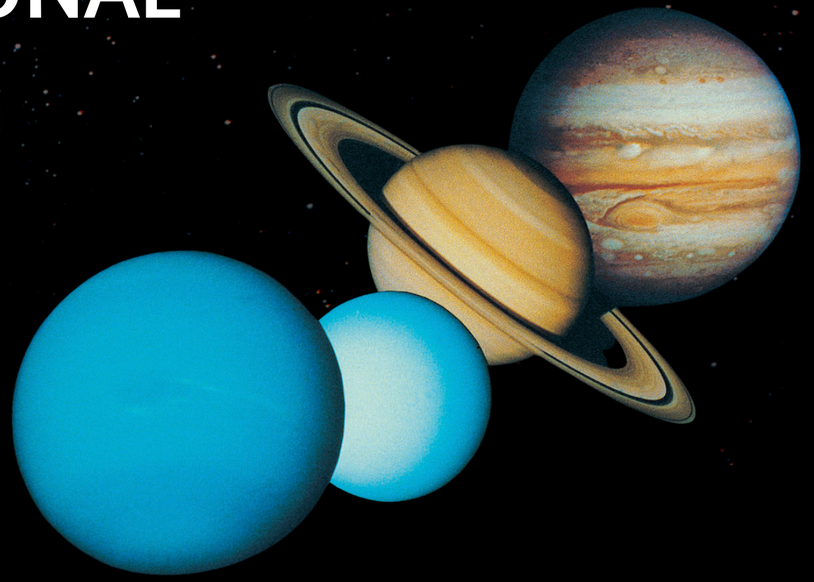
7th Institute of Space Sciences Summer School

Hands-on session

WHAT YOU NEED BEFORE SUBMITTING OBSERVATIONAL PROPOSALS (RADIO)

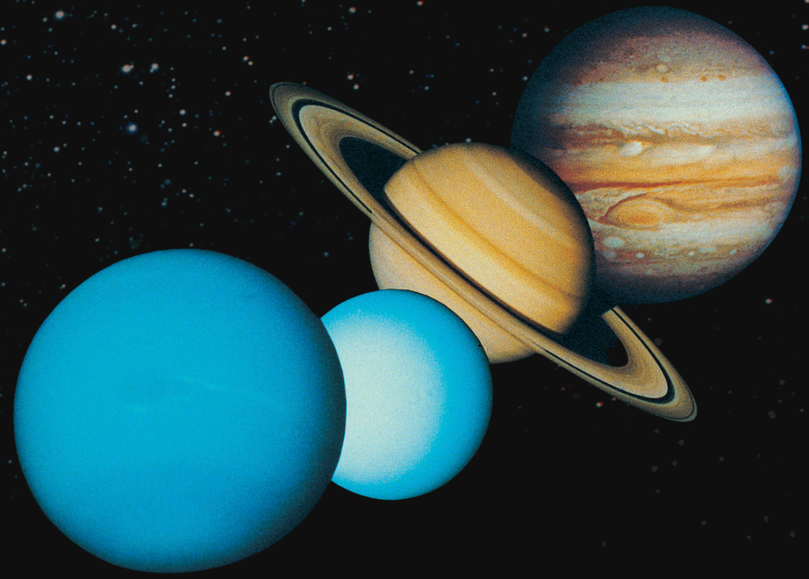
July 09, 2024



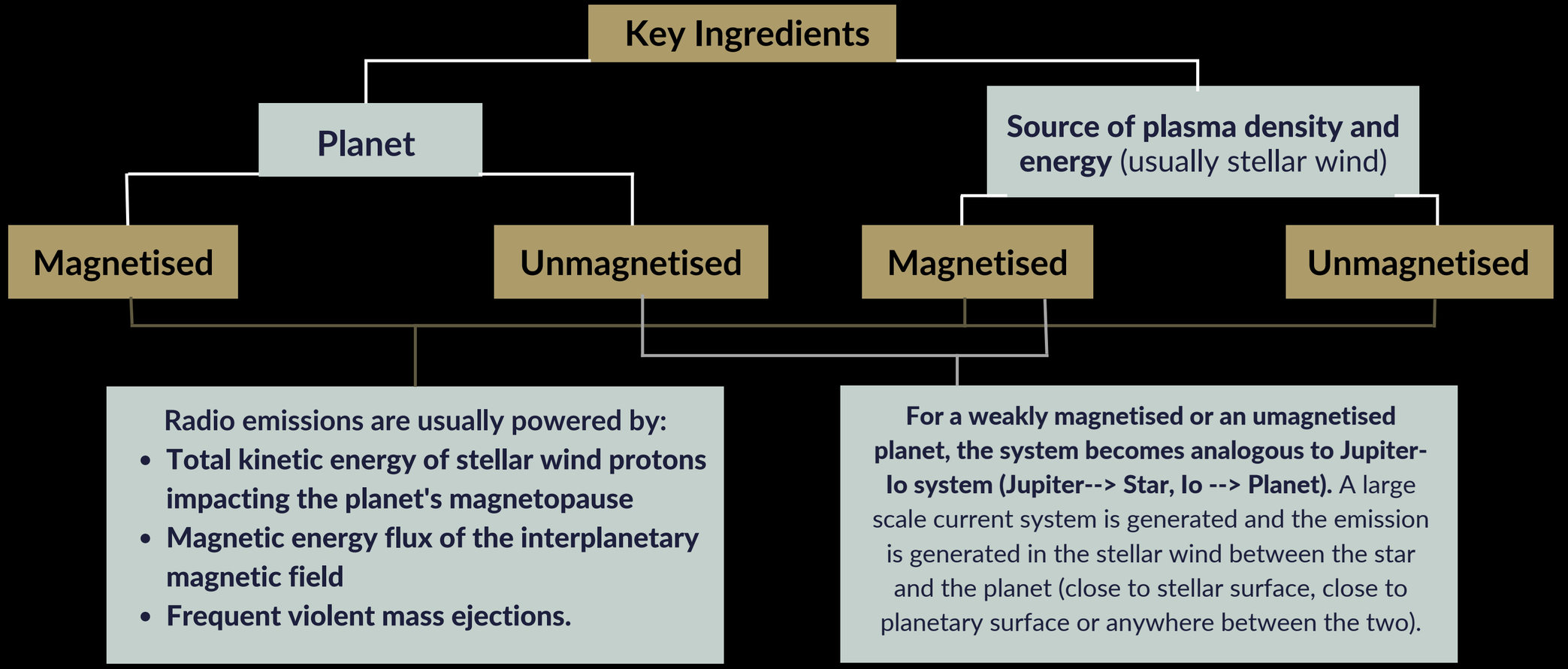
Simranpreet Kaur

KEY INGREDIENTS

- Picking out possible candidates for proposals
- Running flux calculations on these targets
- ETC (Exposure time calculators)
- Checking corresponding archival data (VLA, GMRT, other wavelenths)



POSSIBLE MECHANISMS FOR RADIO EMISSION



- In case of an interaction between an unmagnetised stellar wind and an unmagnetised planet, no intense radio emission is possible.
- Jupiter-Io like interaction is possible only if the planet lies in the star's Alfven region.
- In some cases, massive magnetised planets lying far away from their stars can also emit in a way similar to isolated brown dwarfs (plasma density provided by co-rotation breakdown of plasma or by an Io like satellite)

WHICH PLANET WOULD BE A GOOD CANDIDATE?

WHICH PLANET WOULD BE A GOOD CANDIDATE?

- HIGH MASS?
- SMALL SEPARATION FROM HOST STAR?
- FAST ROTATOR?
- CLOSE TO EARTH?
- YOUNG?

FLUX ESTIMATES

$$P_r \propto \dot{M}_*^{2/3} V_{\rm w}^{5/3} M_E^{2/3} A^{-4/3}$$

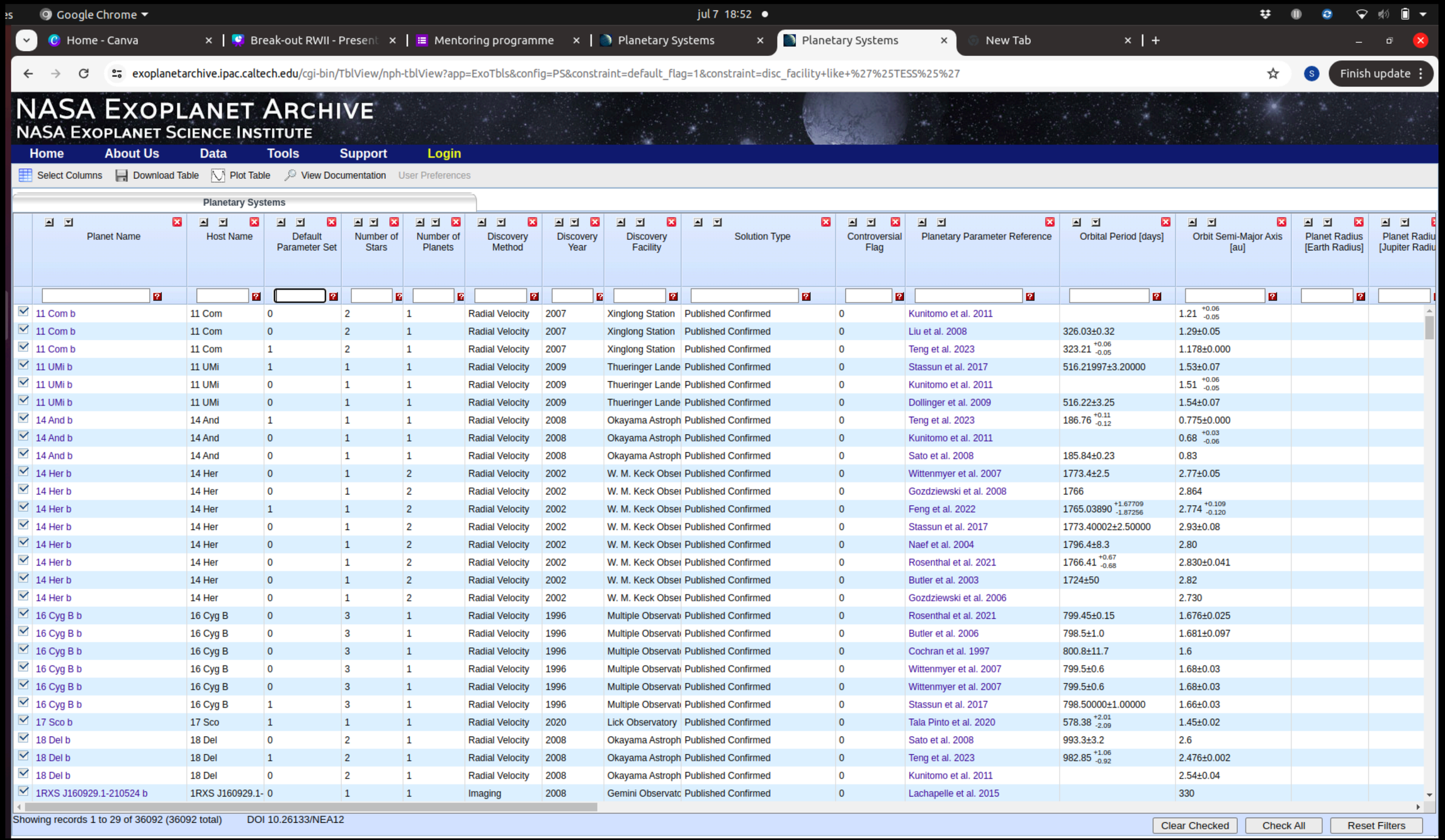
$$P_{\rm input,kin} \propto n v_{\rm eff}^3 R_{\rm s}^2$$

$$P_{\rm input,mag} \propto v_{\rm eff} B_\perp^2 R_{\rm s}^2$$

$$\Phi = \frac{P_{\rm radio}}{\Omega s^2 \Delta f} = \frac{4\pi^2 m_{\rm e} R_{\rm p}^3 P_{\rm radio}}{e\mu_0 \Omega s^2 \mathcal{M}}$$

$$f_{\rm c}^{\rm max} = \frac{eB_{\rm p}^{\rm max}}{2\pi m_{\rm e}} = \frac{e\mu_0 \mathcal{M}}{4\pi^2 m_{\rm e} R_{\rm p}^3} \approx 24\ {\rm MHz}\ \frac{\widetilde{\mathcal{M}}}{\widetilde{R_{\rm p}}^3}.$$

Grießmeier et al. 2007, Stevens 2005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11 UMi b 11 UMi 0 1 1 Radial Velocity 2009 Thueringer Lande Published Confirmed 0 Dollinger et al. 2009 516.22±3.25 1.54±0.07
14 And b 14 And 1 1 1 Radial Velocity 2008 Okayama Astroph Published Confirmed 0 Teng et al. 2023 186.76 +0.11 -0.12 0.775±0.000
14 And b 14 And 0 1 1 Radial Velocity 2008 Okayama Astroph Published Confirmed 0 Kunitomo et al. 2011 0.68 +0.03 -0.06
14 And b 14 And 0 1 1 Radial Velocity 2008 Okayama Astroph Published Confirmed 0 Sato et al. 2008 185.84±0.23 0.83
14 Her b 14 Her 0 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Wittenmyer et al. 2007 1773.4±2.5 2.77±0.05
14 Her b 14 Her 0 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Gozdziewski et al. 2008 1766 2.864
14 Her b 14 Her 1 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Feng et al. 2022 1765.03890 +1.67709 -1.87256 2.774 +0.109 -0.120
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14 Her b 14 Her 0 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Naef et al. 2004 1796.4±8.3 2.80
14 Her b 14 Her 0 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Rosenthal et al. 2021 1766.41 +0.67 -0.68 2.830±0.041
14 Her b 14 Her 0 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Butler et al. 2003 1724±50 2.82
14 Her b 14 Her 0 1 2 Radial Velocity 2002 W. M. Keck Obser Published Confirmed 0 Gozdziewski et al. 2006 2.730
16 Cyg B b 16 Cyg B 0 3 1 Radial Velocity 1996 Multiple Observat Published Confirmed 0 Rosenthal et al. 2021 799.45±0.15 1.676±0.025
16 Cyg B b 16 Cyg B 0 3 1 Radial Velocity 1996 Multiple Observat Published Confirmed 0 Butler et al. 2006 798.5±1.0 1.681±0.097
16 Cyg B b 16 Cyg B 0 3 1 Radial Velocity 1996 Multiple Observat Published Confirmed 0 Cochran et al. 1997 800.8±11.7 1.6
16 Cyg B b 16 Cyg B 0 3 1 Radial Velocity 1996 Multiple Observat Published Confirmed 0 Wittenmyer et al. 2007 799.5±0.6 1.68±0.03
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18 Del b 18 Del 0 2 1 Radial Velocity 2008 Okayama Astroph Published Confirmed 0 Sato et al. 2008 993.3±3.2 2.6
18 Del b 18 Del 1 2 1 Radial Velocity 2008 Okayama Astroph Published Confirmed 0 Teng et al. 2023 982.85 +1.06 -0.92 2.476±0.002
18 Del b 18 Del 0 2 1 Radial Velocity 2008 Okayama Astroph Published Confirmed 0 Kunitomo et al. 2011 2.54±0.04
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NASA EXOPLANET ARCHIVE

https://exoplanetarchive.ipac.caltech.edu

A SIMPLE TOOL TO ESTIMATE RADIO FLUX FOR PLANETS

(under development)

https://tinyurl.com/radio-flux-calculator

HOW TO CHOOSE YOUR TELESCOPE?

DEPENDS ON VARIOUS FACTORS:

- Desired sensitivity
- Suitable Frequency band
- Declination of the source

Observational companions:

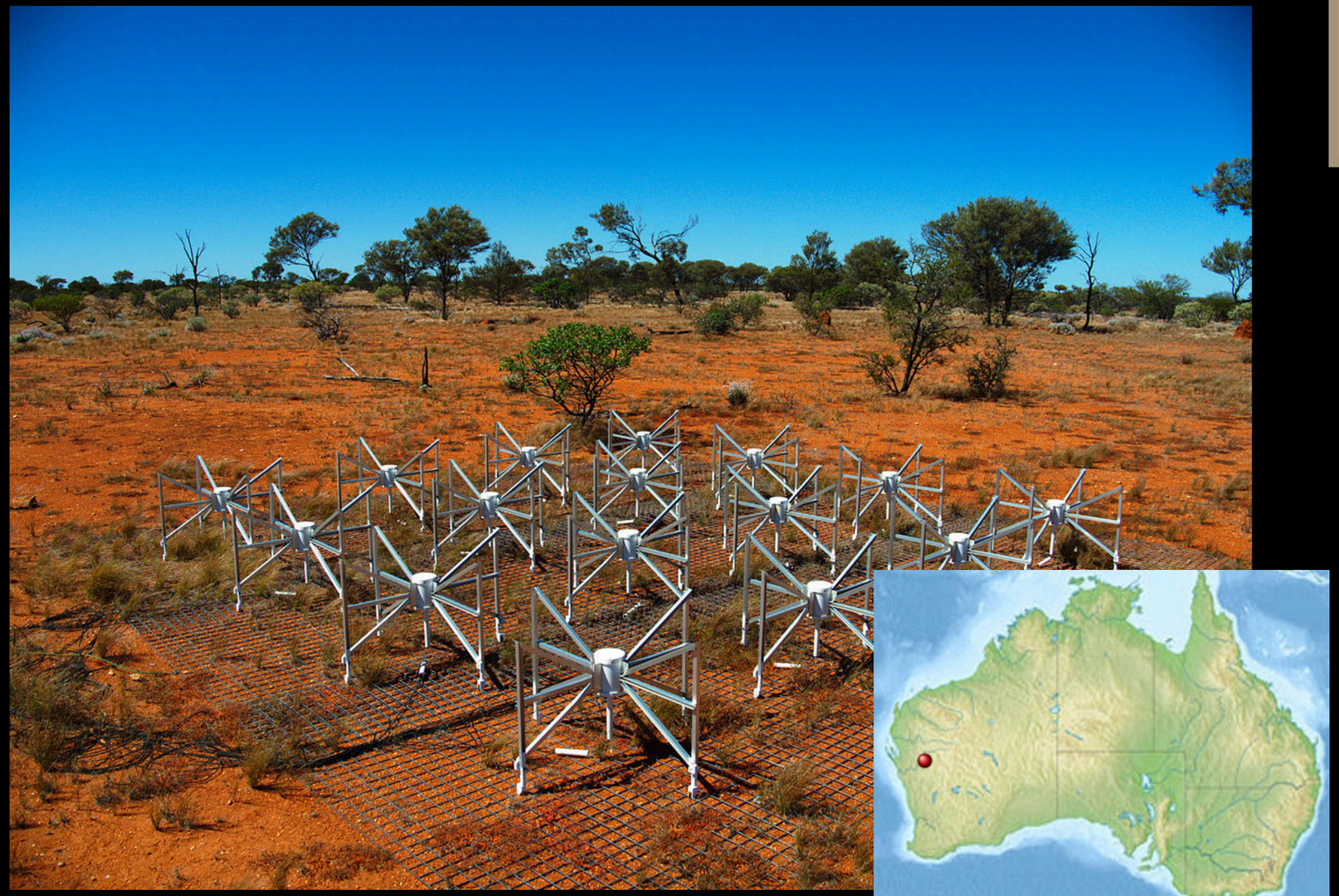
Upgraded Giant Meterwave Radio Telescope (uGMRT)

- An array of 30 steerable parabolic telescopes, each of 45 m diameter
- Spans over 25 km, provides a total collecting area of about 30,000 sq. m at metre wavelengths, with a fairly
- good angular resolution (~arcsec)

Obseravtional bands

- Band 2: 120MHz-250MHz
- Band 3: 250MHz-500MHz
- Band 4: 550MHz-850MHz
- Band 5: 1050MHz-1450MHz

Observational companions:



Murchison Widefield Array (MWA)

Consists of 4,096 spider-like antennas arranged in 256 regular grids called ‘tiles’, spread over ~3 Km diameter area.

Operational frequency: 70–300 MHz, with a bandwidth of 30.72 MHz

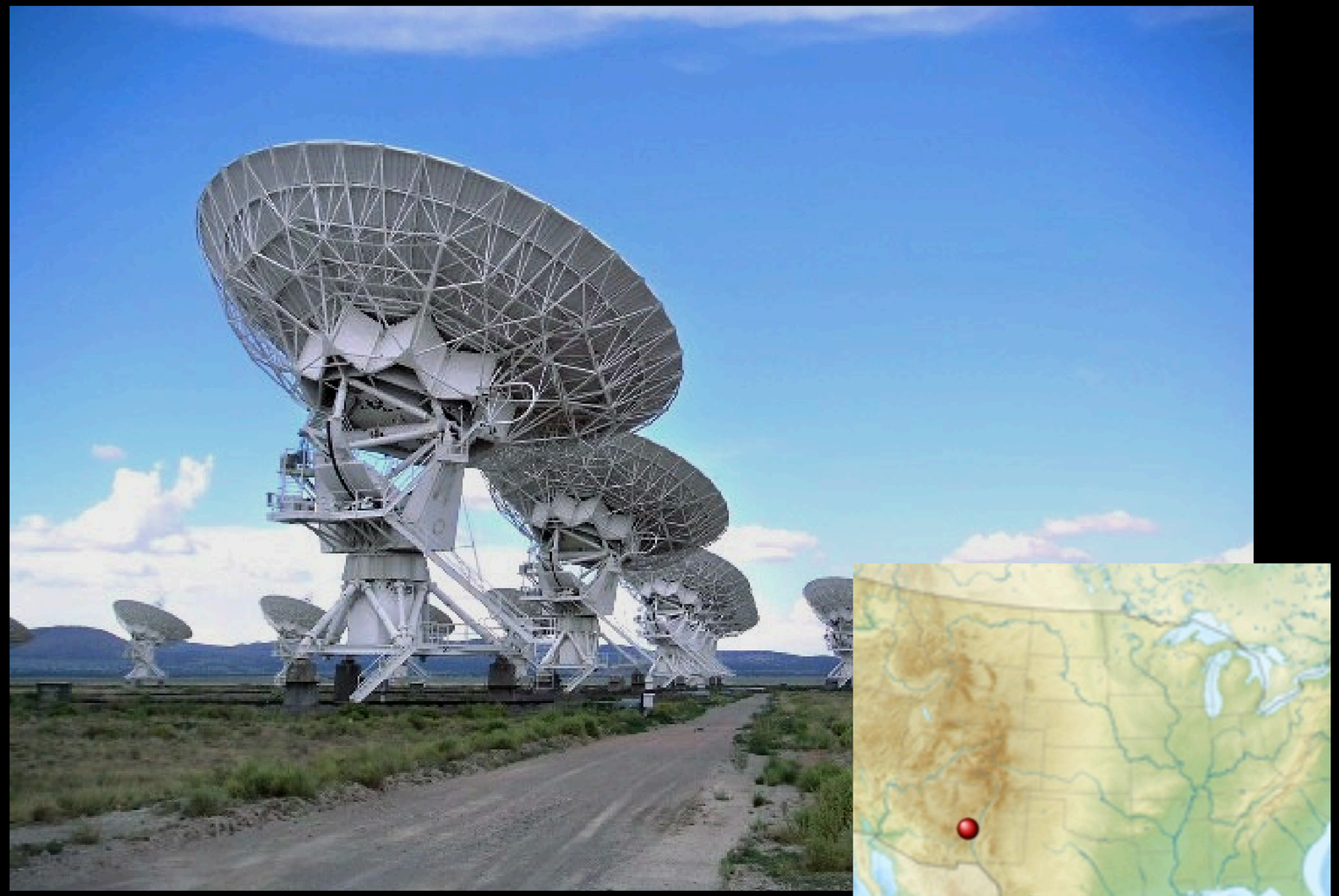
Observational companions:

Low Frequency Array (LOFAR)

An interferometric array comprising 20,000 small antennas concentrated in 52 stations and still expanding

Operational frequency :
LBA: 10-80 Mhz
HBA: 120-240 Mhz

Observational companions:



Very Large Array (VLA)

A network of27 antennas arranged in a huge Y pattern up to 36km across

Observational bands

- 4 band: 0.058 – 0.084GHz
- P band: 0.23 – 0.47GHz
- L band: 1.0 – 2.0GHz
- S band: 2.0 – 4.0GHz
- C band: 4.0 – 8.0GHz
- X band: 8.0 – 12.0GHz
- Ku band: 12.0 – 18.0GHz
- K band: 18.0 – 26.5GHz
- Ka band: 26.5 – 40.0GHz
- Q band: 40.0 – 50.0GHz

Observational companions:

Telescope	Sky covered
VLA	+90° to -40°
uGMRT	+90° to -53°
MWA	+30° to -90°
LOFAR	Preferably +90° to +10°

ARCHIVAL DATABASES (RADIO)

https://naps.ncra.tifr.res.in/goa/data/search

https://data.nrao.edu/portal/#/

https://www.cv.nrao.edu/nvss/postage.shtml

https://lofar-surveys.org/dr2_release.html

and many more...

ARCHIVAL DATABASES (OTHER WAVELENGTHS)

https://almascience.nrao.edu/aq/

https://vizier.cds.unistra.fr

and many more...

HOW MUCH TIME TO ASK FOR?

EXPOSURE TIME CALCULATOR

GMRT Exposure Time Calculator (Continuum/Spectral Line)

Help In case of queries, please write to gmrtcalc[at]ncra.tifr.res.in.

Users are advised to run the ETC on the Firefox or Chrome browsers.
Problems have been noticed in some versions of Safari.

1	Observation Type	?	Continuum
2	Observing Band	?	Band-2 (125-250 MHz)
3	Representative Frequency	?	200 MHz
4	Number of antennas	?	26
5	Bandwidth	?	200 MHz
6	Usable Bandwidth	?	50 MHz
7	Number of Polarizations	?	2
8	Image weighting	?	Natural
9	Source co-ordinates(J2000)	?	RA 00h 00m 00.00s Dec 00d 00' 00.00"
10	Sky temperature (T_sky, K)	?	0 auto calculate
11	Calculation Type	?	On-Source Time
12	RMS noise	?	100 µJy/Bm
13	On-source Time	?	00h 00m 00s
14	Fudge Factor	?	1
15	On-source Time including Fudge Factor	?	00h 00m 00s
16	Overheads	?	00h 00m 00s auto calculate
17	Extra Bandpass/Polarization Time	?	00h 00m 00s
18	Total Time (15+16+17)	?	00h 00m 00s
19	Confusion Limit (σ_c*)	?	µJy/Bm

Calculate | Reset | Save as a PDF

uGMRT ETC

EXPOSURE TIME CALCULATOR

VLA Exposure Calculator	
Purpose of Calculation	
Array Configuration	A
Number of Antennas	25
Polarization Setup	Single / Dual
Type of Image Weighting	Natural / Robust
Representative Frequency	0.0000 GHz
Receiver Band	Unspecified
Approximate Beam Size	Unknown
Digital Samplers	3 bit / 8 bit
Elevation	Zenith (90 degrees)
Average Weather	Winter
Calculation Type	Time / BW / Noise/Tb
Number of Sources	1
Time on Source (UT)	0h 0m 0s
Total On-Source Time	0h 0m 0s
Total Time (UT)	0h 0m 0s

VLA ETC

Group Activity:

Let's Discuss!

Thank you!

For feedbacks, you can write to:
k.simranpreet@csic.es