Synergy SKA - CTA

Supernova remnants as cosmic accelerators

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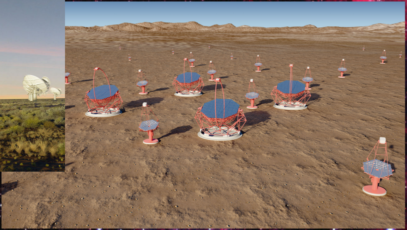


Radio supernova remnants

Radio facts:

- about 300 Galactic SNRs known
- about 50% of Galactic SNRs observed **only** in radio
- tracing the synchrotron emission from relativistic electrons

A unique tool to:

- locate the potential particle **acceleration sites**
- probe the **local plasma conditions**

SNRs: a link between radio and high energies

Radio morphology:

- infer the age of the remnant

Radio spectral index map:

- reveal different plasma populations
- interaction with molecular clouds
  >>> tracing particle acceleration sites
- reveal the presence of a PWN
  >>> TeV emission

SNRs: a link between radio and high energies

Polarimetry:

- intensity and direction of magnetic field
- magnetic field degree of disorder

  >>> plasma turbulence as acceleration engine
- thermal/non-thermal emission mixing
- density and thickness of plasma

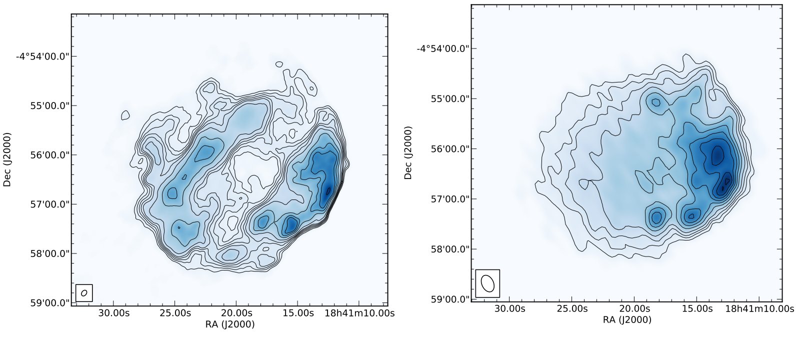
OH masers:

- 1720-MHz transition in shocked medium

  >>> tracing particle acceleration sites

Case study: SNR G027.4+00.0

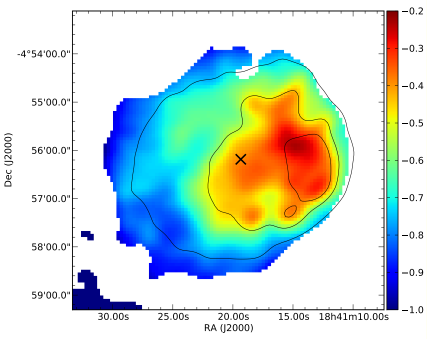
VLA+GBT maps at 1.4 GHz and 5 GHz



Ingallinera et al. 2014b

Case study: SNR G027.4+00.0

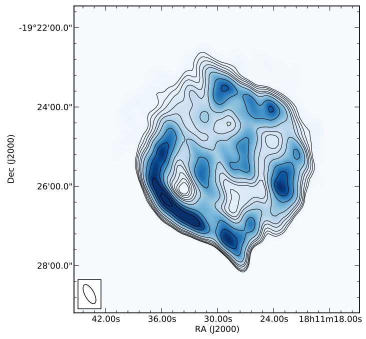
Spectral index map



Ingallinera et al. 2014b

Case study: SNR G011.2-00.3

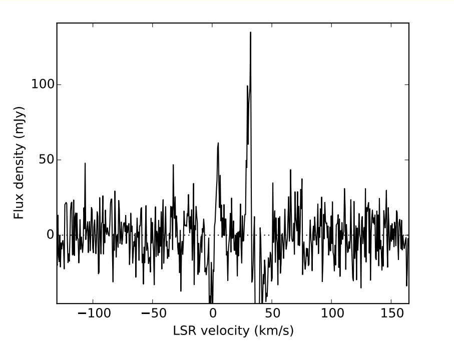
VLA+GBT map at 5 GHz



Ingallinera et al. 2014b

Case study: SNR G011.2-00.3

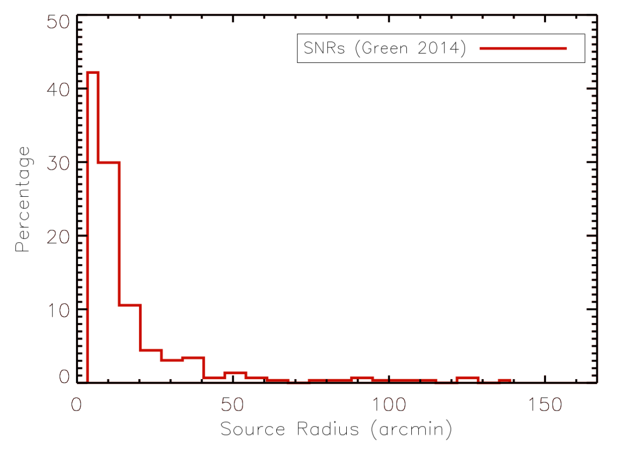
OH maser detection at 1720 MHz



Ingallinera et al. 2015

Studying compact SNRs

Many known Galactic SNRs have a radius $\lesssim 5'$



The Square Kilometre Array:

- three different arrays: LOW, MID and SURVEY
- frequency coverage: 50 MHz to 14 GHz (30 GHz?)
- angular resolution: 20″ to 0.05″ (0.5″ to 0.001″ in phase 2)
- sensitivity (1 h): 5 to 1 µJy/beam (50 to 10 nJy/beam)

SKA-MID (Credits: Wikimedia Commons)

The SKA and its precursors

Construction phases

- SKA-1: 2018? – 2022?
- SKA-2: 2023? – 2030?

Dense Aperture Array *(Credits: flickr.com)*

The SKA precursors:

- addressing scientific and technological challenges of the SKA
- testing innovating elements (e.g. PAF) and huge data sets processing
- MWA, MeerKAT, **ASKAP**

ASKAP *(Credits: Wikimedia Commons)*

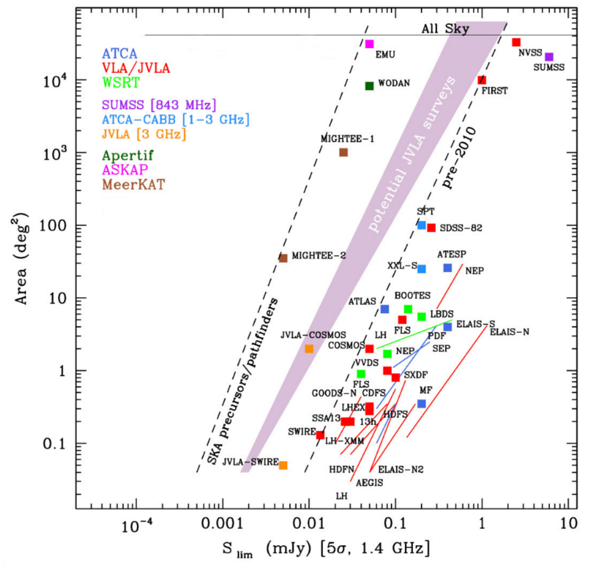
The Evolutionary Map of the Universe (Norris et al. 2011)

EMU is a wide-field survey to be carried out with ASKAP

Overview:

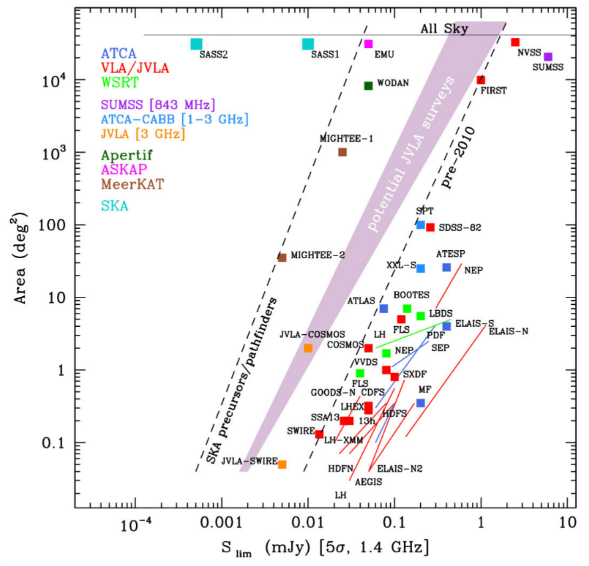
- observations starting in late 2017
- all-sky up to $\delta = +30^\circ$
- frequency coverage: 1130 - 1430 MHz
- resolution: $\sim 10''$
- sensitivity: ~ 10 µJy/beam
- about 75% of the Galactic plane will be covered

The Evolutionary Map of the Universe (Norris et al. 2011)



Norris et al. 2015

The Evolutionary Map of the Universe (Norris et al. 2011)



Norris et al. 2015

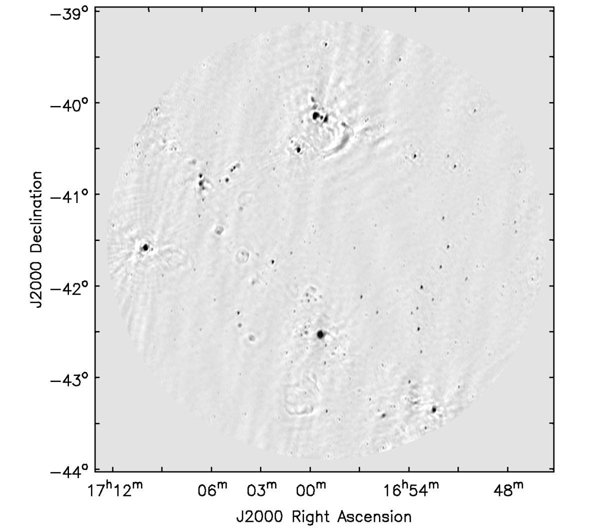
The Evolutionary Map of the Universe (Norris et al. 2011)

Galactic science with EMU:

- a complete census of the early stages of massive star formation in the Southern Galactic plane
- great discovery potential for missing SNRs
- detection of young SNRs
- detection of evolved stars (among which, SN progenitors)
- radio stars and pulsars

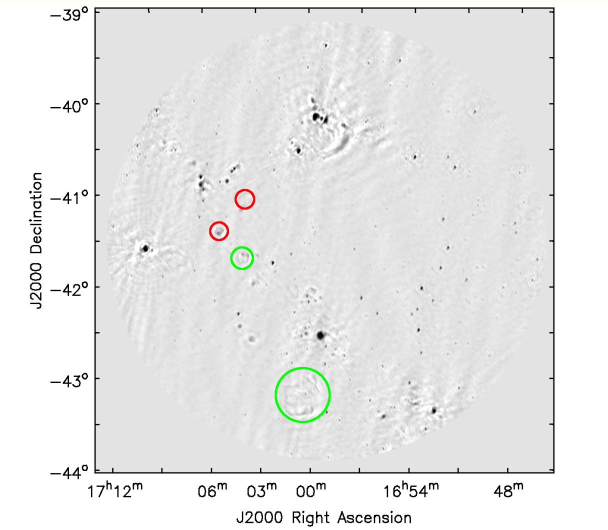
SKA precursors need themselves pathfinders!

ASKAP first "light" of the Galactic plane



(Credits: Josh Marvil)

ASKAP first "light" of the Galactic plane



(Credits: Josh Marvil)

The SCORPIO project

Overview (Umana et al. 2015):

- $2^\circ \times 2^\circ$ survey toward the Galactic plane
- instruments: ATCA + Parkes + ASKAP-beta + ASKAP-12
- frequency range: 1.4 - 3.1 GHz
- sensitivity: $\sim$0.1 mJy/beam – resolution: $\sim 10''$
- more than 2000 point sources
- more than 40 Galactic bubbles (H II reg., evolved stars)
- **one known SNR, two candidates** (likely more)

Other related papers:

- source extraction: Riggi et al. 2016
- spectral index study: Cavallaro et al. *submitted*
- extended sources: Ingallinera et al. *in prep.*

Searching for young SNRs

Young SNRs in SCORPIO and EMU:

- we expect $\sim$1 SNR younger than $\sim$50 yr in 25 deg^2
- for SNRs younger than $\sim$50 yr we expect a flux density $\sim$1 Jy (Bufano et al. 2014)

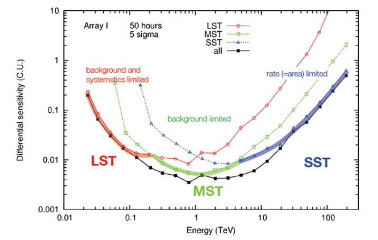
and how to recognize them:

- checking if the SN would have been detected in the optical (taking into account the visual extinction)
- distinguishing from extra-galactic sources:

  >>> long-term flux density stability

  >>> different appearance when observed at high-resolution

Implications on CTA science



Bernlöhr et al. 2013

CTA facts:

- operational in 2024
- energy coverage: 0.02 to 300 TeV

How can SKA help CTA?

- SKA-MID can resolve filamentary structures and reduce depolarization
- SKA-LOW, tracing GeV emission, can distinguish between hadronic and leptonic origin of γ-ray emission from Galactic objects