100-m Radio Telescopes

Green Bank Telescope

Effelsberg Radio Telescope

QiTai Radio Telescope

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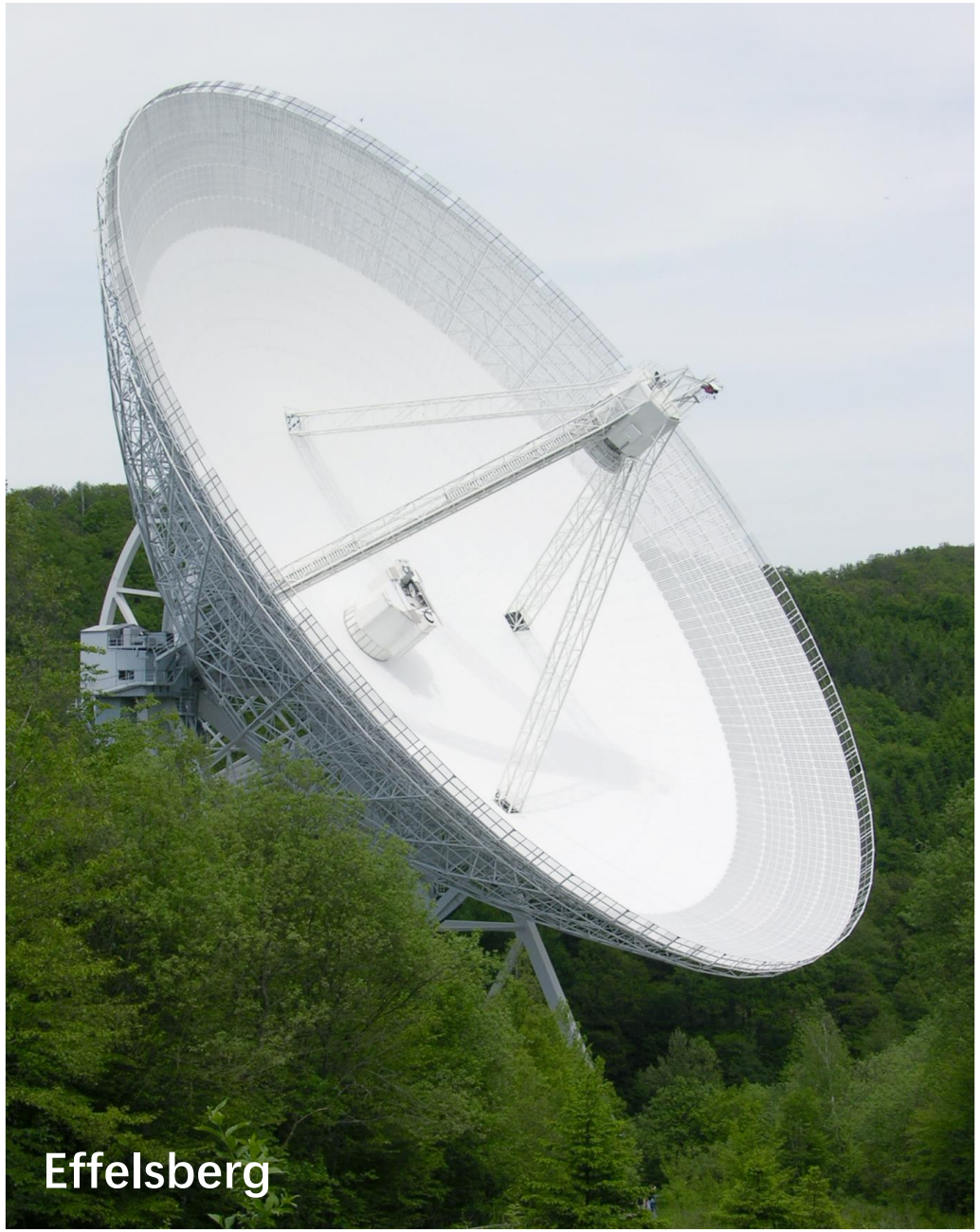
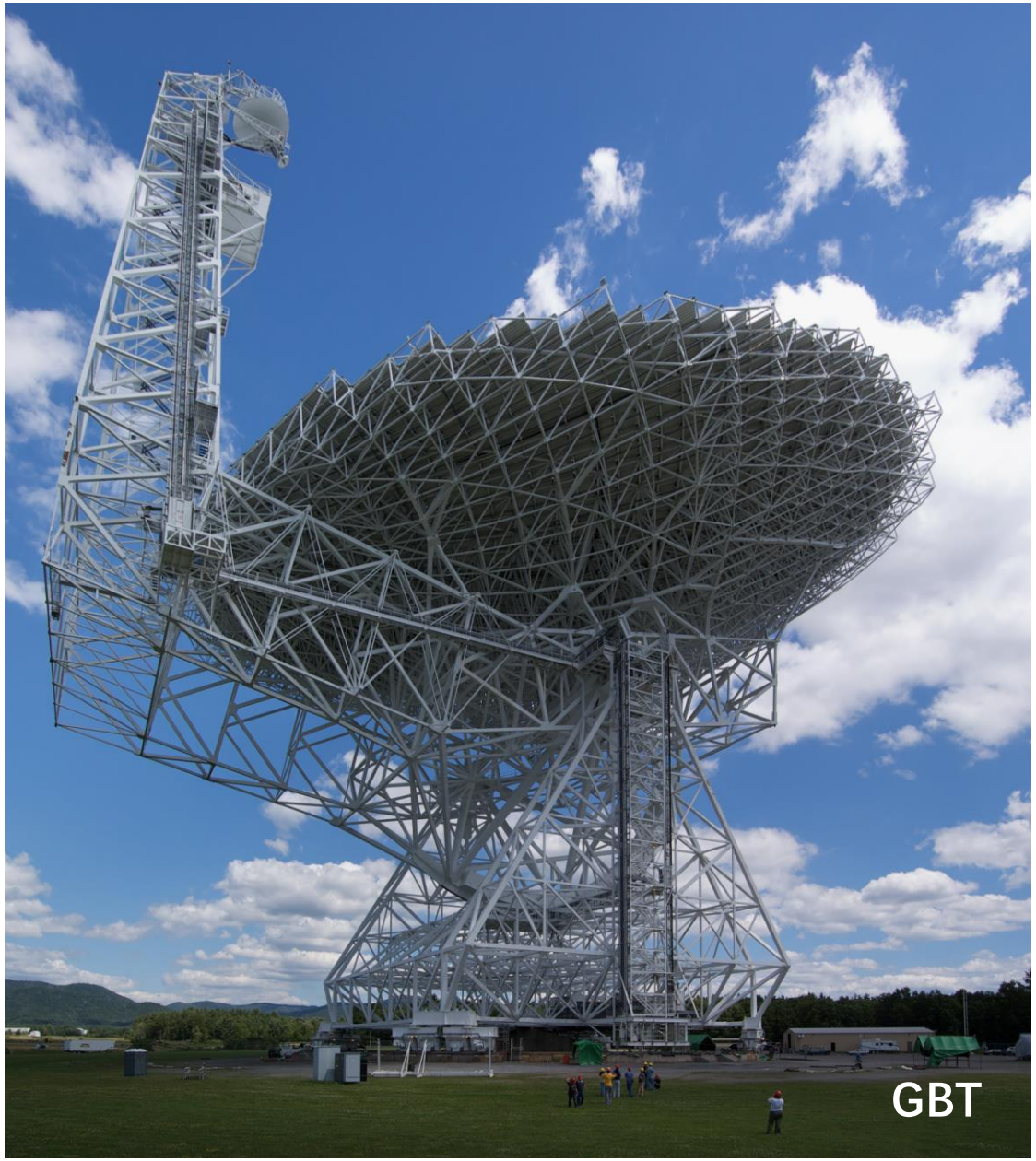


Effelsberg 100-m Radio Telescope

- Built: 1968 to 1972
- Operated by the Max Planck Institute, 1972
- Located near Bad Münstereife, Germany
- The second largest steerable single-dish radio telescope

Green Bank Telescope

- Built: 1991 to 2002
- Operated by National Radio Astronomy Observatory (NRAO) and Green Bank Observatory
- Constructed following a previous telescope erected in 1962
- Located in Green Bank, West Virginia, US
- The world's largest fully steerable radio telescope



QiTai Radio Telescope

- Planned radio telescope
- Led by Xinjiang Astronomical Observatory of the Chinese Academy of Sciences
- Completion is scheduled for 2023
- the world's largest fully steerable single-dish radio telescope

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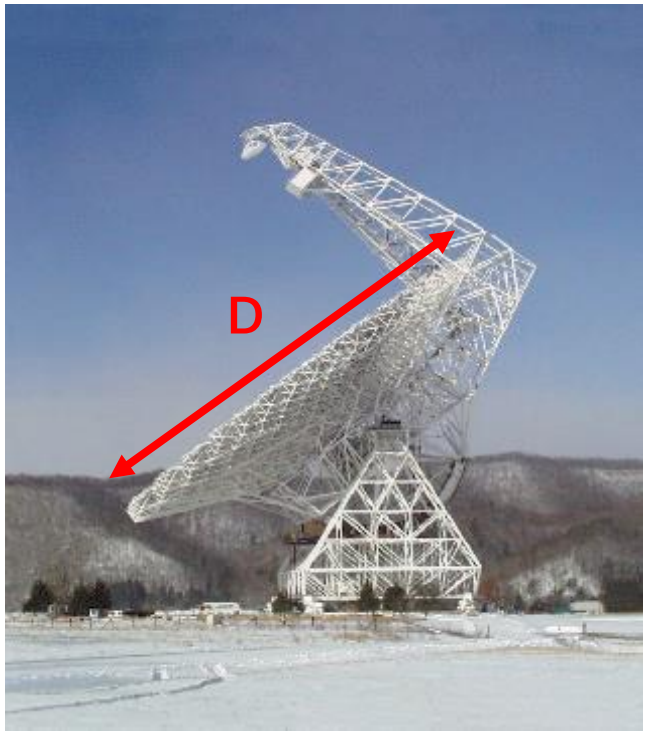
		Effelsberg	GBT
Coordinates	Longitude	6° 53’ 01.0” East	79° 50’ 23.406” West (NAD83)
	Latitude	50° 31’ 29.4” North	38° 25’ 59.236” North (NAD83)
	Track Elevation	369 m	807.43 m (NAVD88)
Operating range		300MHz - 86 GHz (90 - 0.35 cm)	290 MHz to 115.3 GHz (103 - 0.26 cm)
Telescope Diameter		100 m	100 m
FWHM Beamwidth		1.4 GHz: ~ 9.2 arcmin 32 GHz: ~ 25 arcsec	Gregorian Feed: ~ $12.60/f_{GHz}$ arcmin Prime Focus: ~ $13.01/f_{GHz}$ arcmin
Pointing accuracy		Not found QAQ	1σ values from 2-D data; 5” blind; 2.2” offset
Declination Range		Lower limit: ~ -31 degrees Upper limit: 90 degrees	Lower limit: ~ -46 degrees Upper limit: 90 degrees
One of the VLBI members?		✓	✓

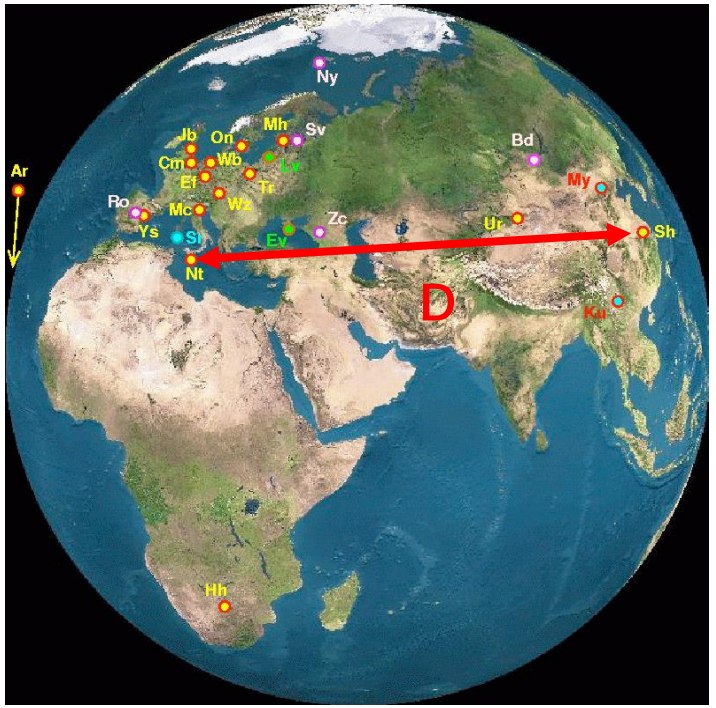
VLBI (Very Long Baseline Interferometry)

- A technique that combines the views of two (or more) telescopes separated by large distances, to capture the finest details of an object in space
- In radio astronomy, the telescopes observe the same radio source for hours at a time

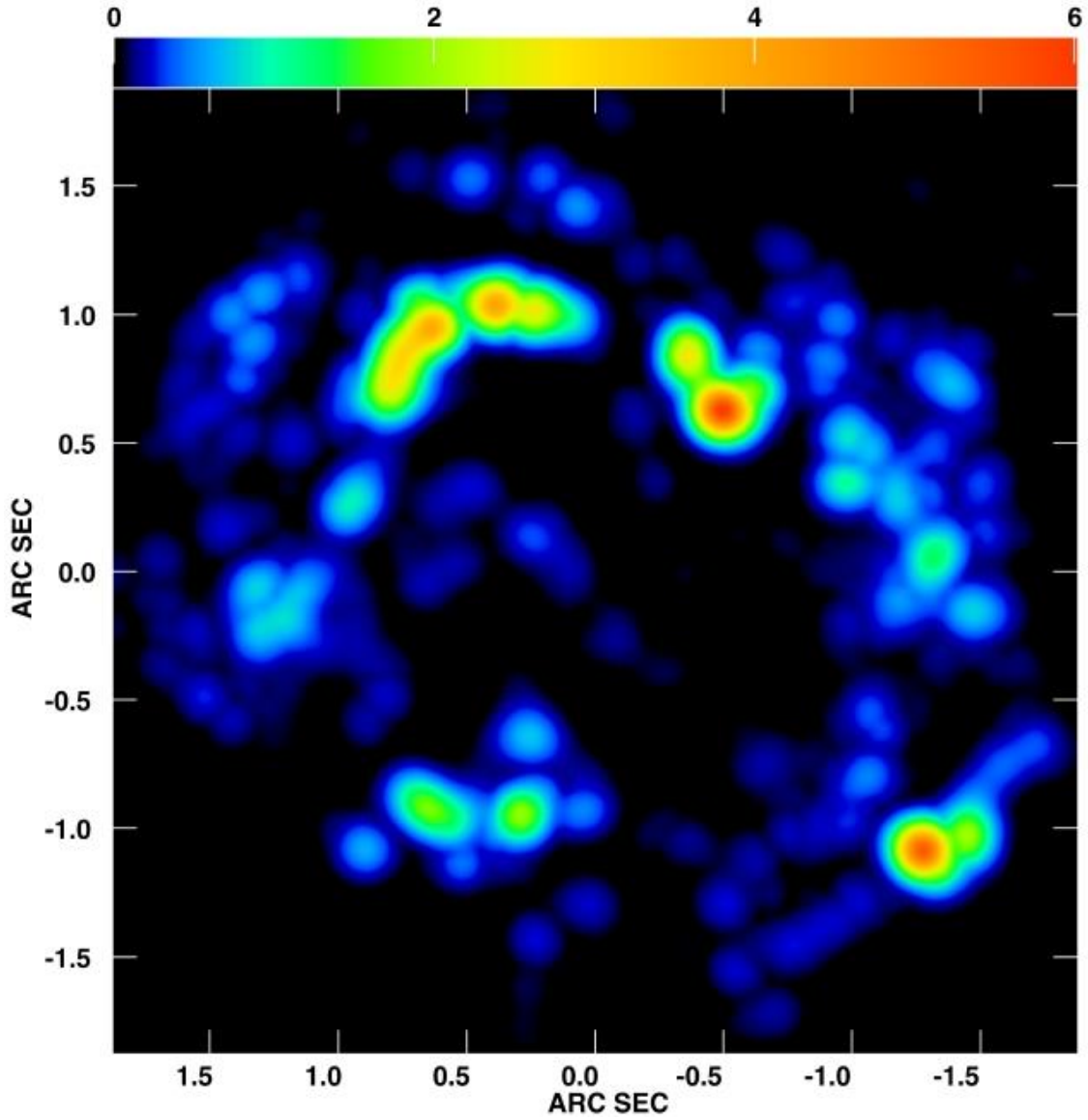
VLBI offers highest resolution

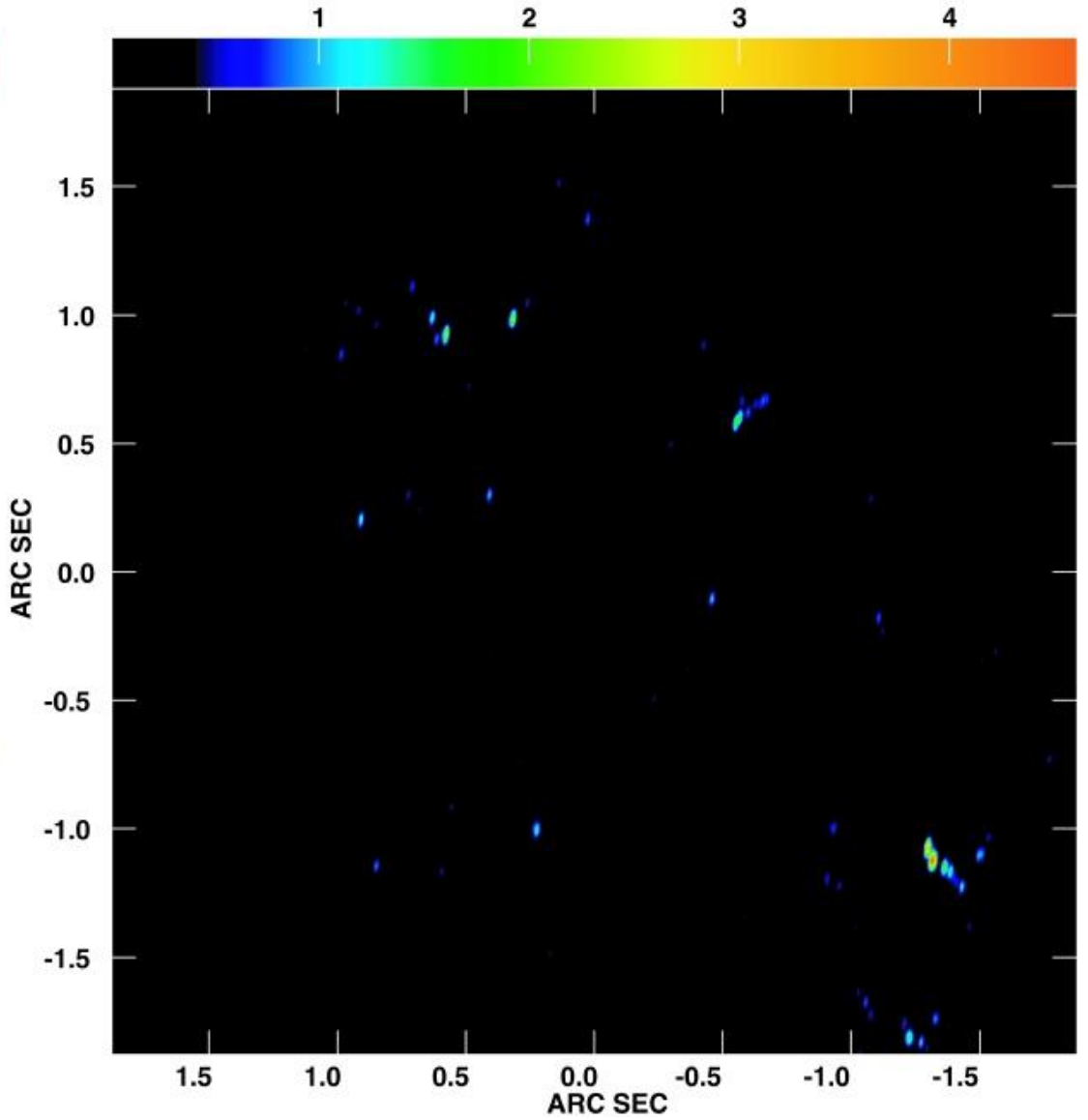
$$\theta \sim \frac{\lambda}{D}$$



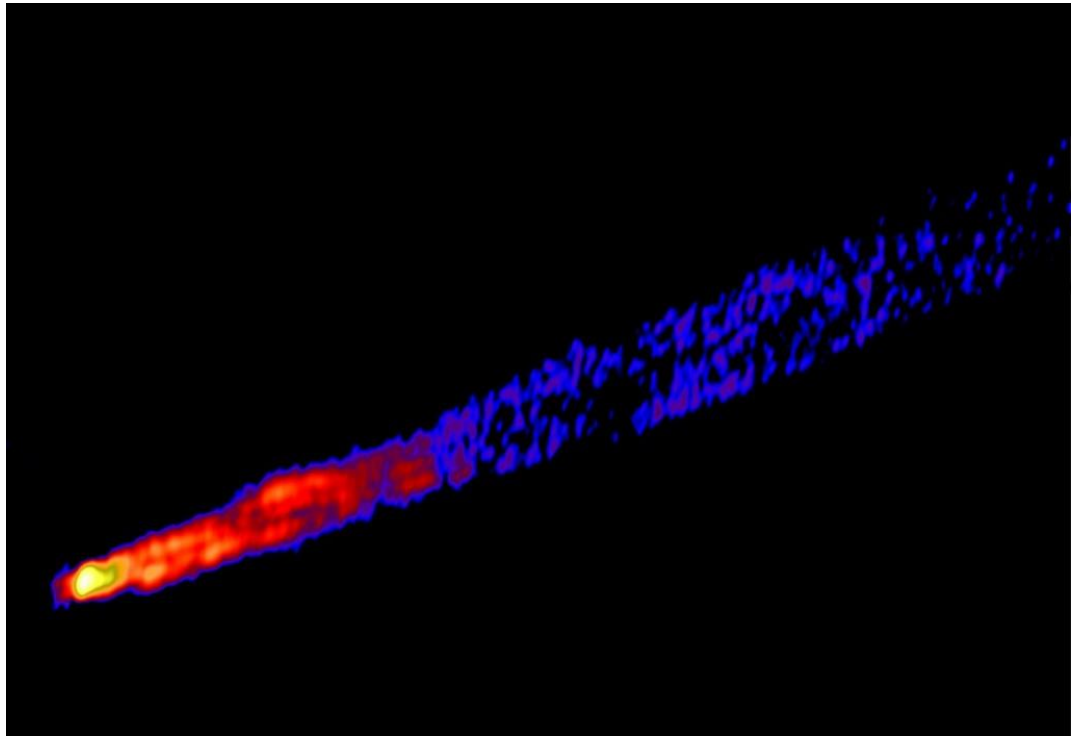


VLBI offers highest resolution

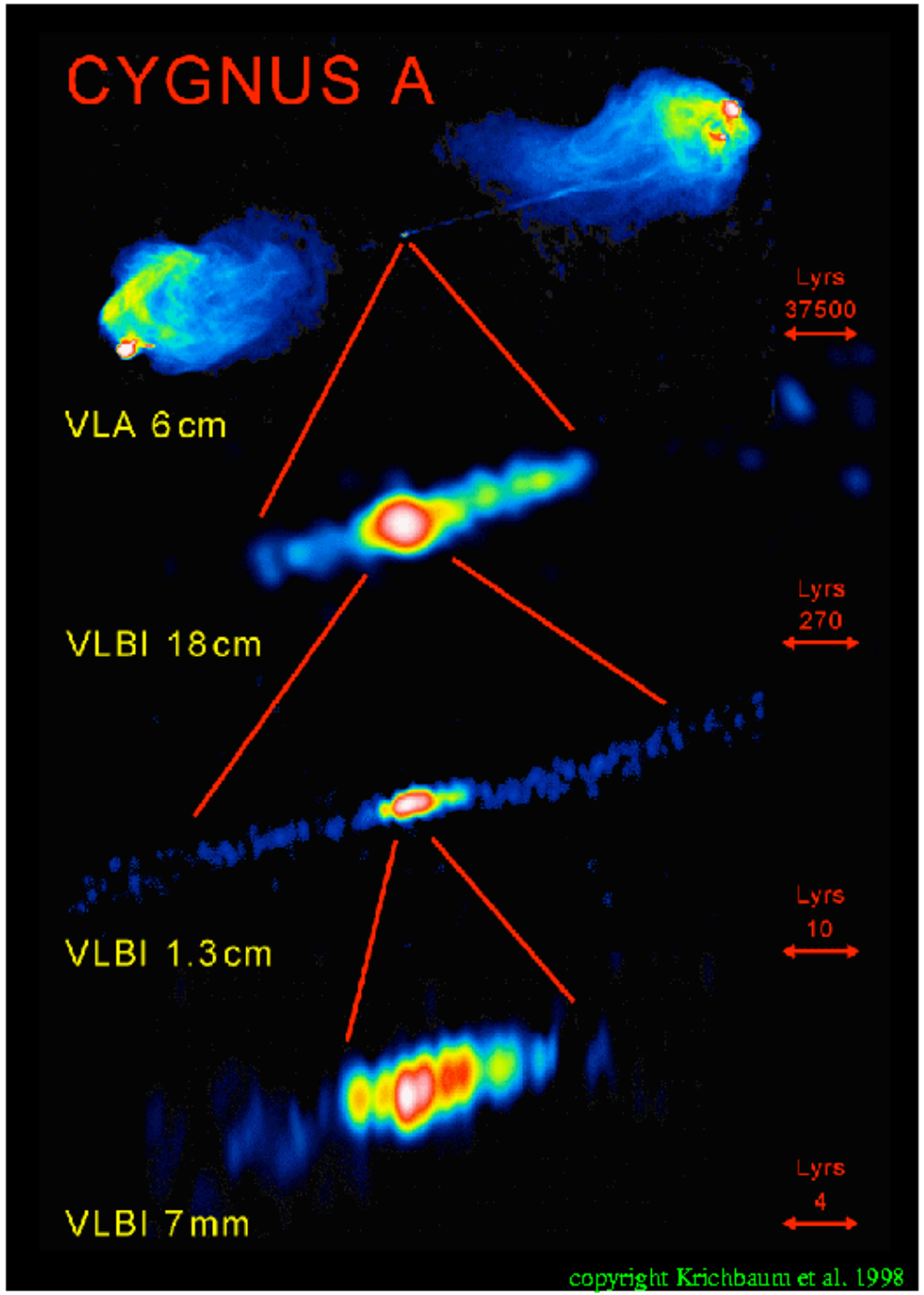




VLBI offers highest resolution



- VLBA image of a jet emanating from the core of the M87 galaxy



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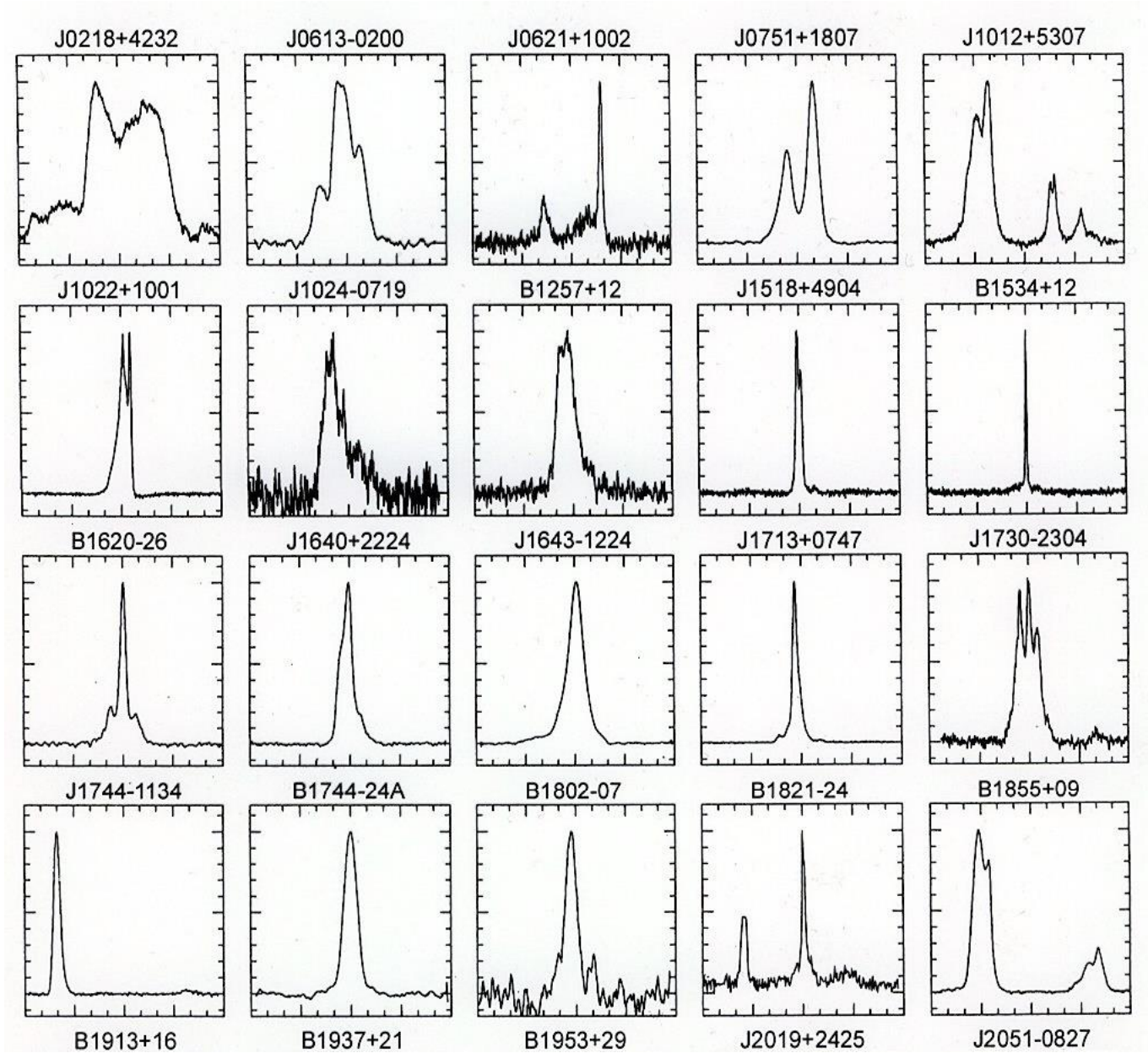
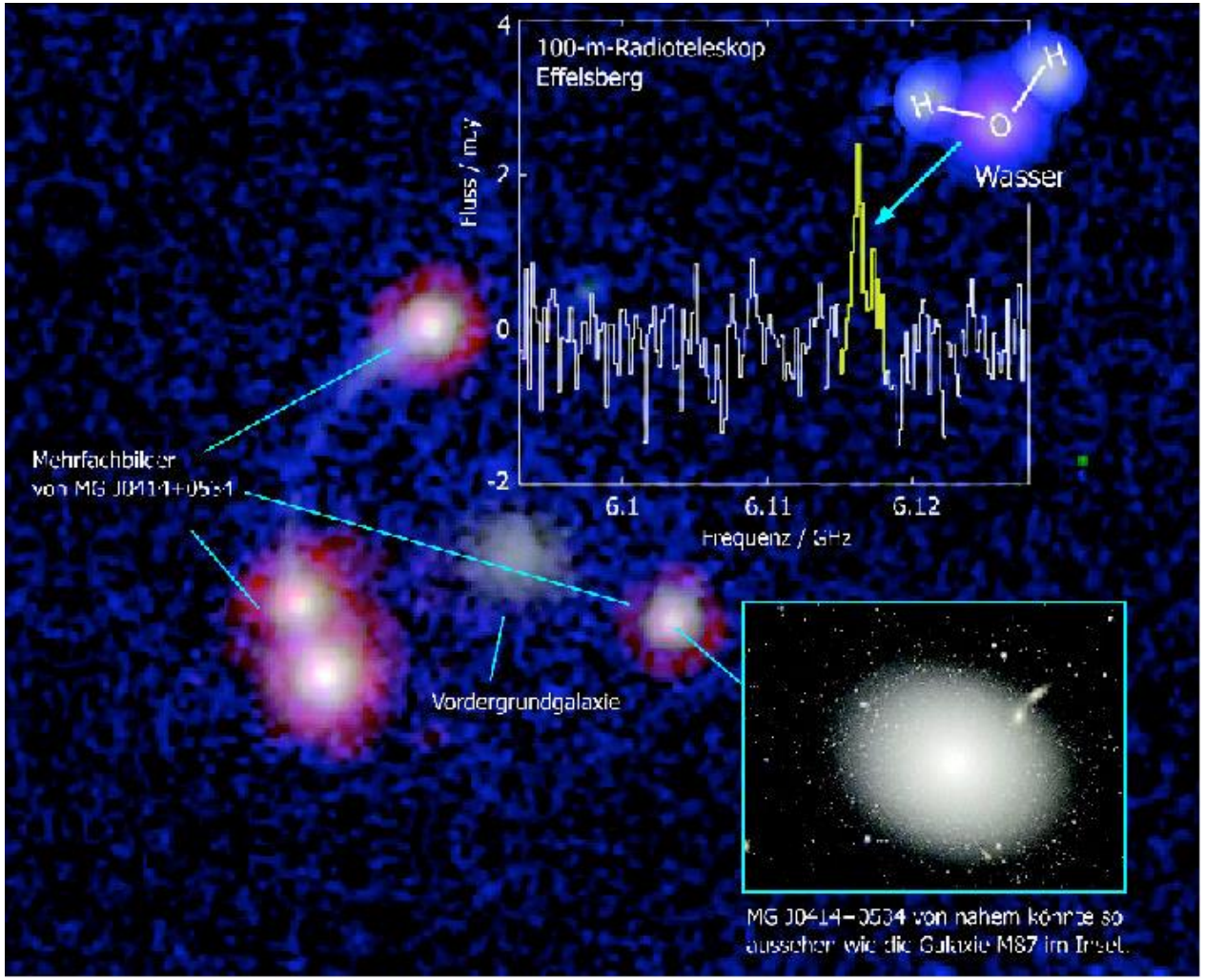
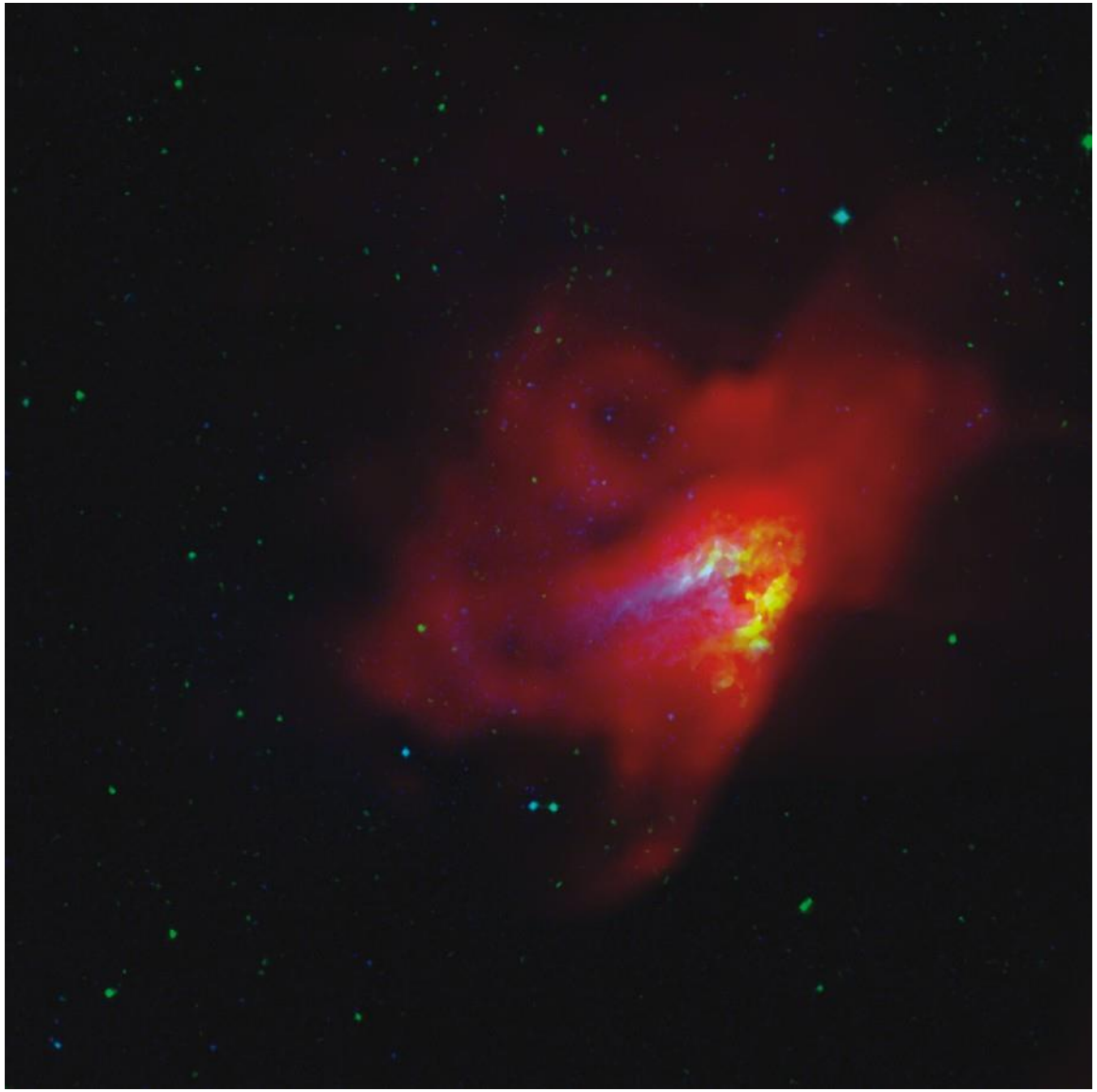
- Pulsars and compact objects
- Star formation
- H1 21cm spectrum



- The Effelsberg millisecond pulsar survey λ = 21 cm (after Kramer et al., 1998)

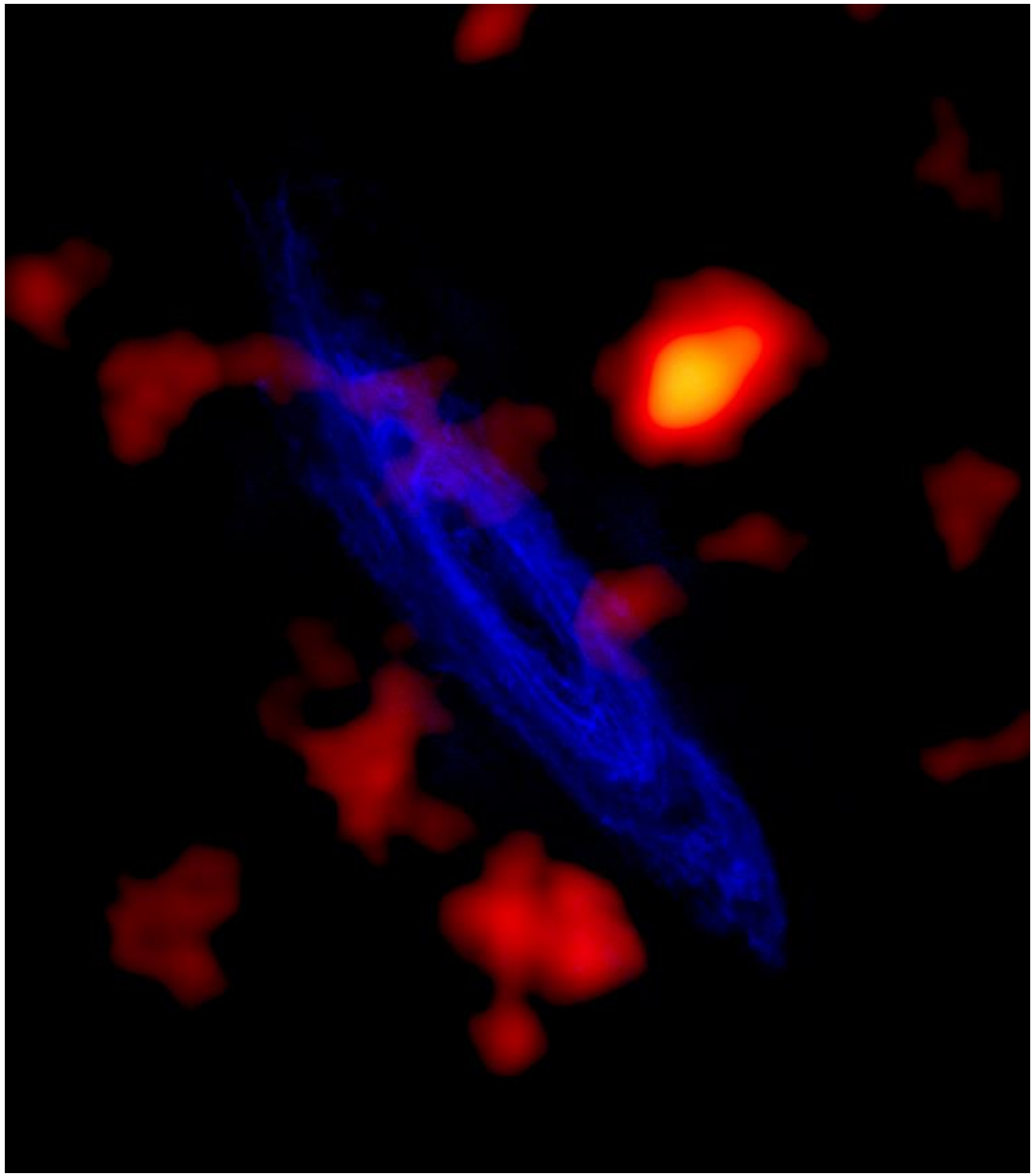


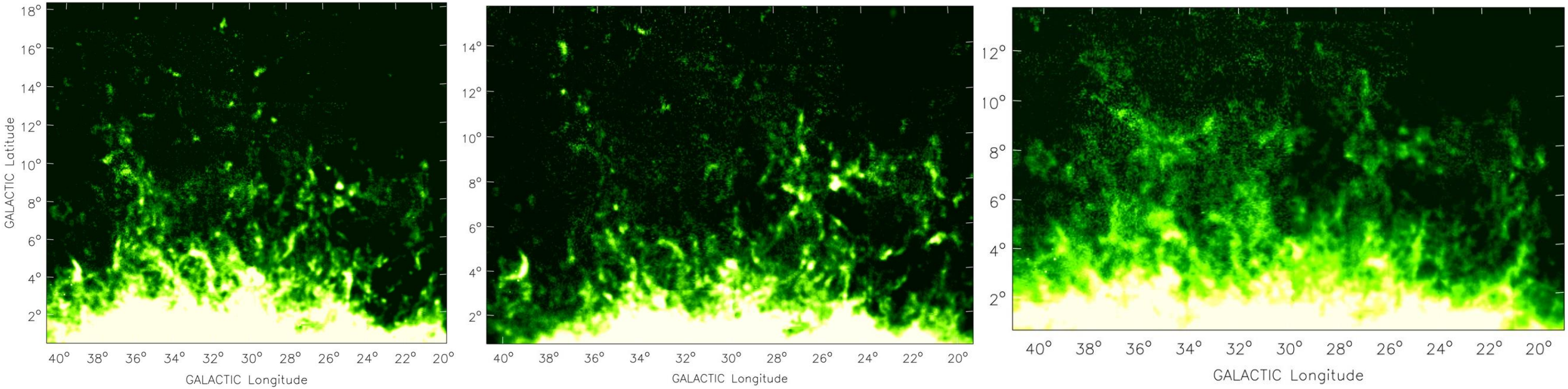
- Water maser emission in quasar MG J0414+534 (after Impellizzeri et al., 2008)
- The magnetic field of M51 based on Effelsberg and VLA observations (Fletcher et al., 2010)



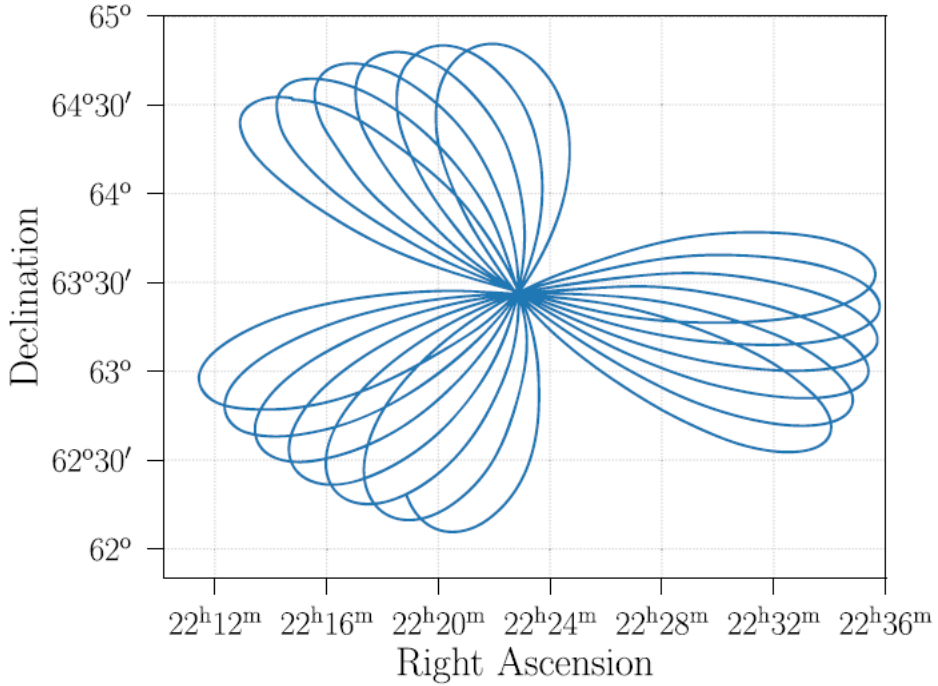
- Telescope: GBT
- The Omega Nebula (M17, the Swan Nebula, and the Lobster Nebula)
- Be found at the edge of a dark gas cloud in which new stars are being born
- Green: the infrared radiation emitted by dust clouds
- Blue and Red: the optical light and radio waves

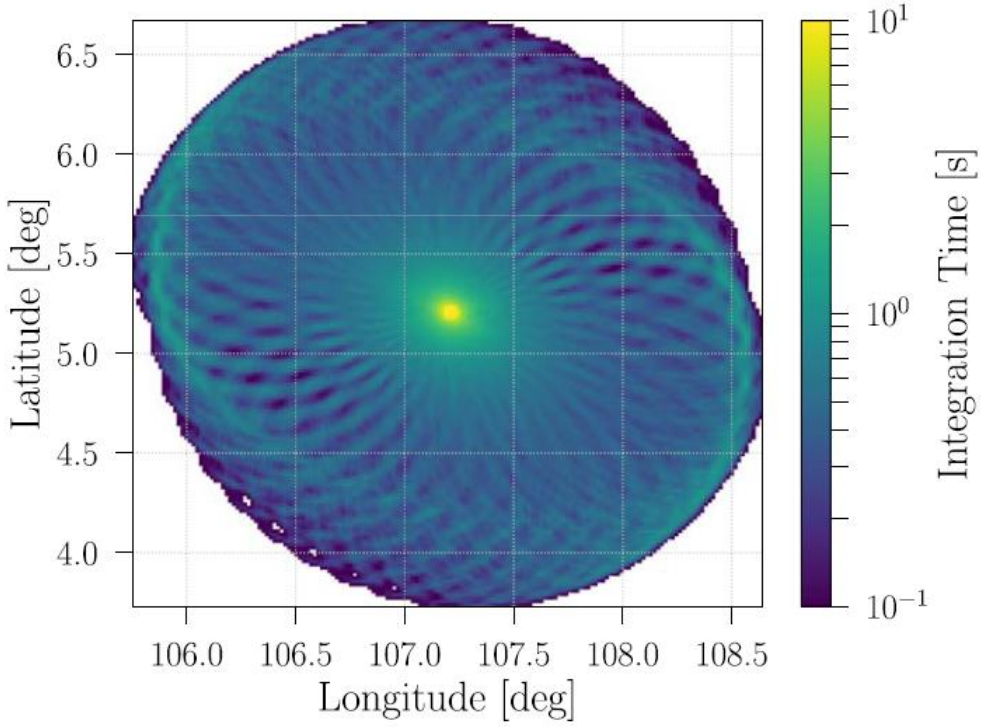
- Telescope: GBT
- Atomic hydrogen (HI) cloud population surrounding the Andromeda galaxy (M31)
- Orange part is the newfound hydrogen clouds
- ~20 discrete features are detected within 50 kpc of the M31 disk
- The velocity line width of discrete clouds is correlated with the cloud HI mass





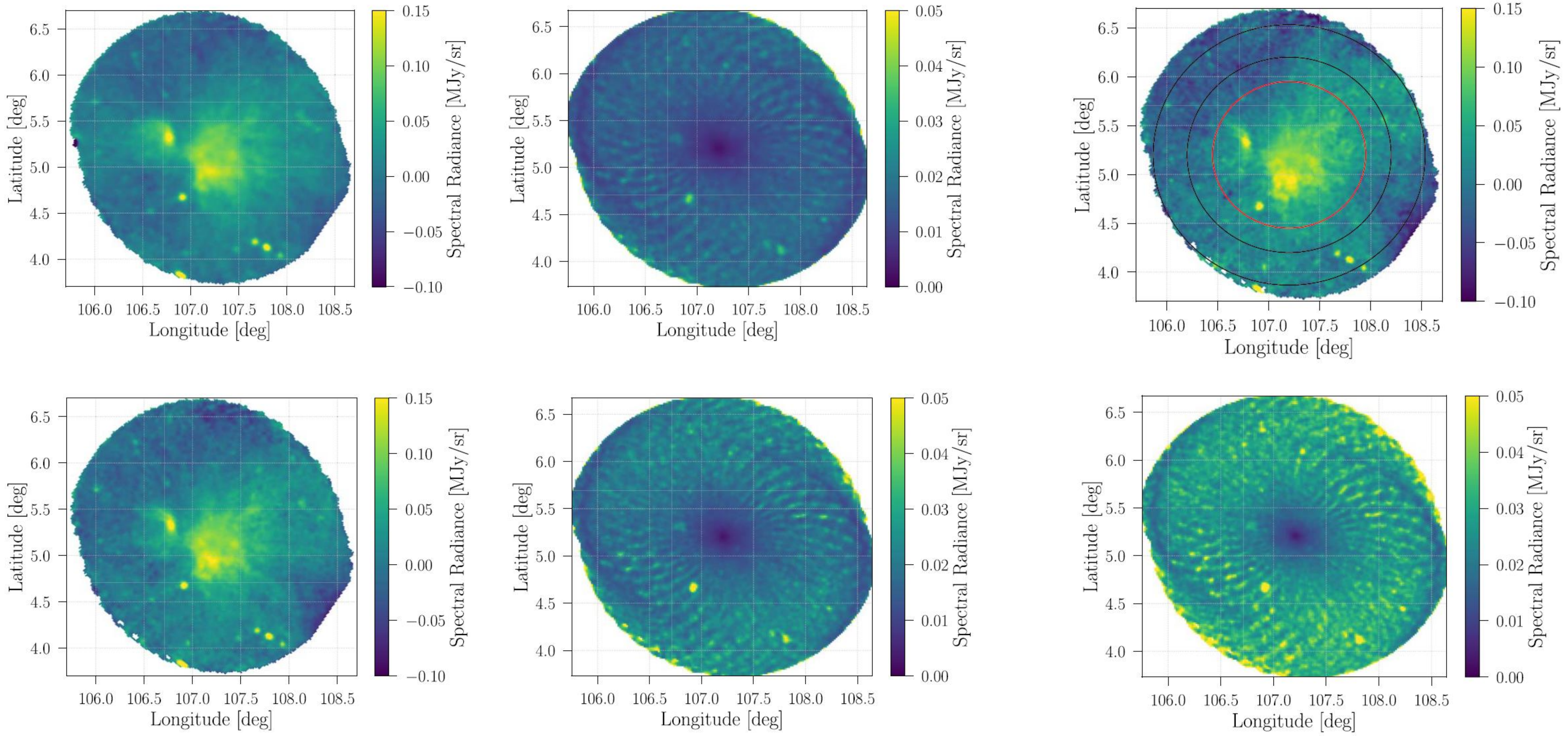
- Telescope: GBT
- The structure of the HI halo of the Milky Way
- Darker green: less H density
- Region location: ~7 kpc from the Sun and 4 kpc from the Galactic center
- First detected by GBT

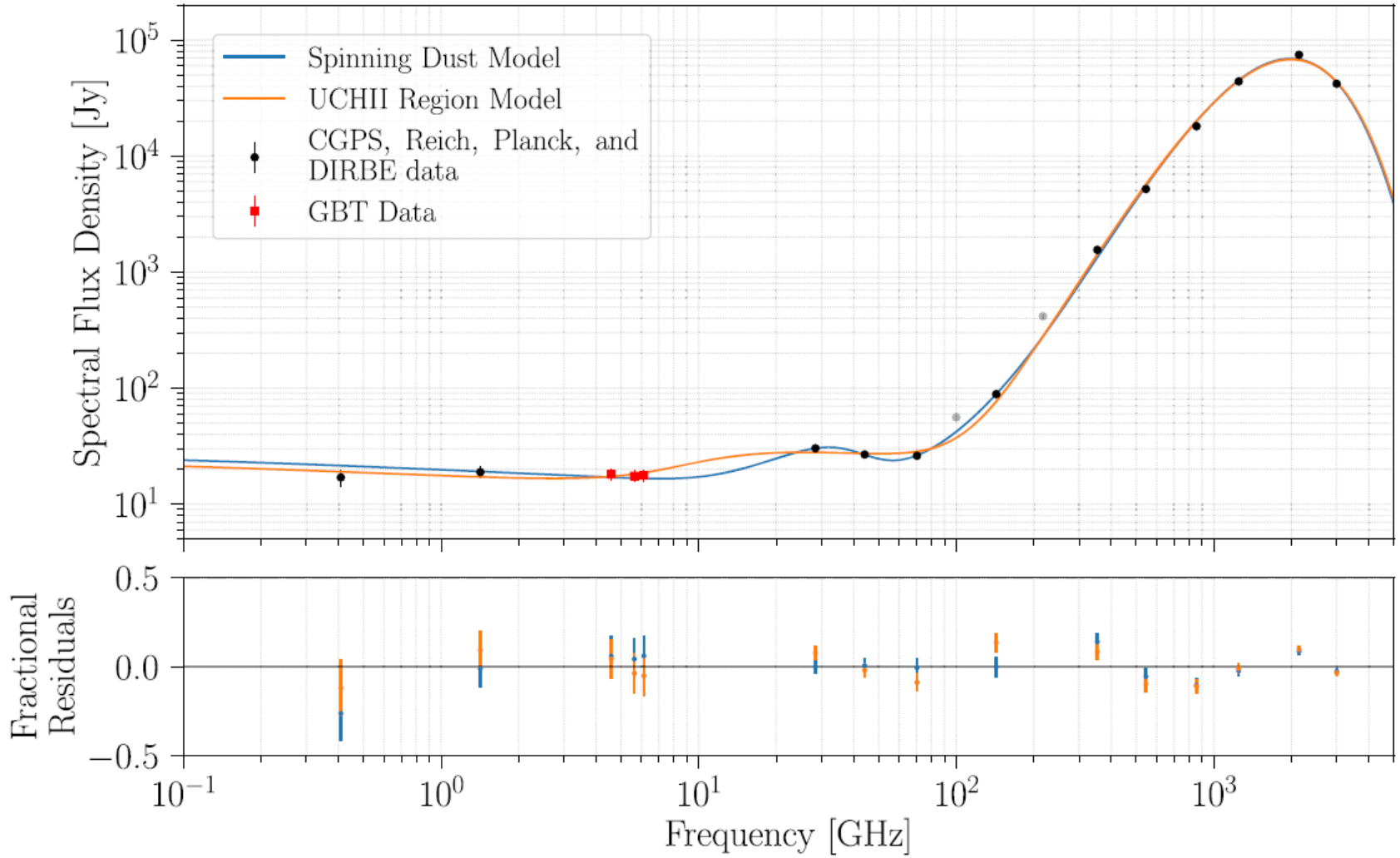




- Target **G107.2+5.20**: centered on (l, b)=(107°.2, 5°.20), near the star-forming region S140
- Using **the *daisy* scan strategy** of GBT and **C-band (4-8 GHz)**
- Every 30 seconds the daisy scan traces out 3 petals (left figure)
- Every 25 minutes the strategy completes a full cycle of a nearly circular region
- 3°.0 in diameter centered on G107.2+5.20

Mapmaking


Latitude [deg]
Longitude [deg]
Spectral Radiance [MJy/sr]
6.5
6.0
5.5
5.0
4.5
4.0
106.0
106.5
107.0
107.5
108.0
108.5
0.15
0.10
0.05
0.00
−0.05
−0.10
0.05
0.04
0.03
0.02
0.01
0.00



- Optically thin free–free emission, thermal dust emission, the CMB, and one AME component are included
- Blue line: the AME component is spinning dust emission
- Orange line: the AME component is UCH II emission

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Summary

- GBT and Effelsberg are the world's largest and second largest steerable radio telescope respectively
- QTT is scheduled to be completed in 2023 and would be the world's largest fully steerable single-dish radio telescope
- Science can be done via GBT and Effelsberg: pulsar discovery, star formation, H1 spectrum
- GBT and Effelsberg are part of the VLBI Array, We can achieve very high angular resolution detection via VLBI

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