Tomography of reionization, 6 < z< 20

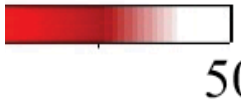
The Dark Ages and Reionization





Bowman+ 2013



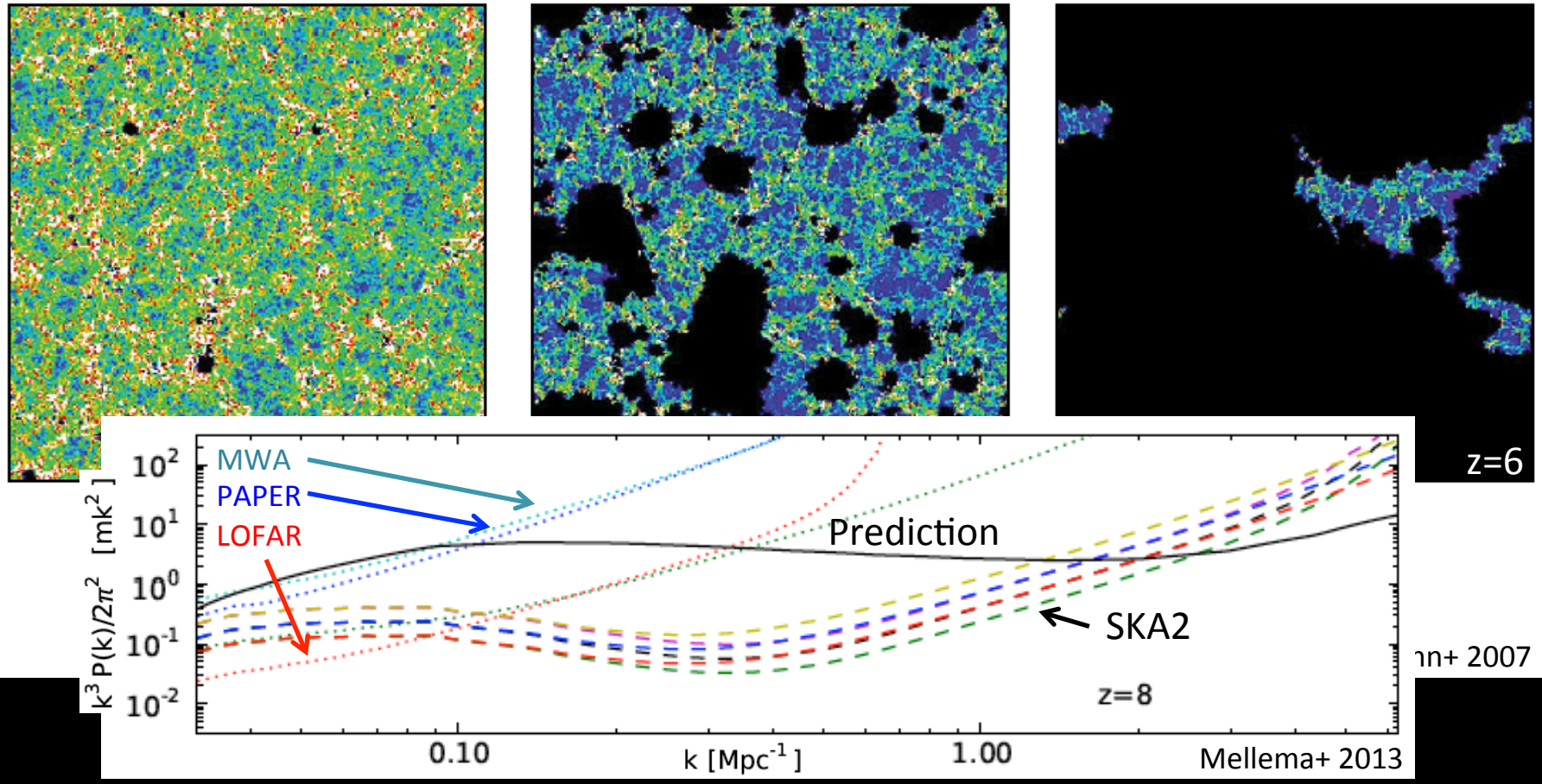


McQuinn+ 2007

Precursors: power spectrum detection, 6 < z < 10

SKA2: Tomography of reionization, 6 < z< 20

The Dark Ages and Reionization

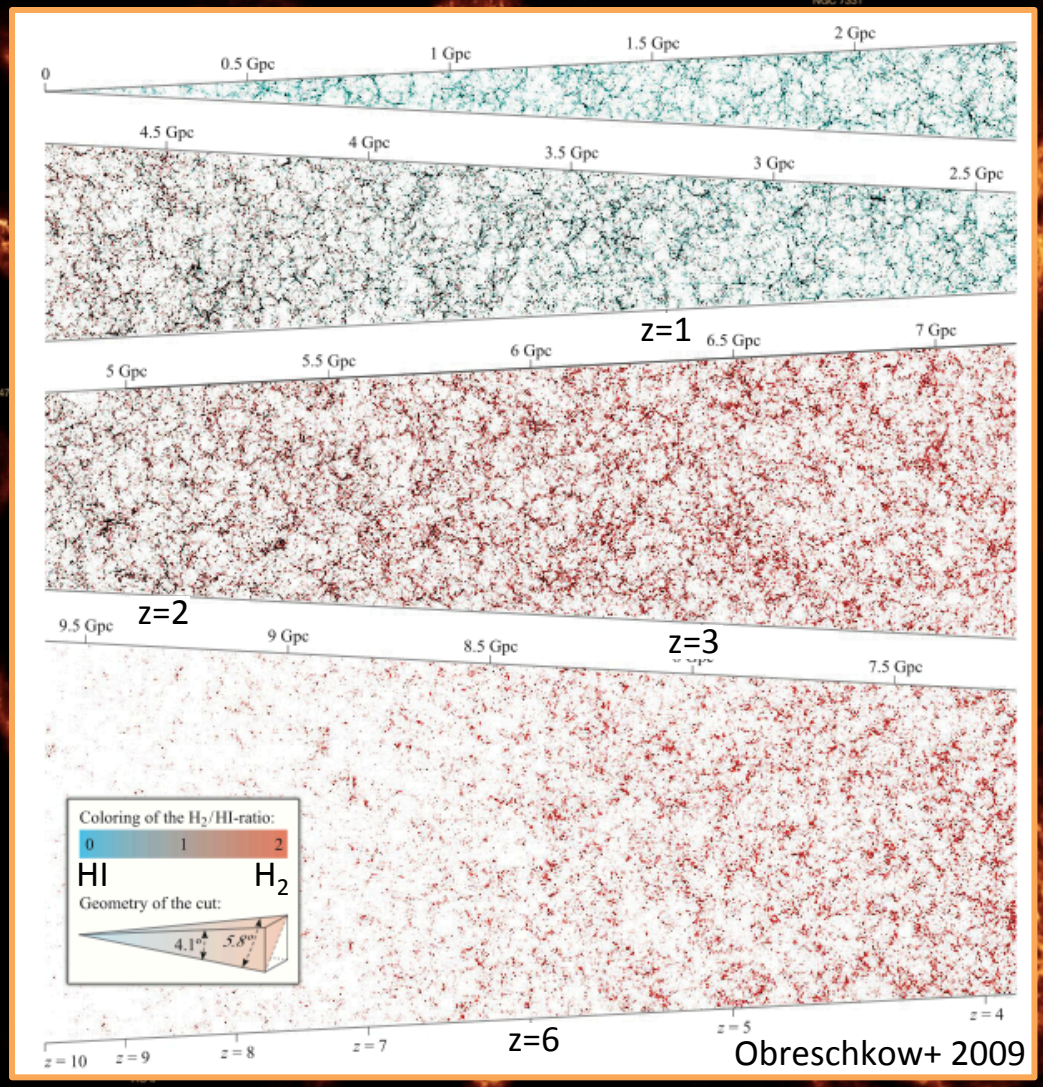


Precursors: power spectrum detection, 6 < z < 10

SKA1: Power spectrum characterization, 6 < z < 20

SKA2: Tomography of reionization, 6 < z< 20

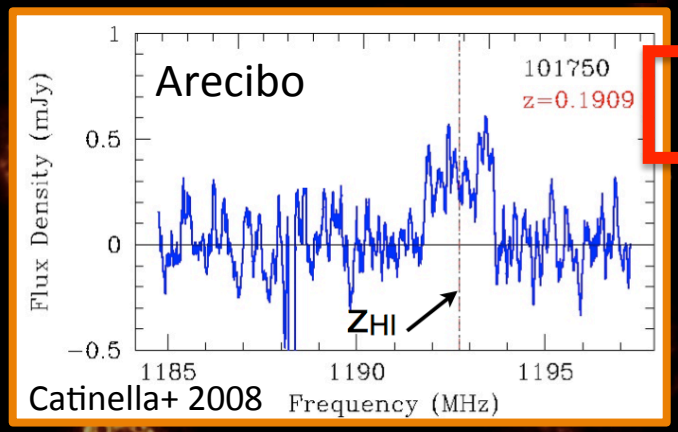
Galaxy Evolution from HI



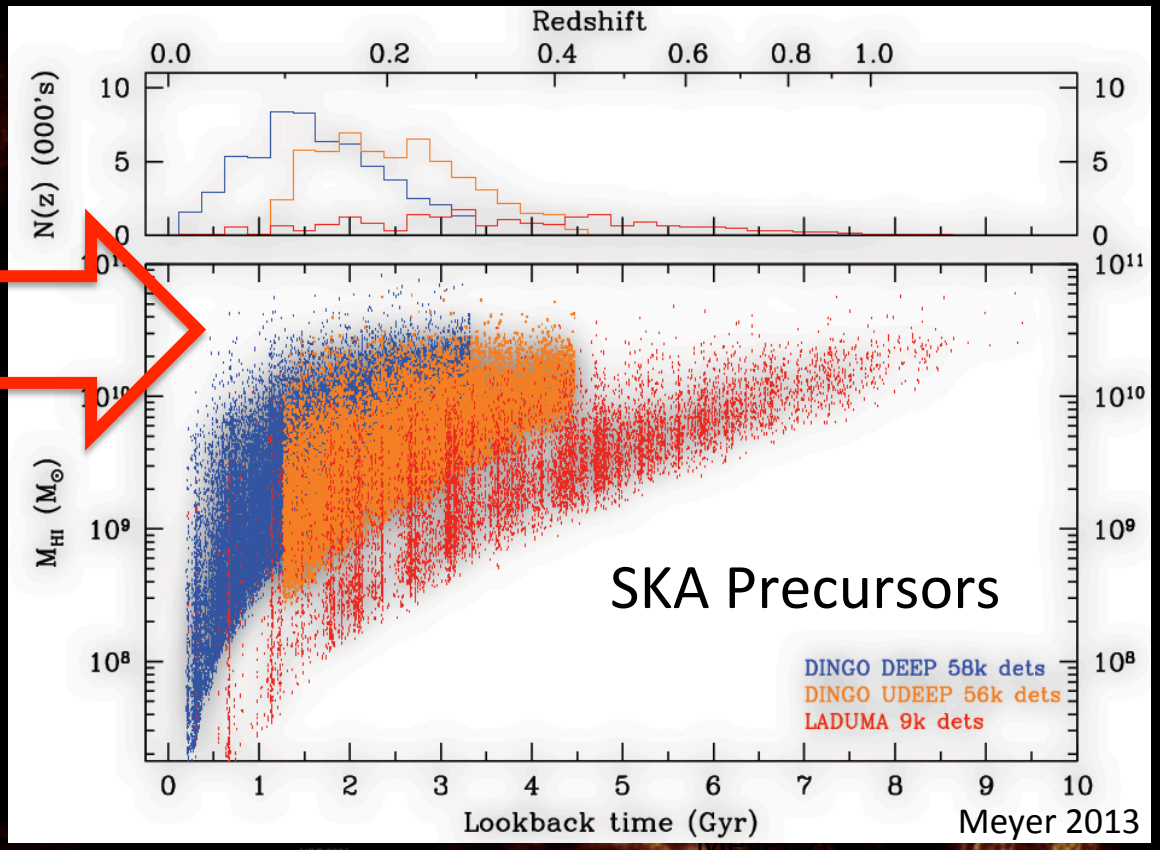
SKA2: Billion-galaxy HI emission survey, z<1.5

Galaxy Evolution from HI

"High-z" in HI now → z≈0.2



Catinella+ 2008

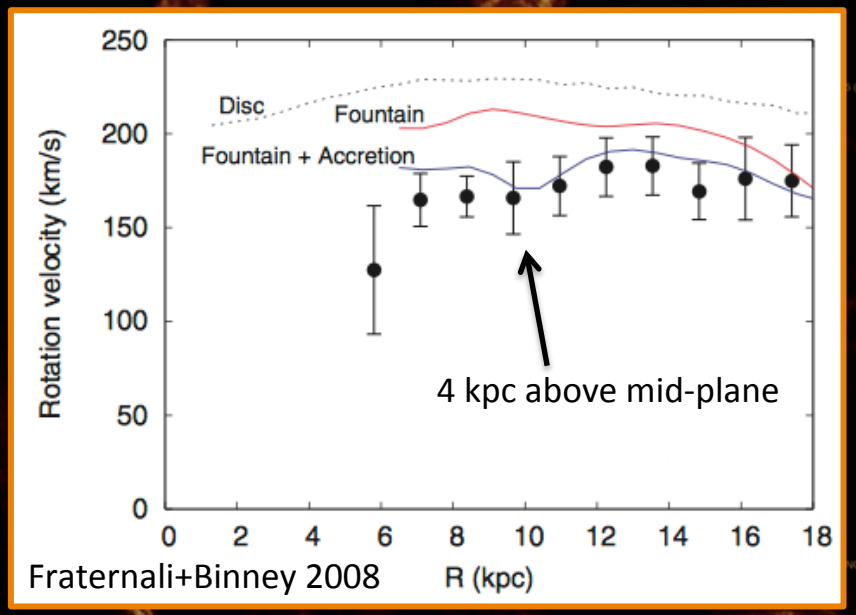


Precursors: 50k - 500k galaxies in HI, z ≤ 1 and z ≤ 0.25

SKA2: Billion-galaxy HI emission survey, z<1.5

Galaxy Evolution from HI

Constraining IGM accretion:



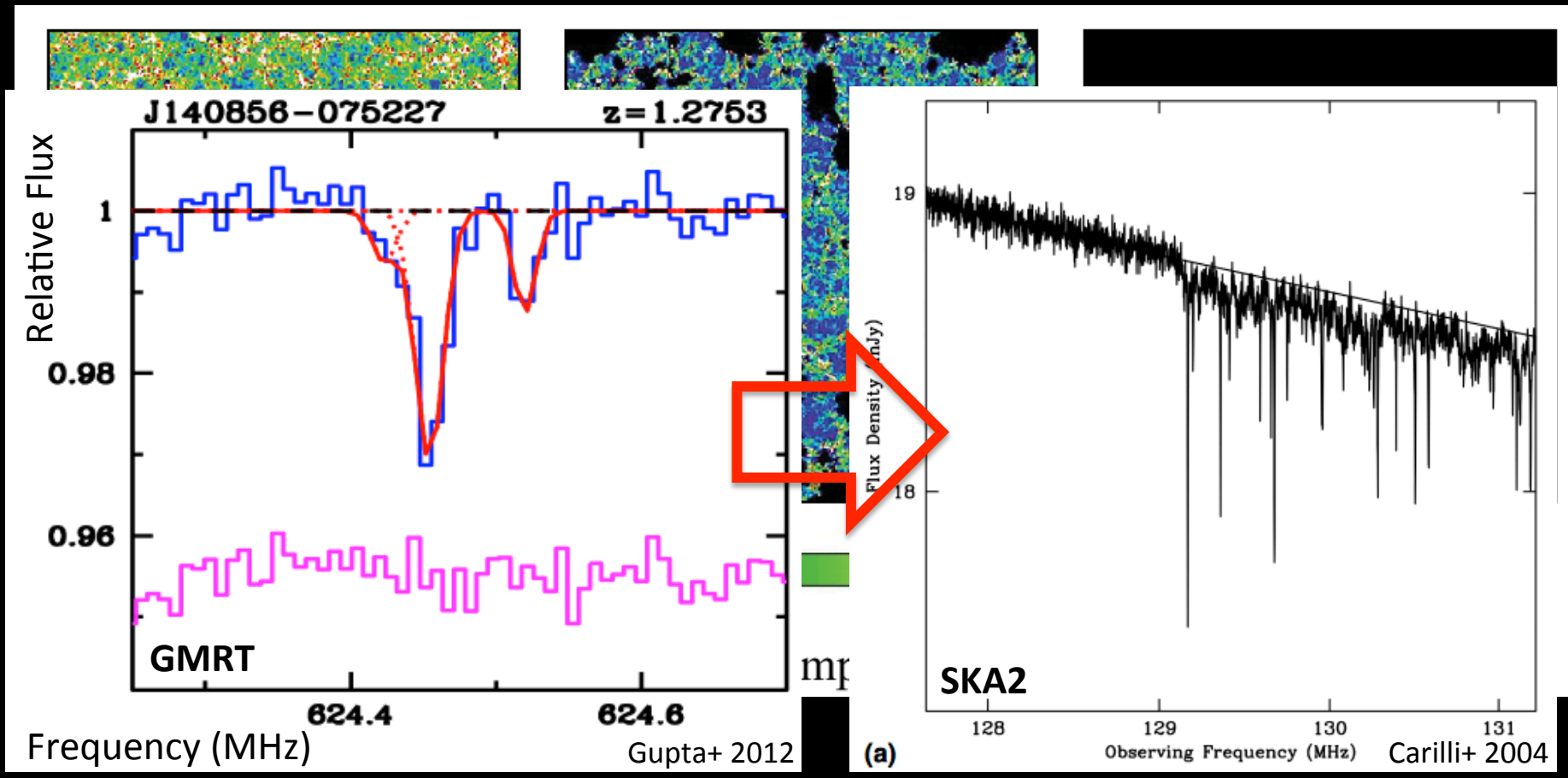
Precursors: 50k - 500k galaxies in HI, $z \leq 1$ and $z \leq 0.25$

≈30 deep (10^{17} cm^{-2}) nearby galaxy maps

SKA1: ≈Million galaxies in HI $z \leq 1$, $\theta \approx 1$" in 100 nearby gals

SKA2: Billion-galaxy HI emission survey, $z<1.5$

Galaxy Evolution from HI

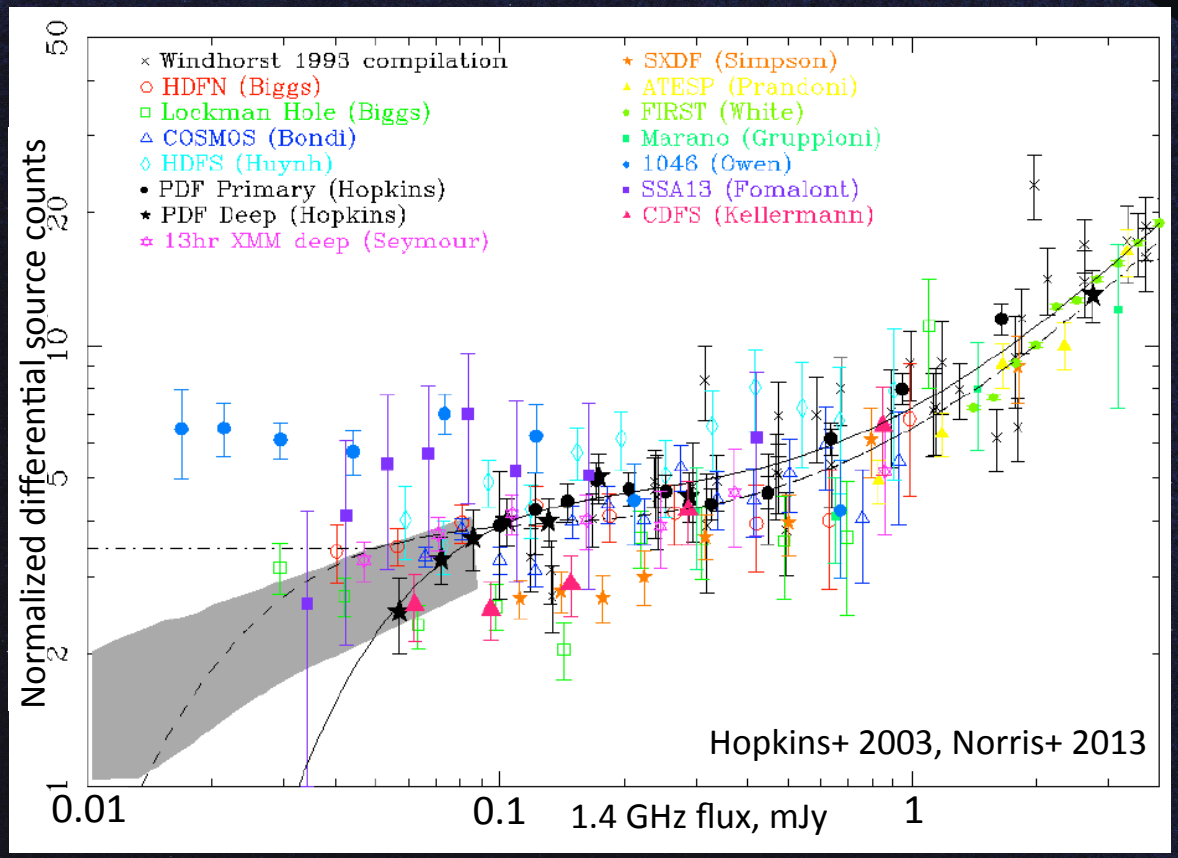


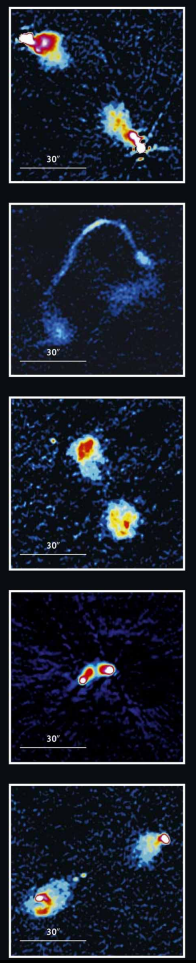
Precursors: HI absorption for 1000 sources at z<1.8

SKA1: HI absorption for ~1000s sources, z<3

SKA2: Probe the 21cm forest (z<7)

Galaxy Evolution from Continuum

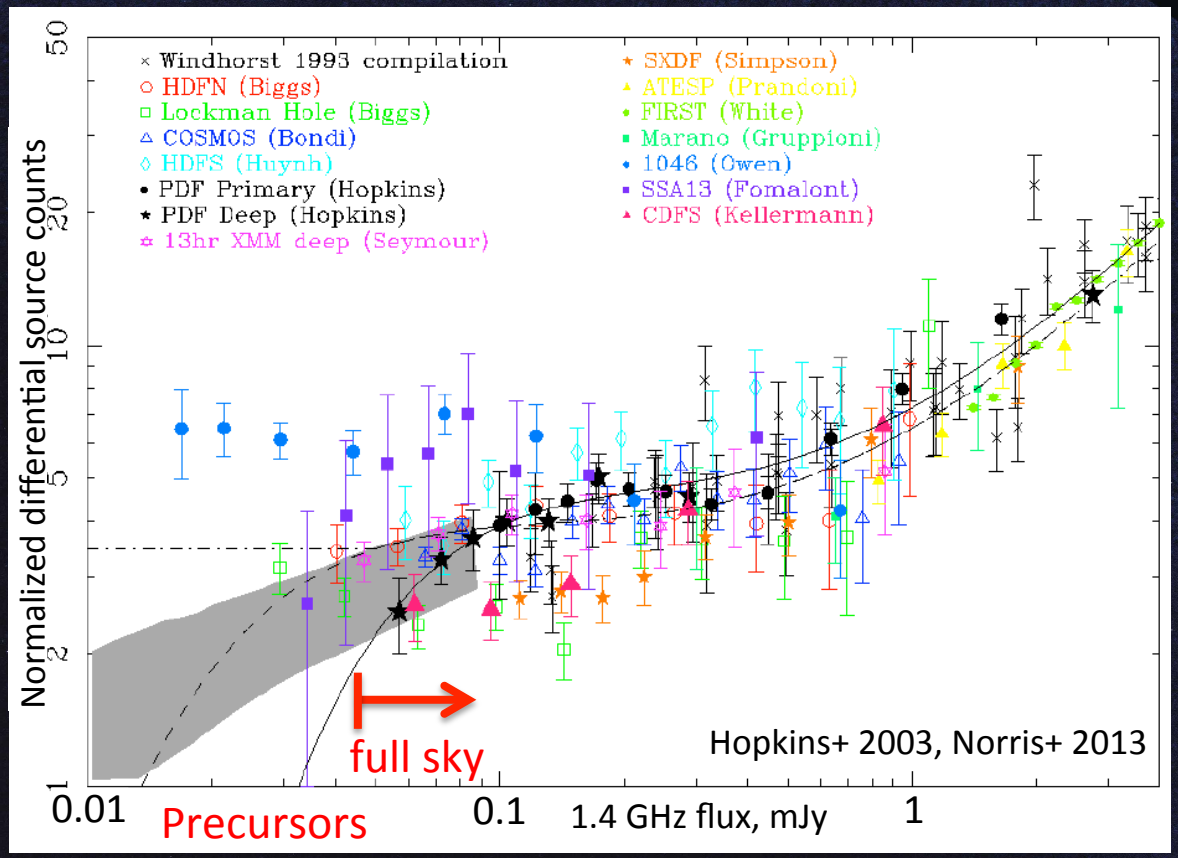




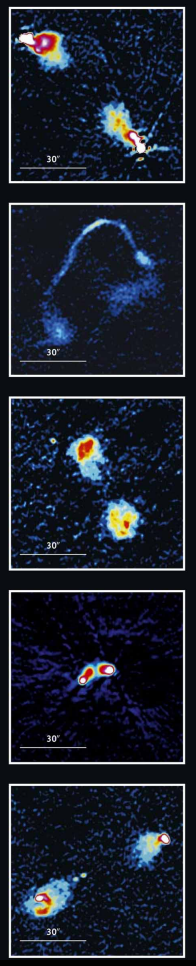
Schinnerer+ 2007

SKA2: Weak lensing of 10 billion galaxies to z~10

Galaxy Evolution from Continuum



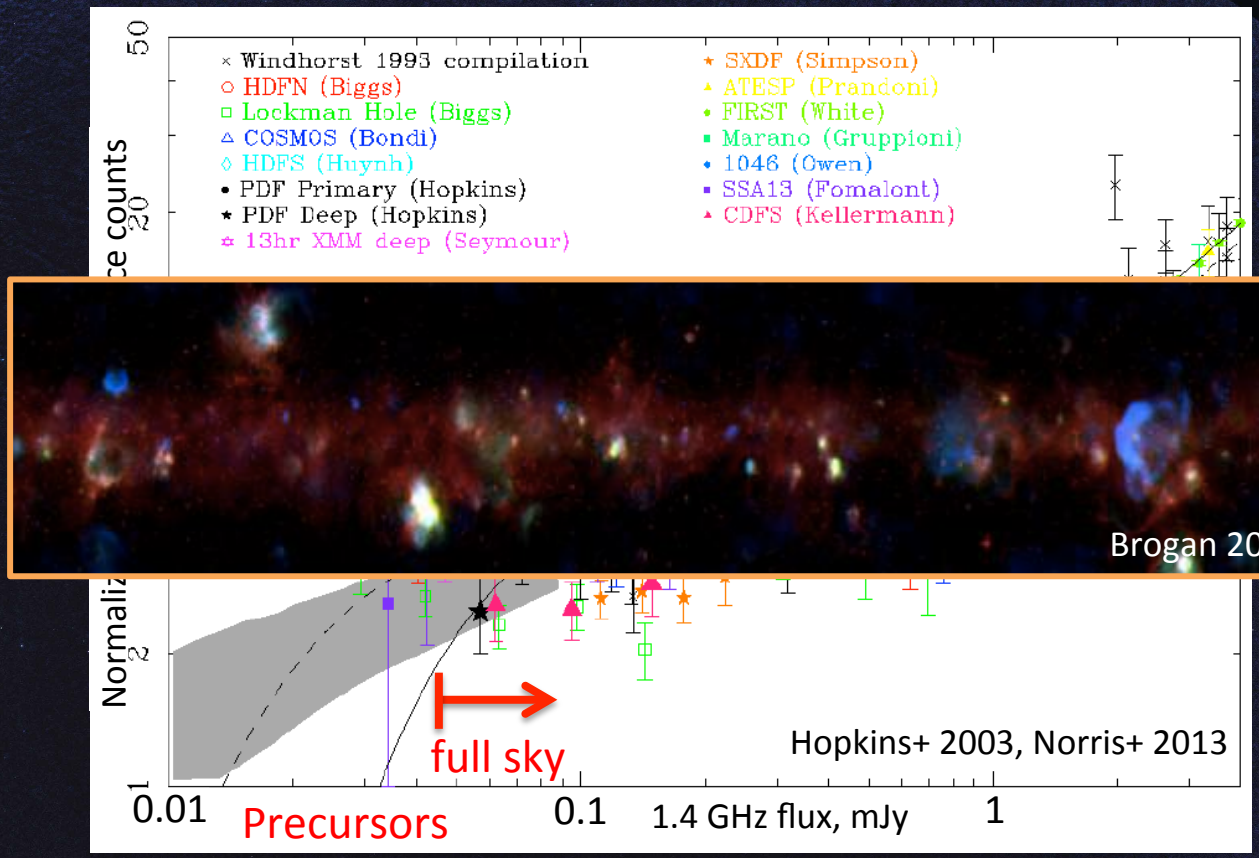
35 deg²



Precursors: AGN and star forming gals, all-sky, S ≥ 0.05 mJy

SKA2: Weak lensing of 10 billion galaxies to z~10

Galaxy Evolution from Continuum



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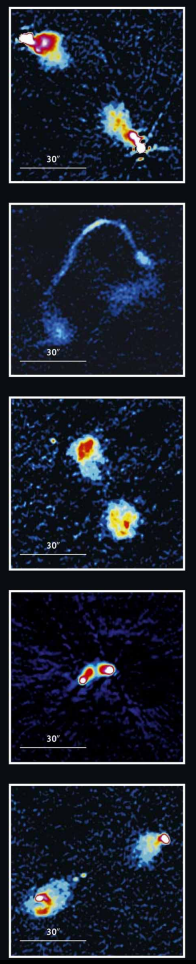


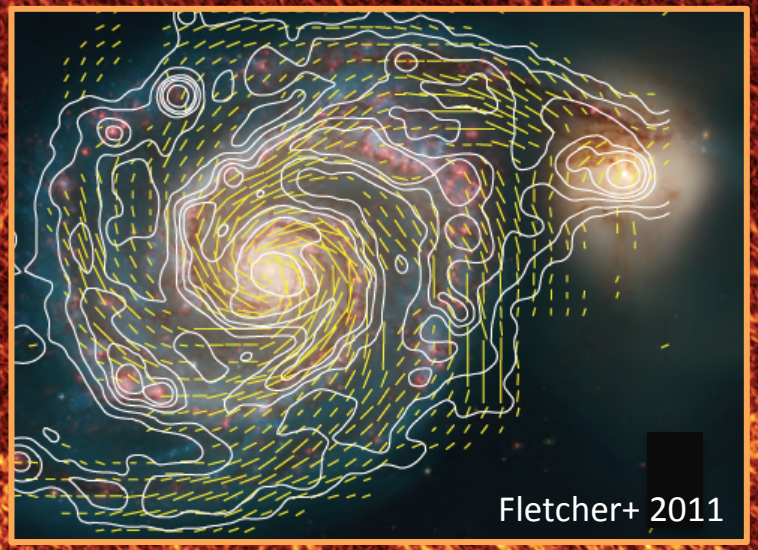
Precursors: AGN and star forming gals, all-sky, S ≥ 0.05 mJy

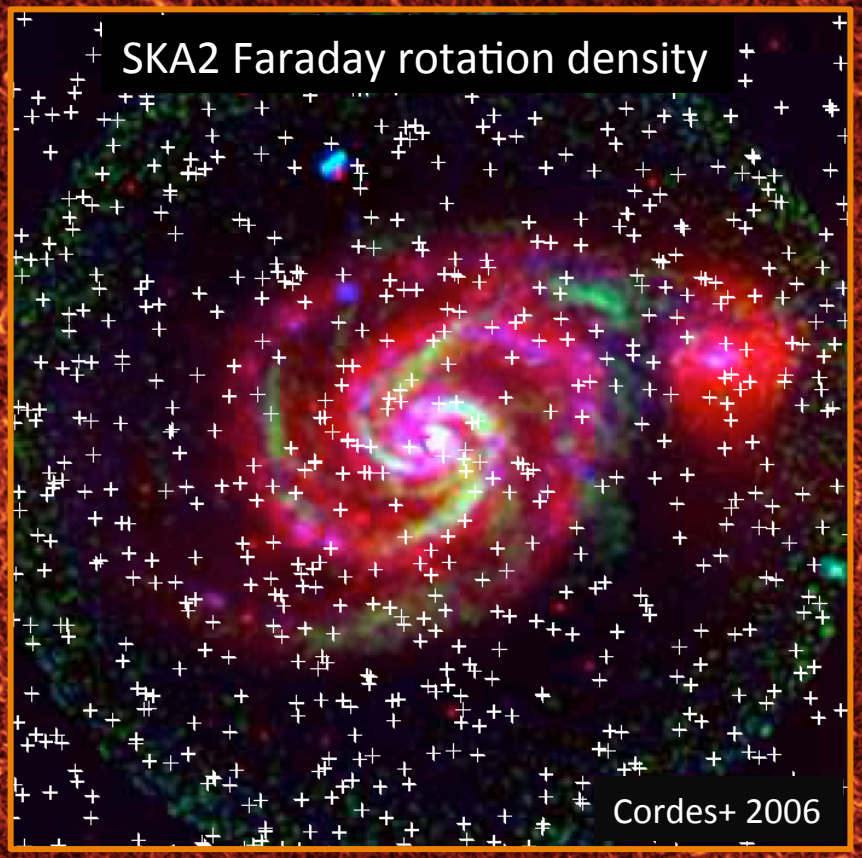
SKA1: Faint cluster and supernova radio halos

SKA2: Weak lensing of 10 billion galaxies to z~10

Cosmic Magnetism

Synchrotron emission:





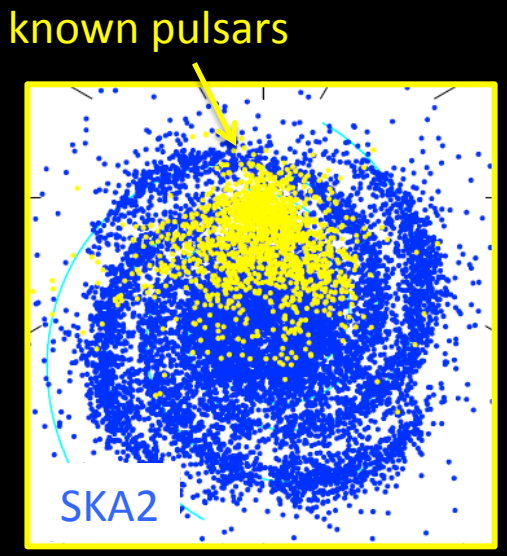
Gaensler+

Precursors: 3D view of the Galactic B-field

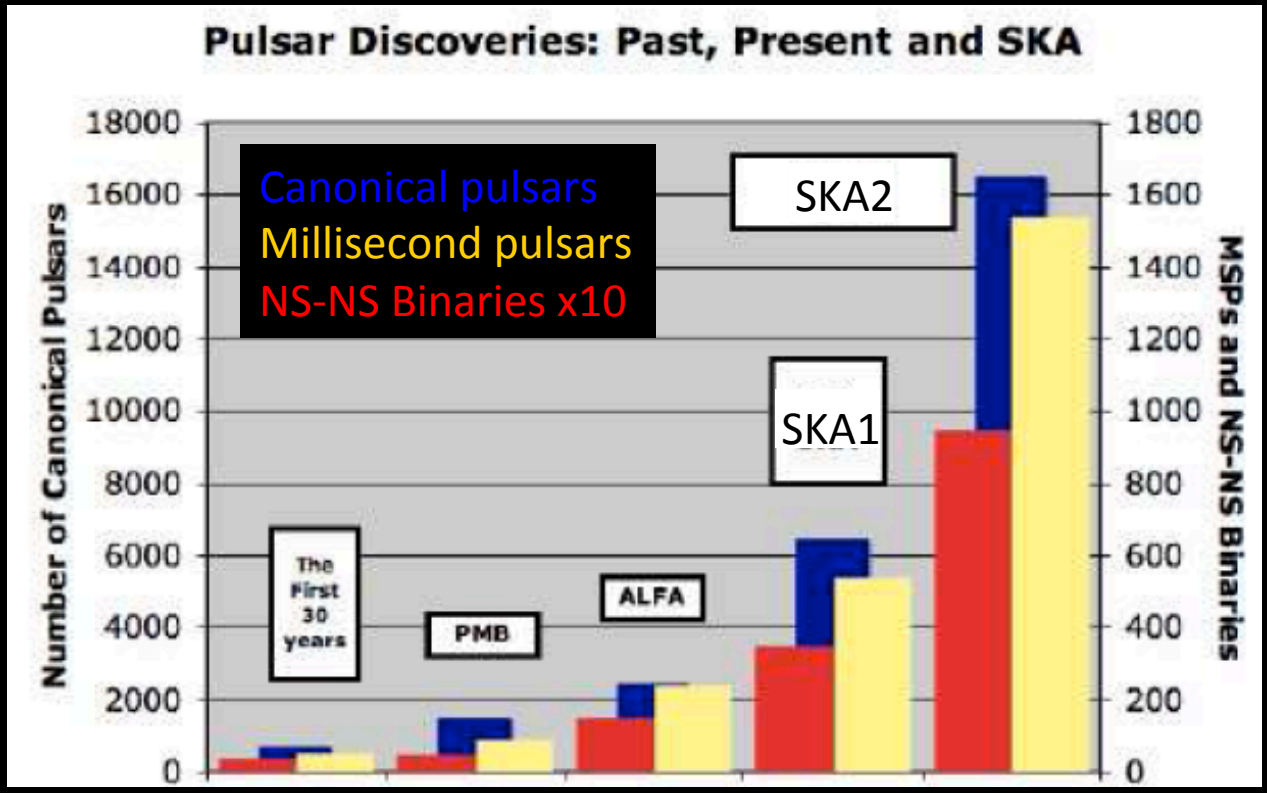
SKA1: Characterize galaxy/cluster B-fields for z<3

SKA2: Measure B-field power spectrum for z<5

Strong Field Gravity Tests with Pulsars



Cordes 2006



Precursors: LOFAR searches/MeerKAT timing

SKA1: Gravity tests with millisecond/binary pulsars

SKA2: Gravity tests with Sgr A* pulsars

Where will we be in 2025?

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The Dark Ages → Detected reionization, measured statistics

Galaxy Evolution → Measured HI $z \leq 3$, all-sky continuum $S > 50$ μJy

Cosmic Magnetism → Probed Galactic, galaxy and cluster B-fields $z \leq 3$

Strong-Field Gravity → Timed 300 pulsar binaries, explored nHz gravity waves