The ASKAP project

and its contribution to Galactic Radioastronomy

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ASKAP as SKA precursor

definition: a facility on one on the two SKA candidates sites carrying out SKA-related activity

Since May 25, 2012:

Australia-New Zeland will host low frequency apertures (SKA1+SKA2)

60 SKA dishes will be added to ASKAP, expanding this unique survey facility

Location


Murchison Radio-Astronomy Observatory (MRO)
S26° 42′ 15″, E116° 39′ 32″
CSIRO

Location


Radio Quiet Zone
Shire of Murchison
Population density: 0.002 km-2

“Locals”

Design goals:

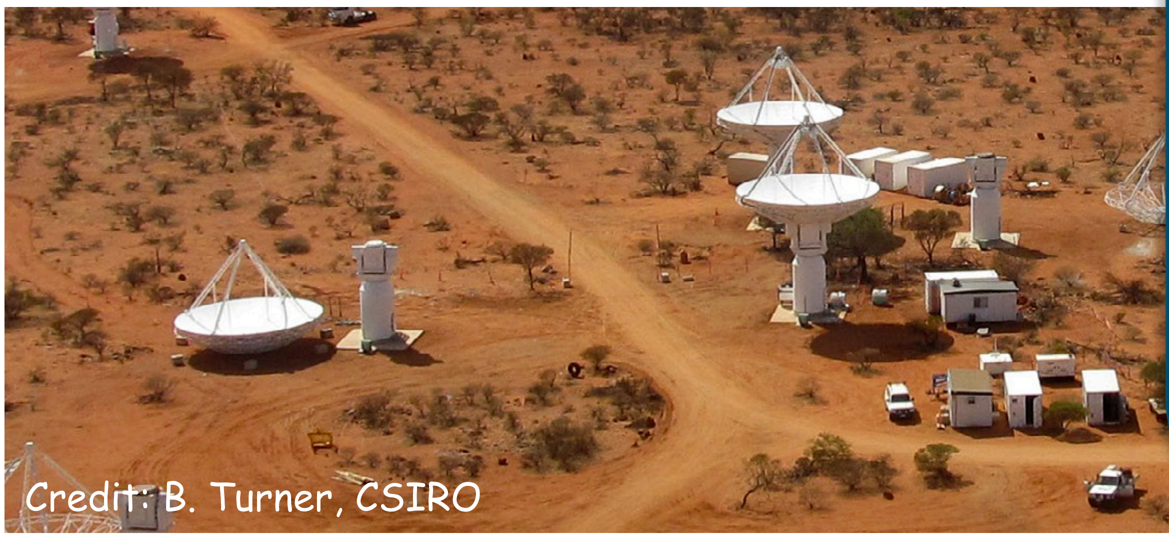
High-dynamical range imaging

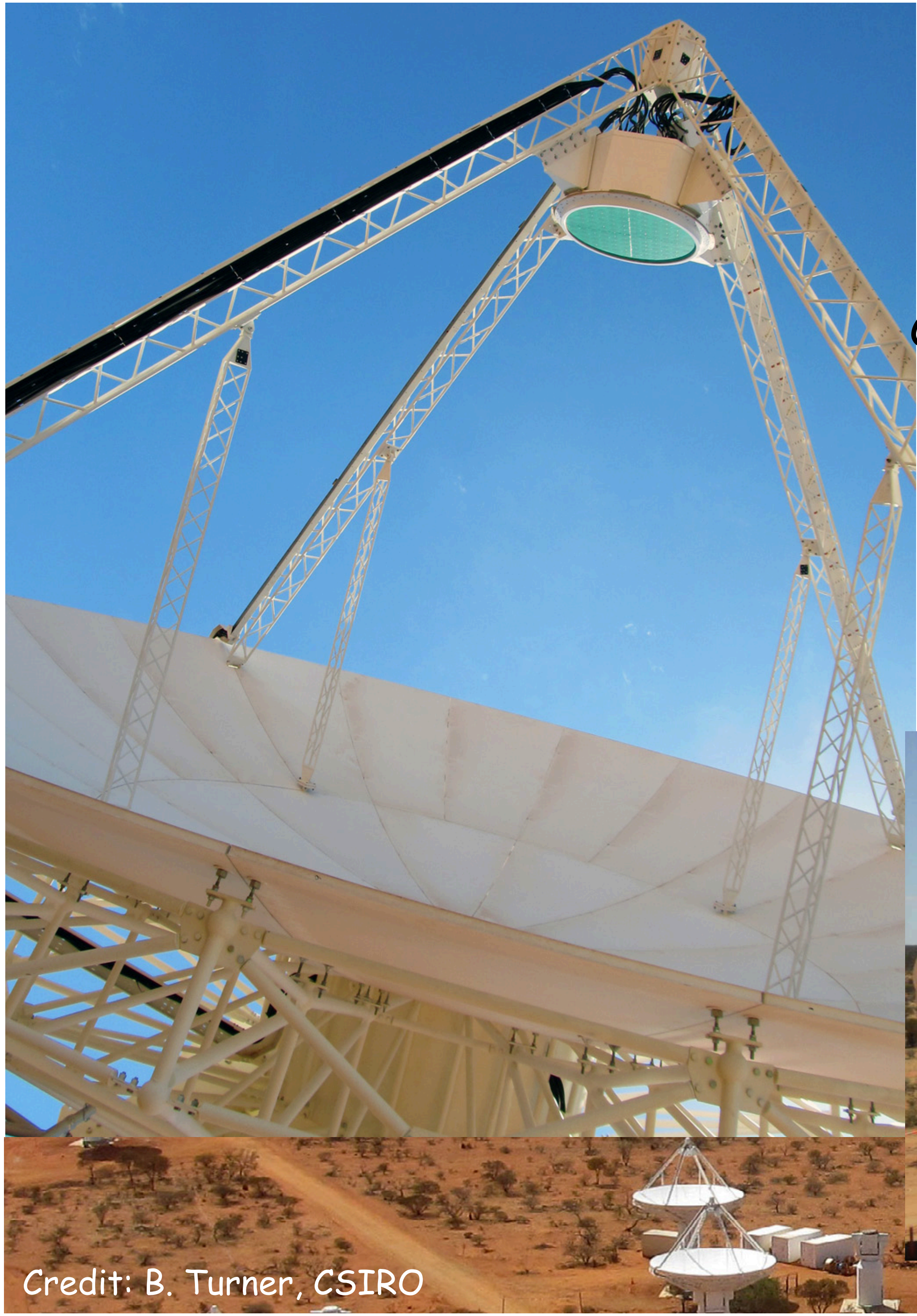
Wide field of view science

SURVEYS

Design specifications

Number of dishes	36
Dish diameter	12m
Maximum baseline	6 km
Resolution	30″
Sensitivity (300 MHz, 1 hr, 10″)	37 μJy/bm
Survey speed (300 MHz, 100 μJy)	220 deg^2/hr
Observing freq.	700-1800 MHz
Field of view	30 deg^2
Bandwidth	300 MHz
Spectral channels	16384
Focal Plane Phased Array	188





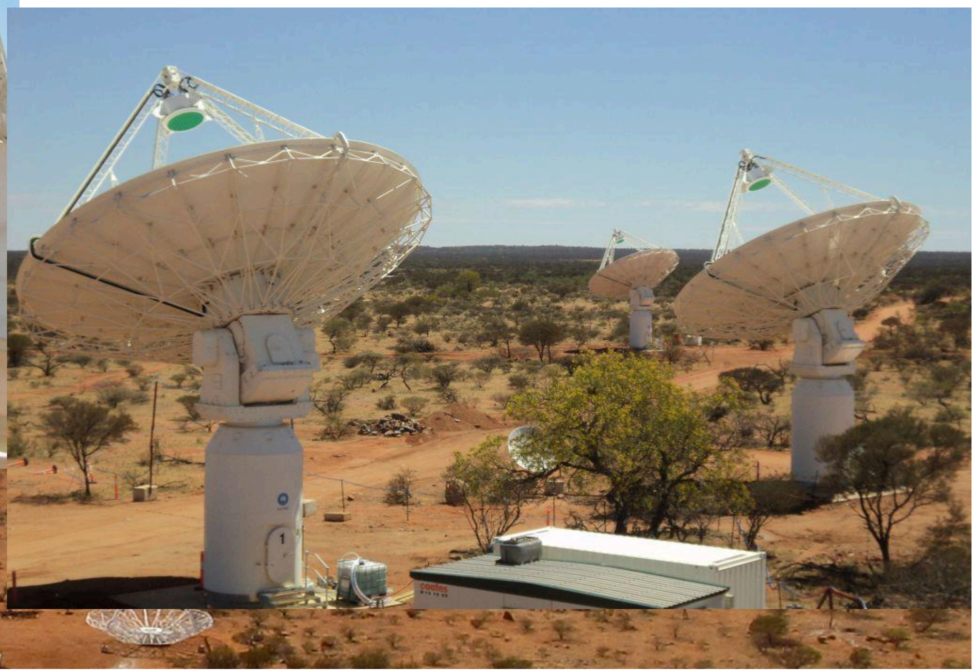
188-pixel phased array feed (PAF)

Combined in 36 beams FOV 30 deg^2

Single-pixel feed FOV 1.2 deg^2

1.4 GHz

RADIO CAMERA

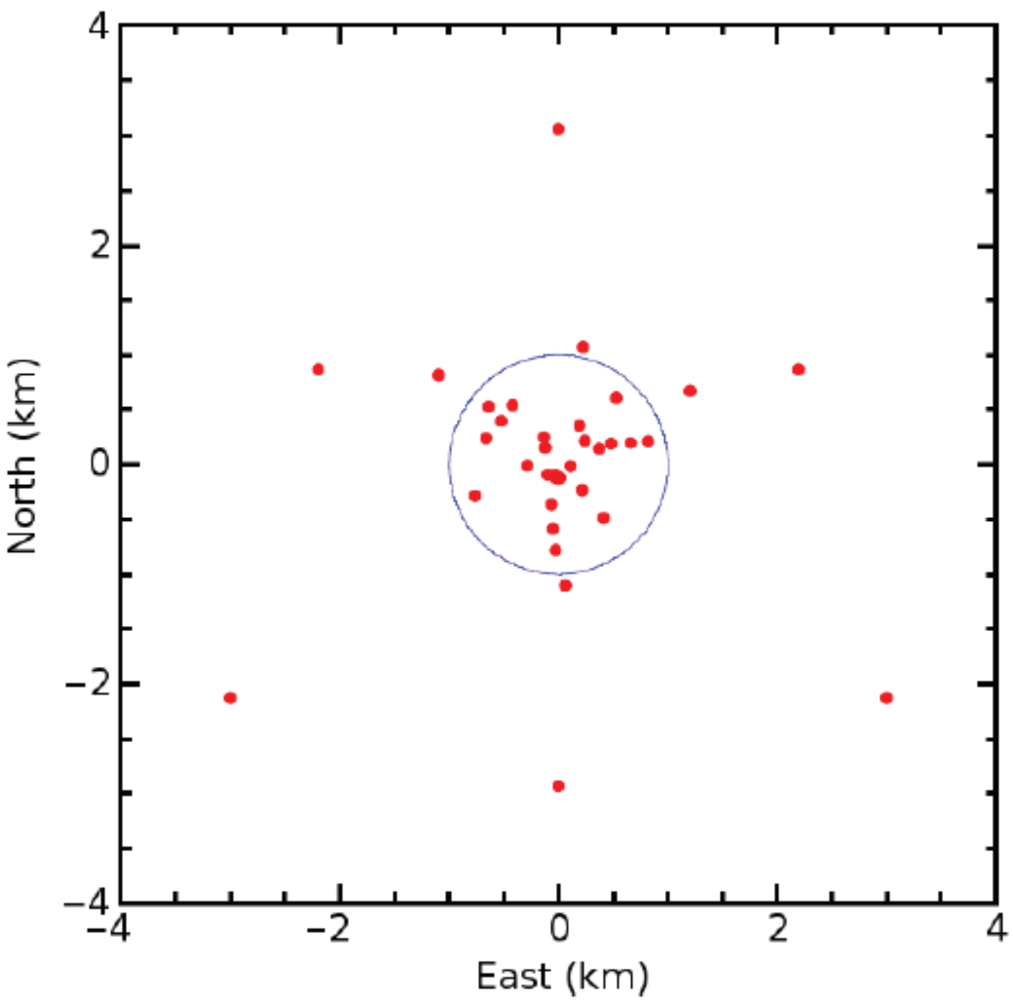


ASKAP current status (Askap Update www.atnf.csiro.au/project/askap)

- Construction well-advanced (36 antennas on site)
- 6 antenna sub-array being equipped with phased-array feeds (Beta Array)
    - Phase 1- engineering commissioning (started)
    - Phase 2- Science commissioning Team
    - Phase 3- Working together with surveys teams

- ASKAP complete by end 2013
- Early science in Q1 2014

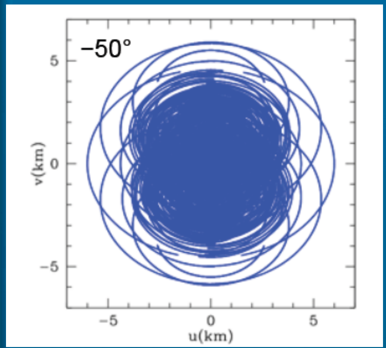
CONFIGURATION UV Coverage

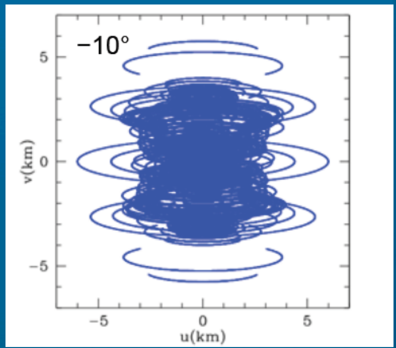


2-km core with 30 antennas

Spectral line: only inner dishes
Res (1.4 GHz): 30″

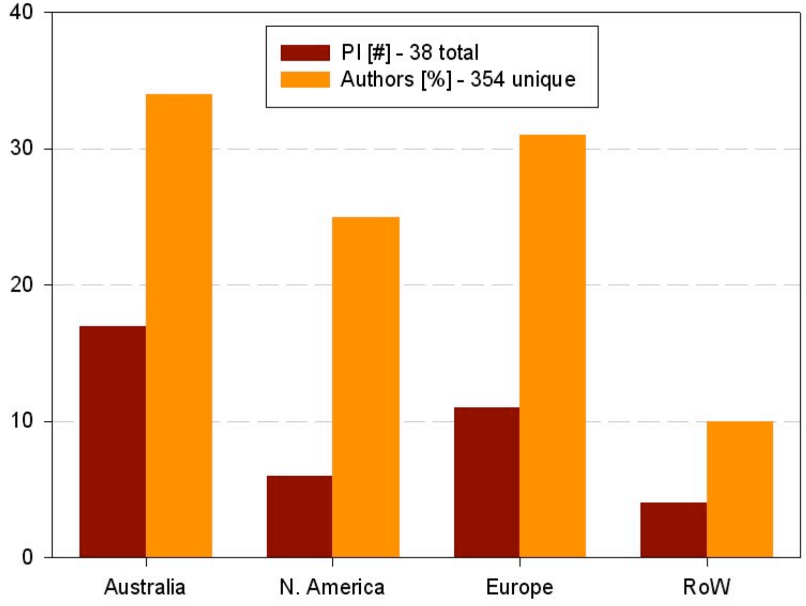
6 antennas further out (6 km)
Highest resolution 10″





Call for expression of Interest (2008-2009)

38 proposals -354 co-authors



ASKAP Project Selection Process

2 selected as highest priority:

EMU: **E**volutionary **M**ap of the **U**niverse
Continuum survey of the sky
PI: R. Norris

Wallaby: **W**ide-field **A**SKAP **L**-band **L**egacy **A**ll-sky **B**lind surve**Y**
Neutral Hydrogen survey of the sky
PI Bärbel Koribalski & Lister Staveley-Smith

ASKAP-FLASH: The First Large Absorption Survey in H I (Sadler)

DINGO: Deep Investigations of Neutral Gas Origins (Meyer)

GASKAP: The Galactic ASKAP Spectral Line Survey (Dickey)

VAST: An ASKAP Survey for Variables and Slow Transients (Murphy and Chatterrjee)

CRAFT: Commensal Real-time ASKAP FastTransients survey (Dodson and Macquart)

POSSUM: Polarization Sky Survey of the Universe's Magnetism (Gaensler, Taylor and Landecker)

COAST: Compact Objects with ASKAP: Surveys and Timing (Stairs)

VLBI (**Tingay**)

Deep radio image of 75% of the sky (to declination +30°)

Will detect and image ~70 million galaxies at 20cm

Primary science goal: **How did galaxies form and evolve?**

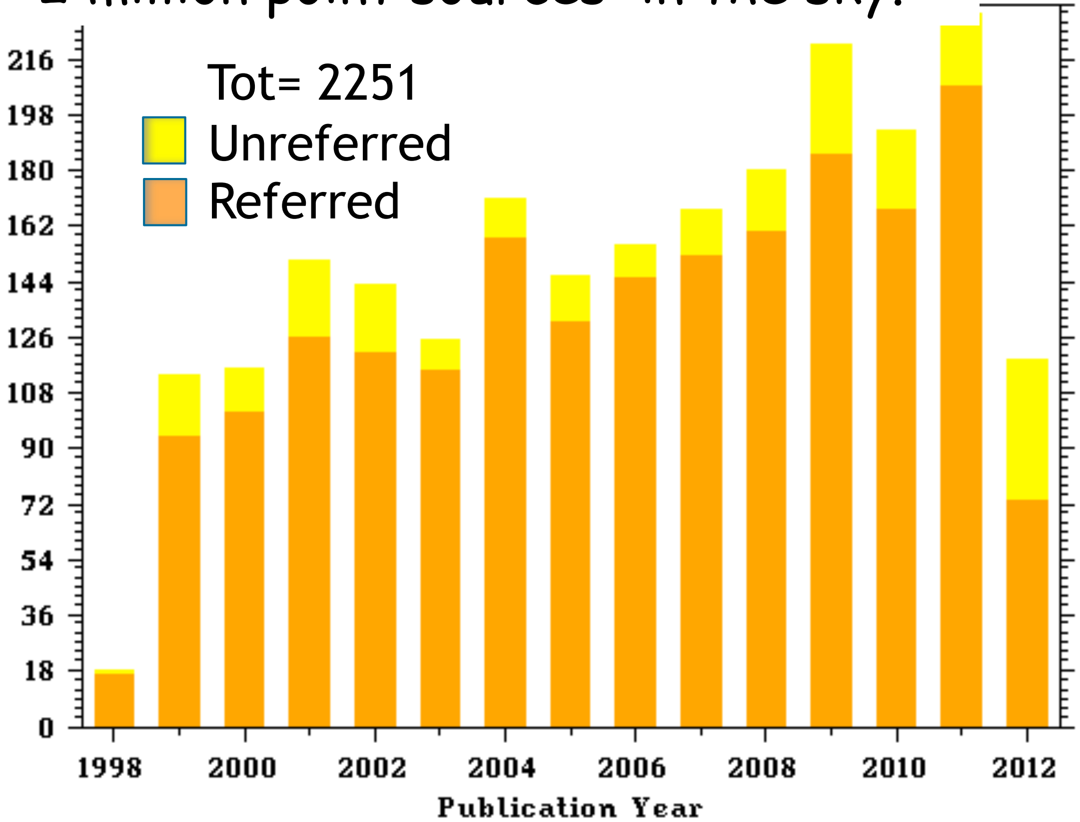
All data to be processed in pipeline
Images, catalogues, cross-IDs, to be placed in public domain
Survey starts early 2014

The Legacy Value of EMU

NVSS VLA

1.4 GHz, σ=0.45 mJy/beam
45" FWHM resolution

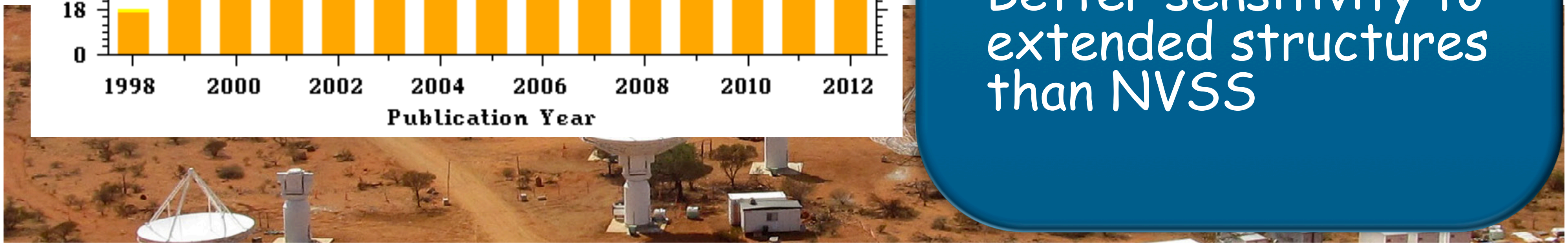
The NVSS survey catalogued over 2 million point sources in the sky.



40 x better sensitivity than NVSS (10 μJy rms across the sky)

5 x better resolution than NVSS (10 arcsec)

Better sensitivity to extended structures than NVSS



The impact of EMU on Galactic Science

EMU will include the Galactic Plane:
-provide a sensitive atlas of Galactic continuum emission
-much deeper and higher resolution than any other survey
(EMU, 30-50 μJy, 10 arcsec)

High angular resolution, limited areas:

- CORNISH (Purcell and Hoare, 2010) 6cm, 1-6 arcsec, ≈100 deg^2, few mJy
- MAGPIS (Helfand et al., 2006) 20/6cm " "

Lower angular resolution, wide areas:

- CGPS (Taylor et al., 2006), 20cm, arcmin, several 100 deg^2, few mJy
- SGPS (McClure-Griffiths et al., 2005) " "

The impact of EMU on Galactic Science

EMU results will address several science goals:

- A complete census of the early stage of massive stars formation in the SGP
- Giant HII and interaction with their environments: triggered star formation
- Detection of SNRs
- Detection of PNs
- Serendipitous discoveries

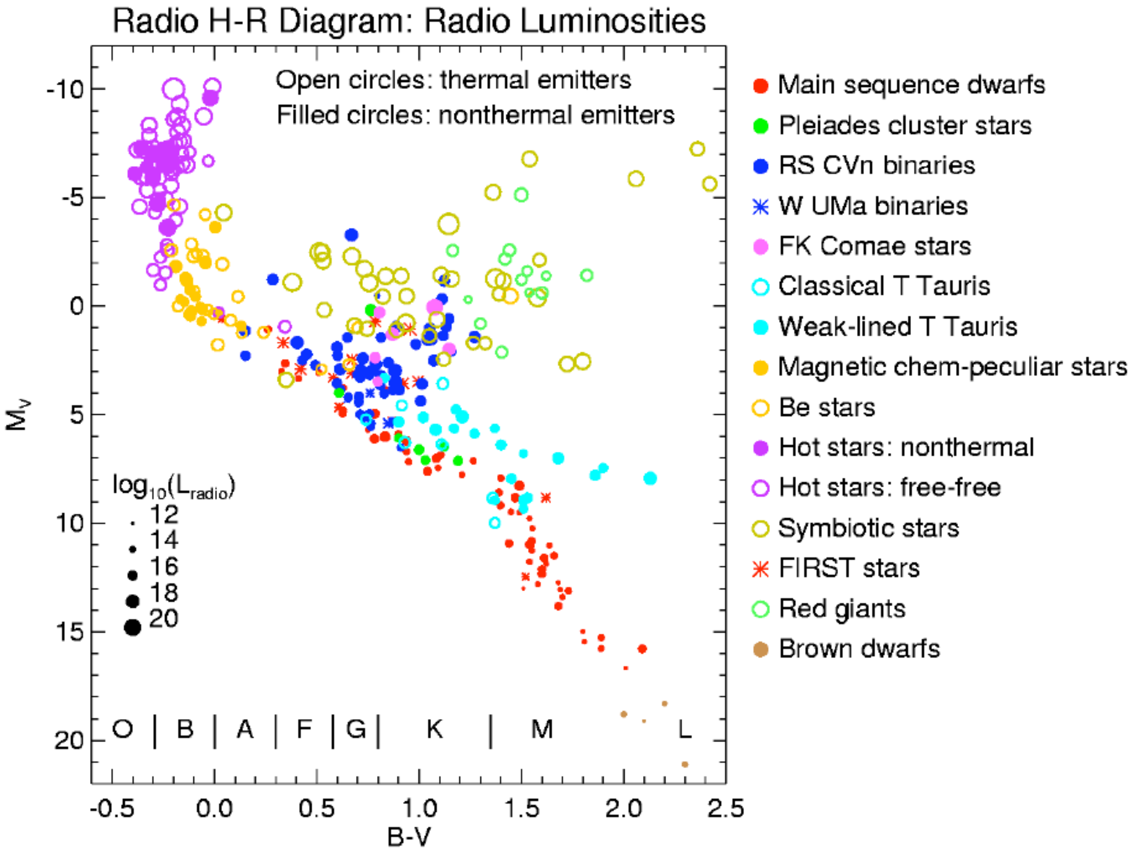
To derive accurate space density and rate formation need for robust identification

Particularly important for synergy

the MIPSGAL survey at 24 μm (Carey et al., 2009)
and the HI-GAL survey at 70+ μm (Molinari et al., 2010)

Stellar radio emission

HR diagram for the 420 radio detected stars
(Gudel, 2002)



L_{radio} a tiny fraction of L
Quiet Sun emits only 10^{-12} of its L_{bol}

Radio probes astrophysical phenomena non detectable by other means:

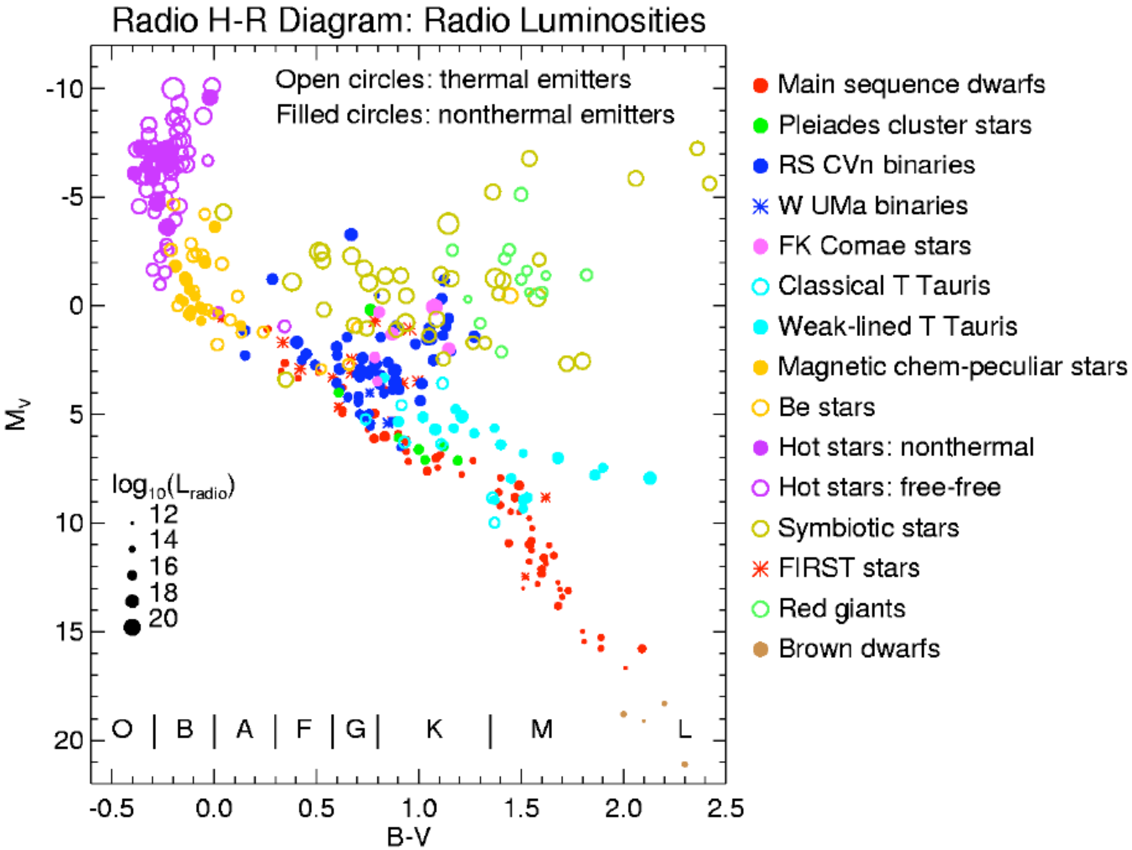
- B and its topology in flares stars, RS CVn
- HII region in dust enshrouded sources
- Winds-winds interactions….

Important for:

Stellar evolution
Physical processes in a wider context

Stellar radio emission

HR diagram for the 420 radio detected stars
(Gudel, 2002)



The brightest stellar radio emission associated with:

-Large mass-loss (*large emitting surface*): free-free from stellar winds (OB, WR)

$S_\nu \approx \nu^\alpha$ $\alpha = 0.6-2$

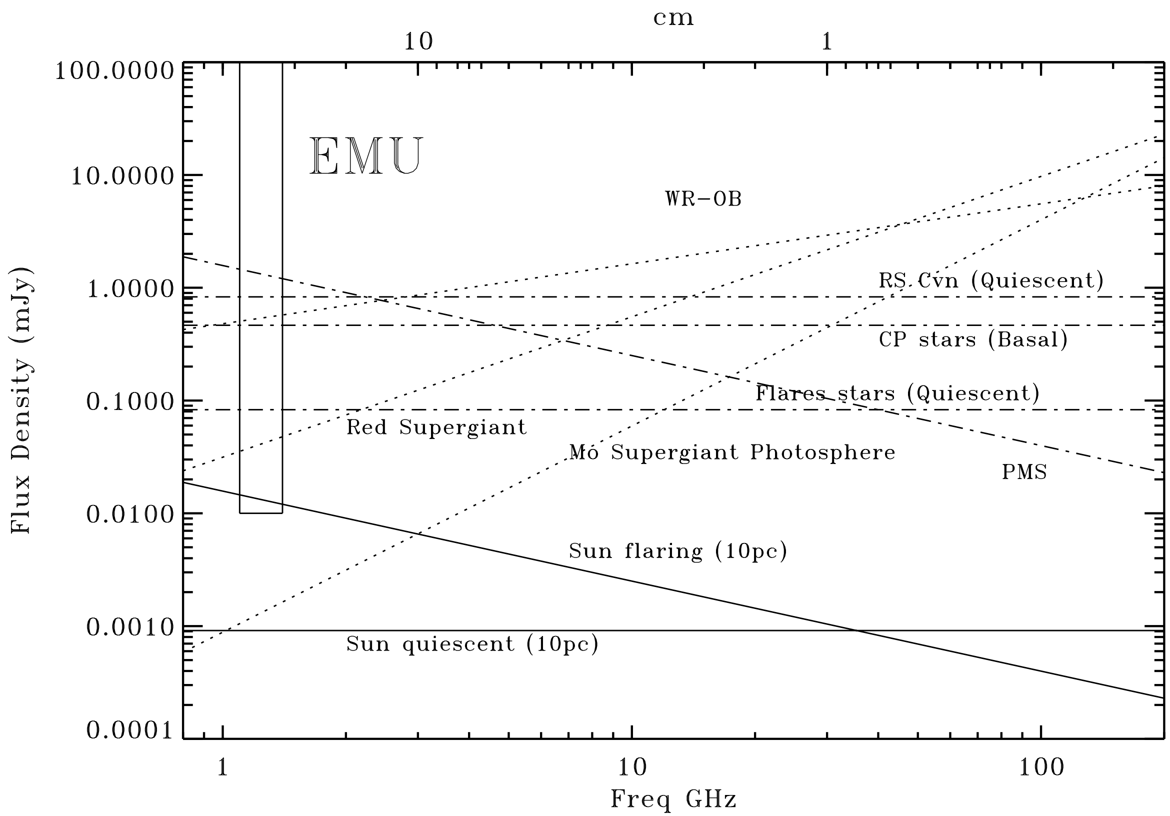
-Solar-type, non-thermal phenomena (*high T_B*): gyrosynchrotron, related to a strong and (often) variable Magnetic field

α=flat or negative

EMU detection forecast

…from what we have so far

-Stellar winds OB, WR
-Non-therm RS, flare stars, PMS
-Flares from a Sun-twin at 10pc



The actual knowledge of stellar radio emission suffers of:

- ***Limited sensitivity:*** no radio stars with L_{radio} of the quiescent Sun ($L_{6cm} \approx 10^{11}$ erg/sec Hz) detected yet.

- ***Selection bias:*** Based on targeted observations aimed at addressing a specific astrophysical problem…

Surveys?
NVSS, too shallow and low res. for stellar work
FIRST, ATLAS,…designed for extragalactic➔
High Galactic Latitude

Stellar radio emission in the SKA era: the SCORPIO project

2 x 2 deg^2 l=343, b=1.0

Grazia Umana INAF-OAC

C. Trigilio, R. Norris, T. Franzen, A. Ingallinera, C. Agliozzo
P. Leto, C. Buemi, E. Budding, B. Slee, G. Ramsay, G. Doyle, M. Thompson, J.C. Guirado,
S. Keller, J.D. Bunton, J. Lazio, F. Leone, G. Hallinan, M. Johnston-Hollit, G. Hobbs,
M. Mao

The SCORPIO project

Expected outcomes- Science

- Enlarge the stellar radio emitting population, with no selection bias

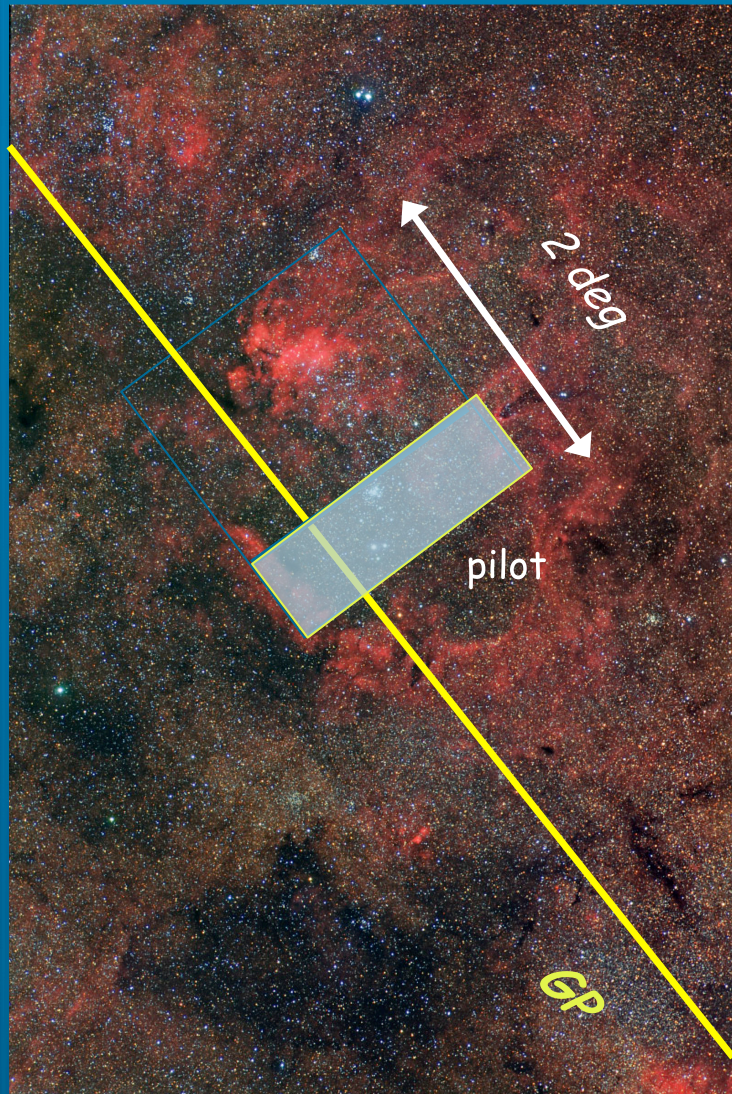
Expected outcomes- Planning the EMU project

- Dynamic range from sources complexity: issues related to complex, extended structure in the GP

- Dynamic range from source variability: issues related to the presence of variability in most of non-therm sources

- Source extractions: what is the most appropriate method for sources embedded in the diffuse emission in the Galactic Plane

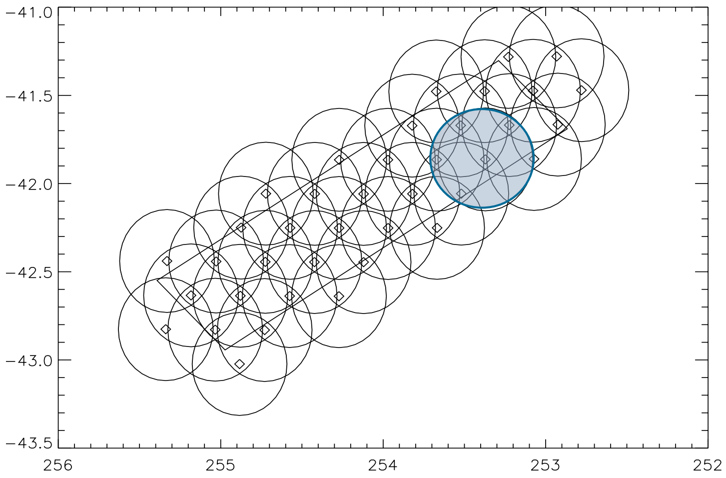
A deep radio survey with the ATCA (200 hrs)

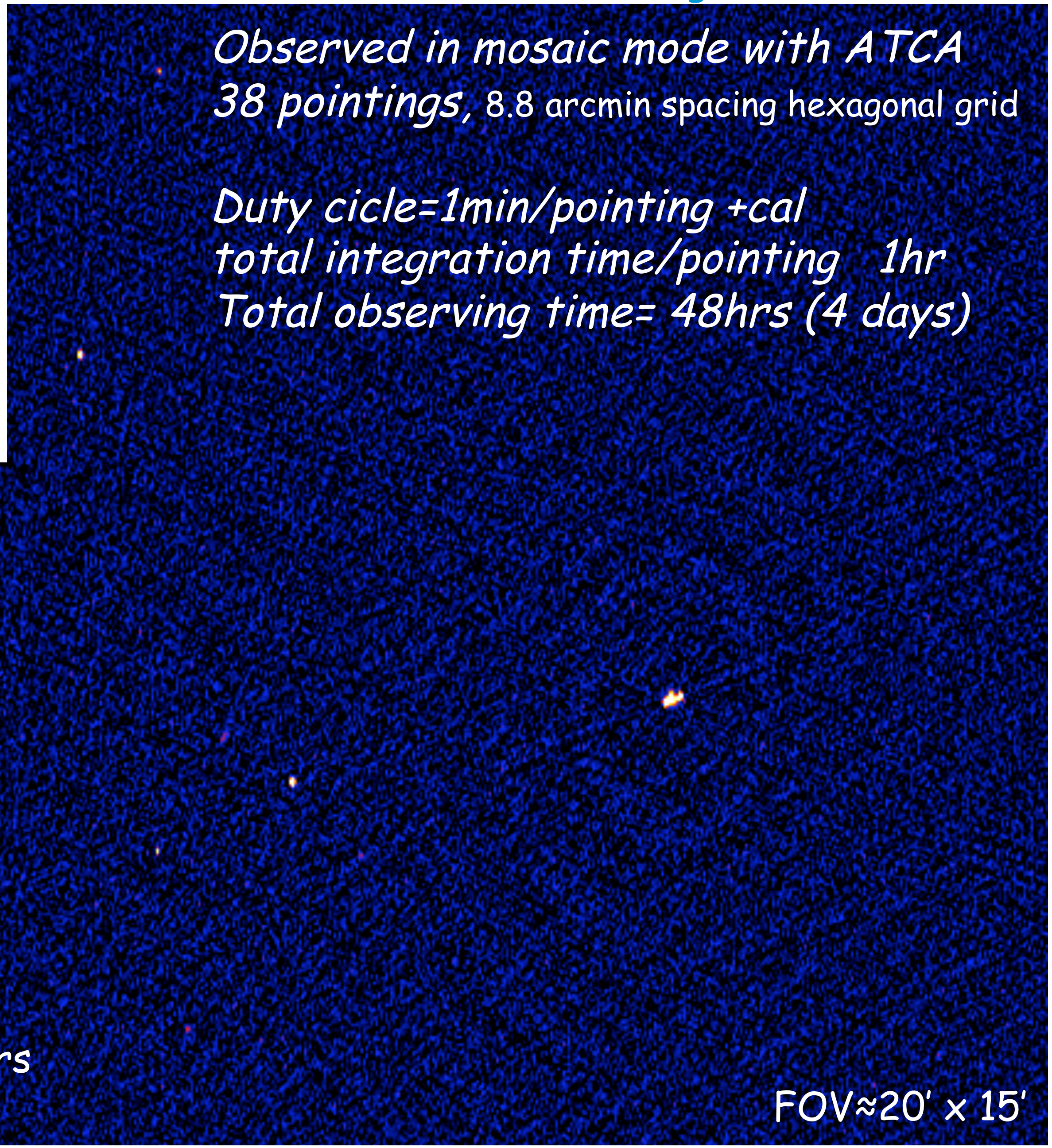


Observed in *MOSAIC* mode

SCORPIO: the pilot experiment

0.5 x 2 deg^{2},





Observed in mosaic mode with ATCA
38 pointings, 8.8 arcmin spacing hexagonal grid

Duty cicle=1min/pointing +cal
total integration time/pointing 1hr
Total observing time= 48hrs (4 days)

1 pointing, 300 MHz (2 GHz)
rms ≅90 μJy

-About 50 *islands* found by imsad (>5 rms)
-no matchs with NED
-5 matchs with SIMBAD (search radius 10”)

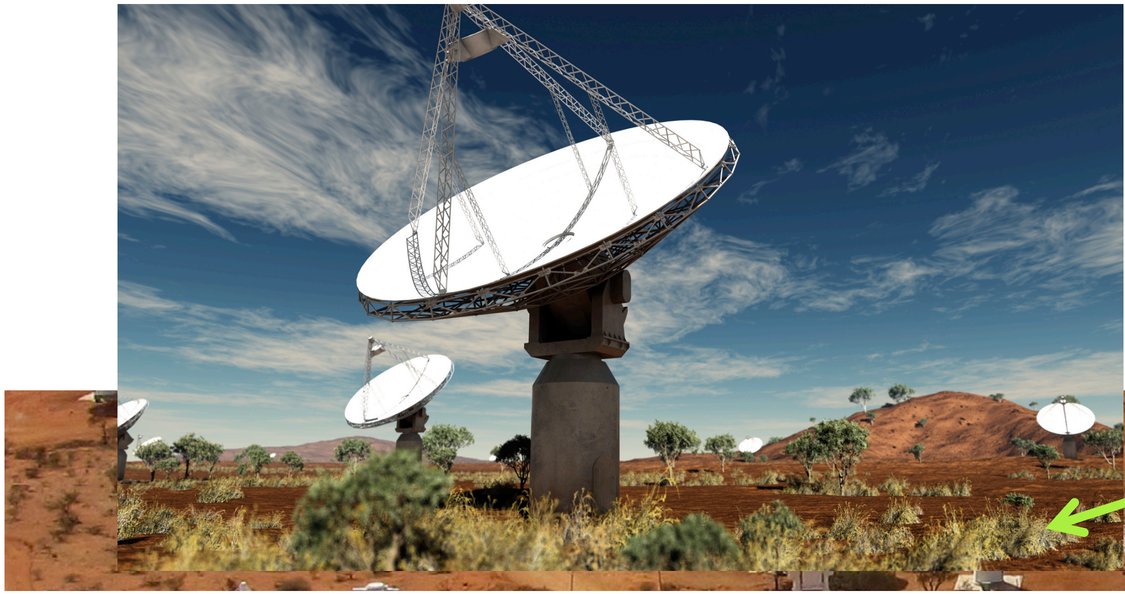
Evident side-lobes
Need checks for calibrations errors
And/or RFI effects left

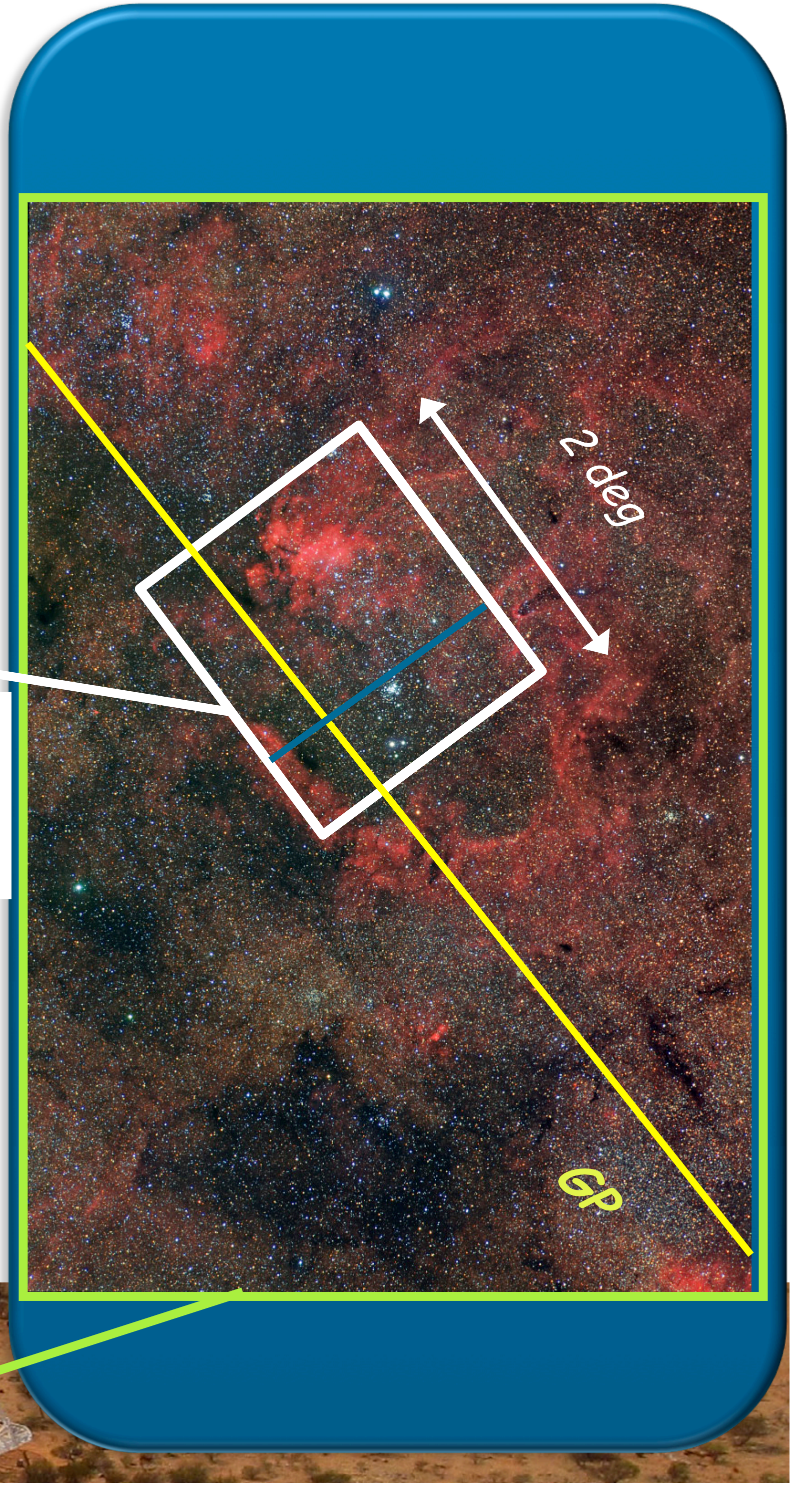
FOV≈20′ x 15′

The SCORPIO field

ATCA- 200 hrs (rms= 90 μJy)

ASKAP- 0.5 hr (1 pointing!)





Stellar coronae

- Gyro-synchrotron *VARIABLE*

  quiescent periods

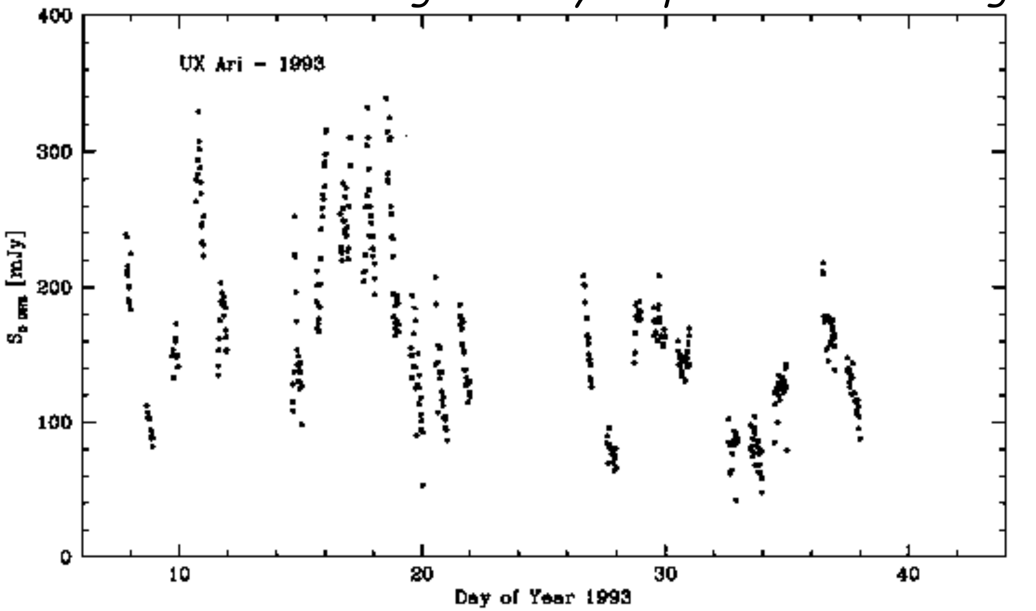
  -slowly varying flux density, up to several mJy

  active periods

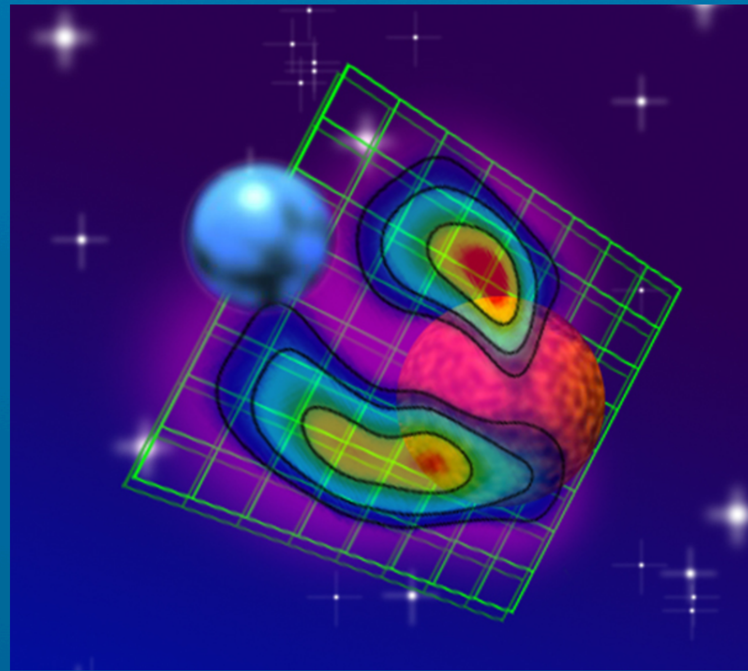
  -series of strong outburst, up to 1Jy

Active periods can last several months

Noto 6cm monitoring- 23 days/ up to 12 hrs coverage

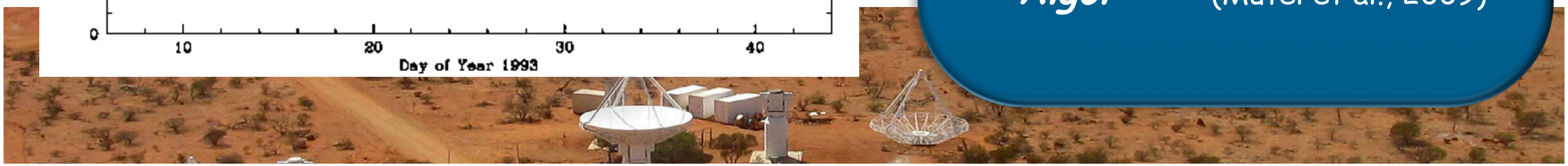


Radio emission related to solar-type magnetic activity



Sites: in large magnetic structures (loops); in binaries could be intersystem:

Algol (Mutel et al., 2009)



The impact of EMU on stellar coronae

The Solar-stellar connection

Discovery of serendipitous flaring activity

-typical behaviour (occurance rate..) from a statistical study of a larger source population.

Important synergy with VAST survey (Variables and Slow transients)

Detailed studies of a large number of stellar coronae

-understanding of energy release in upper atmospheres of stars with different age and mass.

-Study the correlation with the hot local plasma (x-ray)

Coherents events (usually observed in addition to gyrosynchrotron)

- Modelled as electron cyclotron maser emission (ECME)

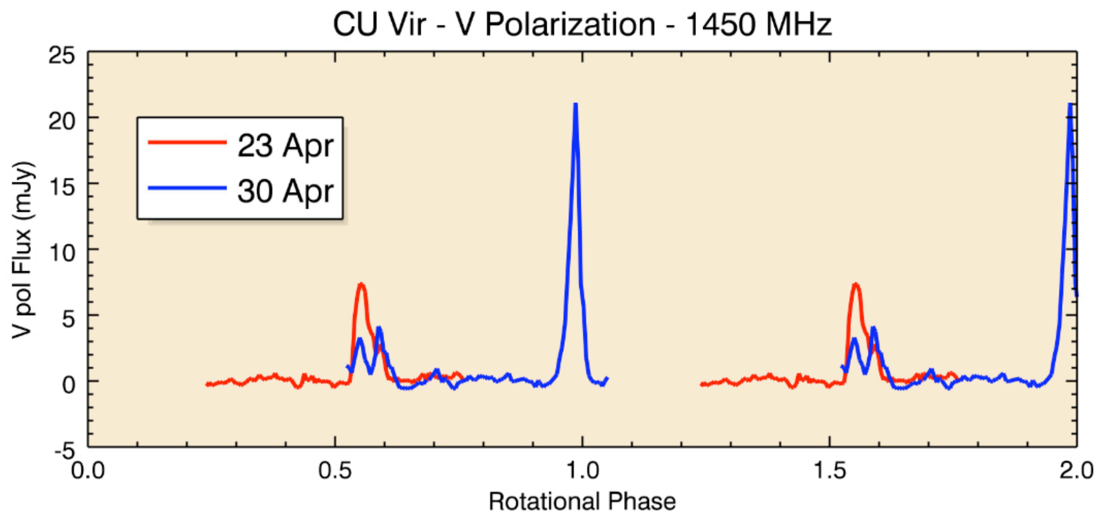
<u>Astrophysical environments</u>

common ingredient strong B and energetic particles

Active stars and stellar systems (Osten et al., 2004; Slee et al., 2008..)

Ultra Cool Dwarf (Hallinan et al., 2008)

CPs stars (Trigilio et al., 2000; Trigilio et al., 2008, 2011)



Polarization up to 100%
Frequency structure
Narrow bandwidth
Short duration (time)
Usually observed at low frequency

Trigilio et al., 2011

The impact of EMU on coherent events

Detection of coherent emission from a larger source population

-Implication for magnetic activity and dynamos studies

- Emission mechanisms

Detailed studies of stellar magnetospheres

-Modelling coherent radio emission from CP:

B, $N_{non\text{-}thermal}$ and spectral energy distribution

-If CE is stable (CU Vir): timing the star rotation

The impact of EMU on Galactic Science

This is just a starter....