Galactic Science with SPARCS: The study of Planetary Nebulae and HII regions.

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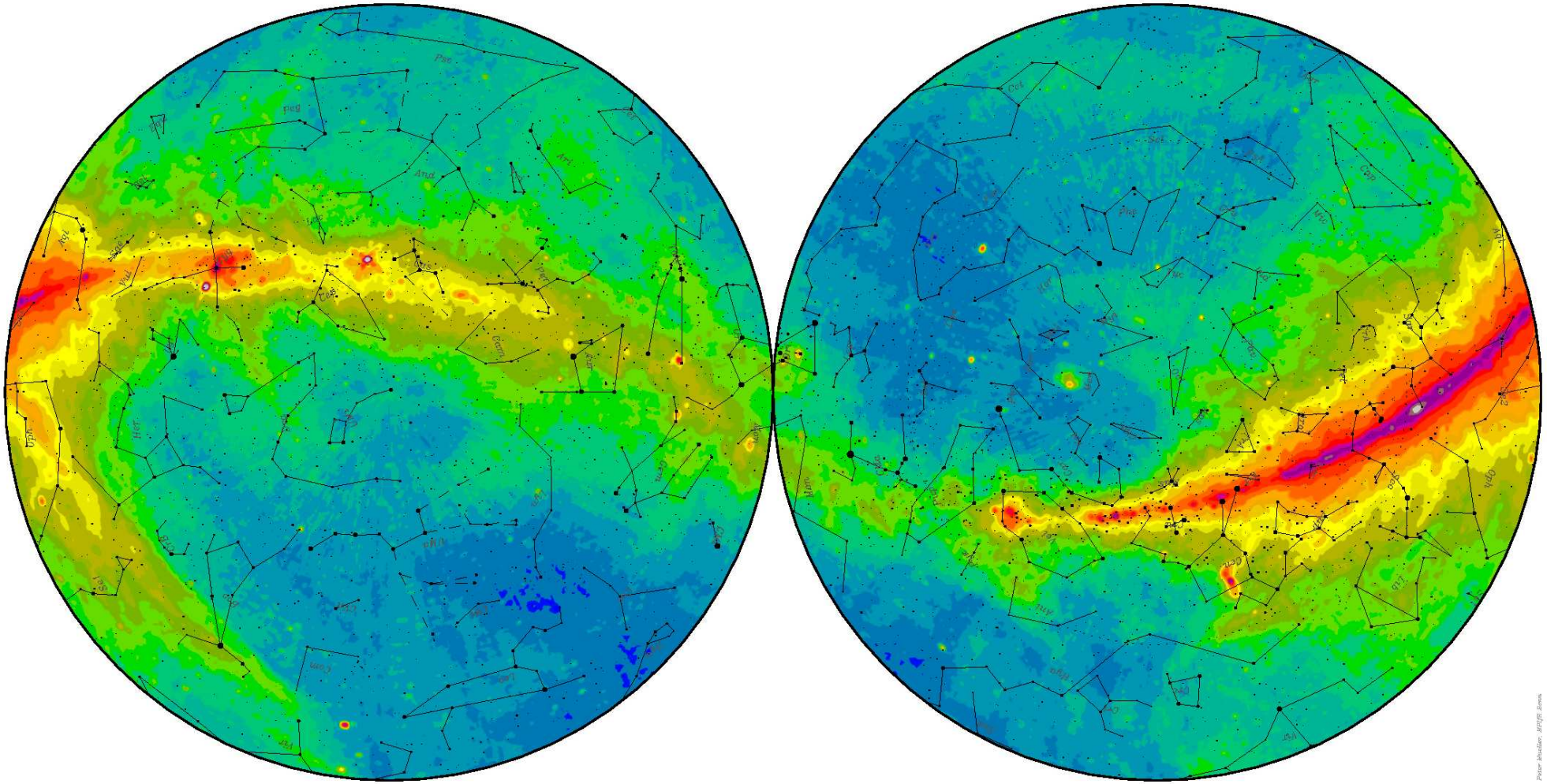
Dominion Radio Astrophysical Observatory
National Research Council
Herzberg Programs of Astrophysics

SPARCS/EMU Meeting, Catania, June 6, 2014

The Radio Sky

Haslam et al, 1982



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- However, very distant PNe will be difficult to identify.

Planetary Nebulae Sh 2-216 + DeHt 5

Ransom, Uyanıker, Kothes, & Landecker, 2008:

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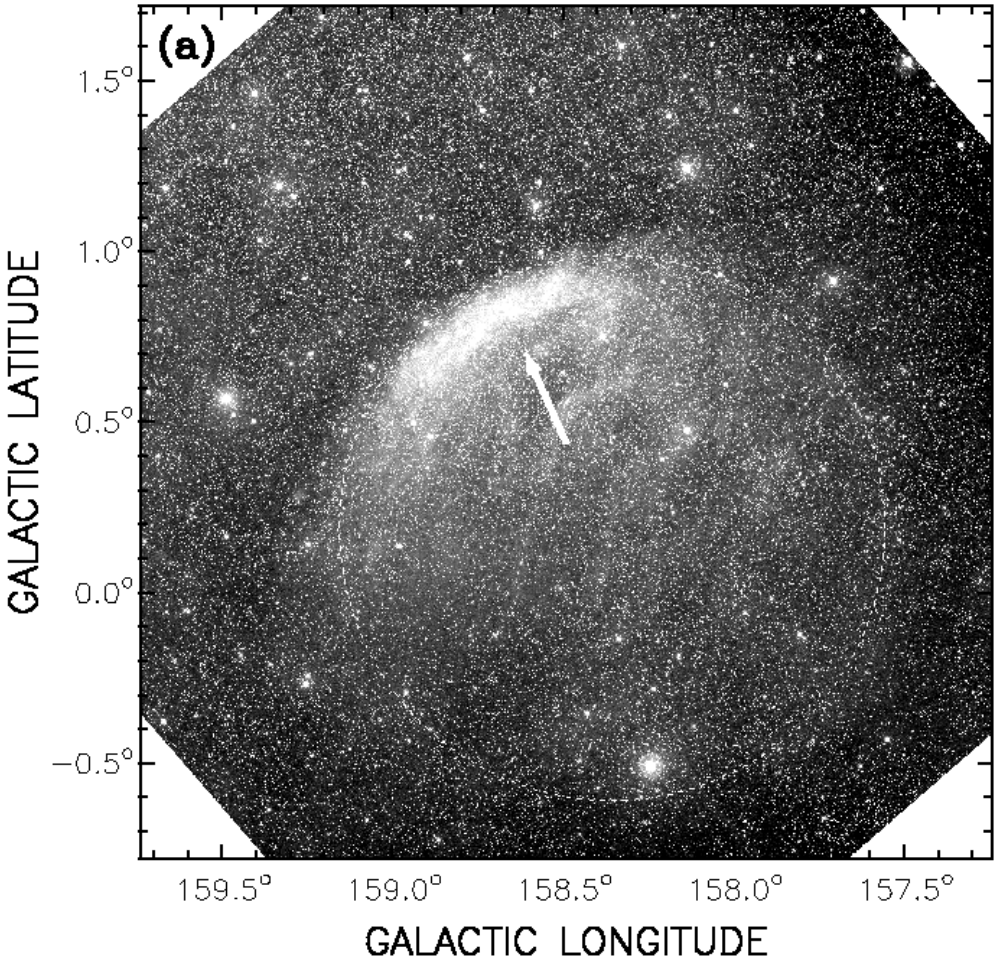

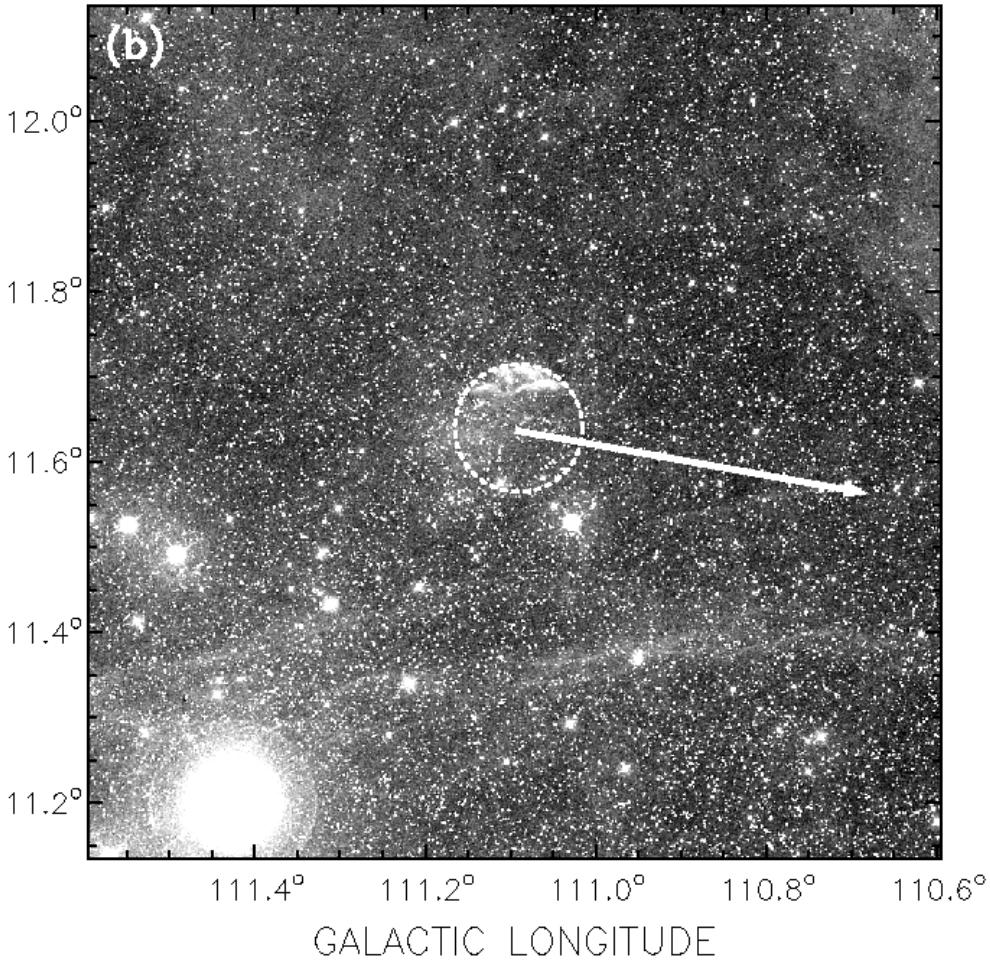

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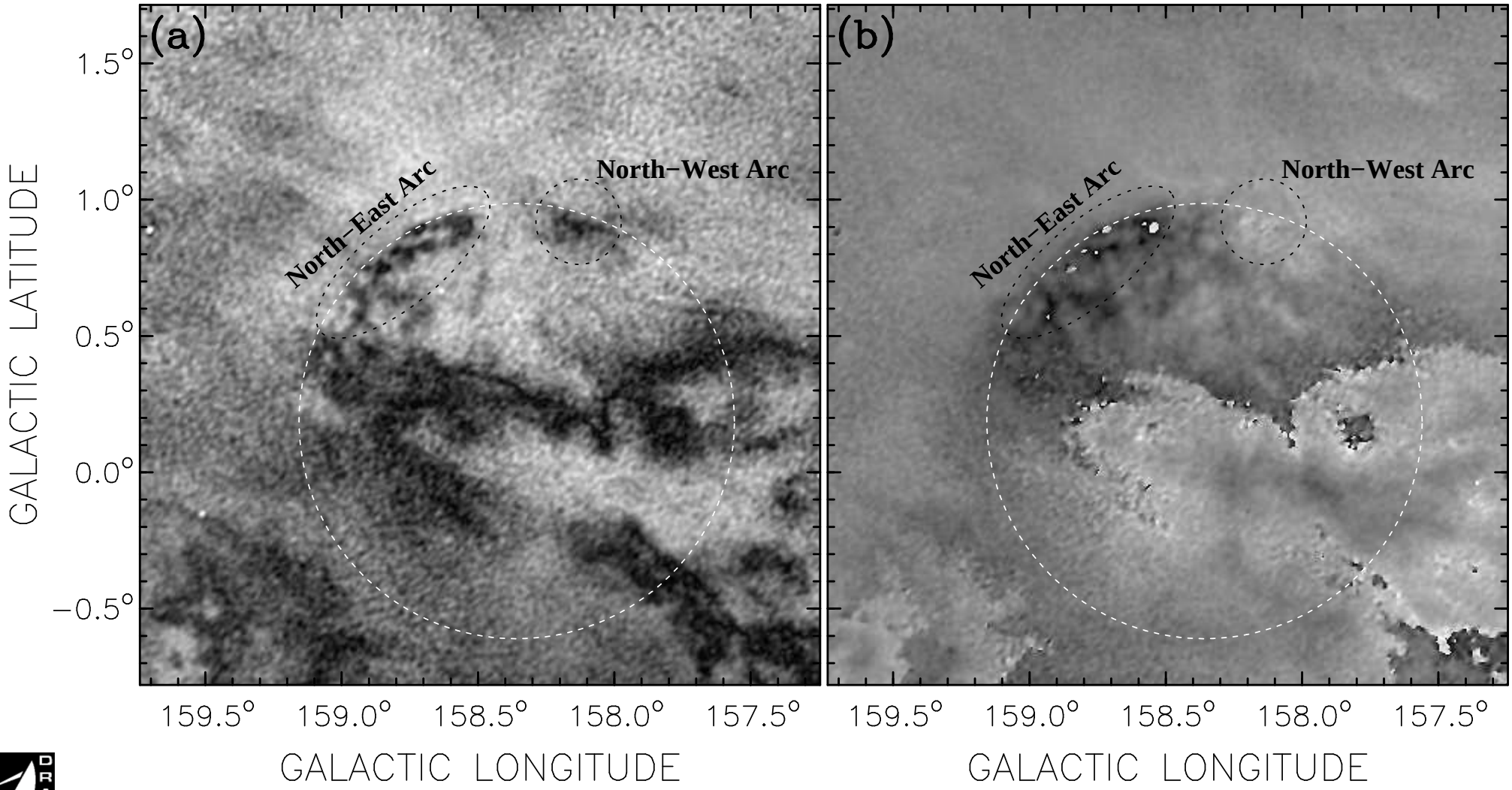

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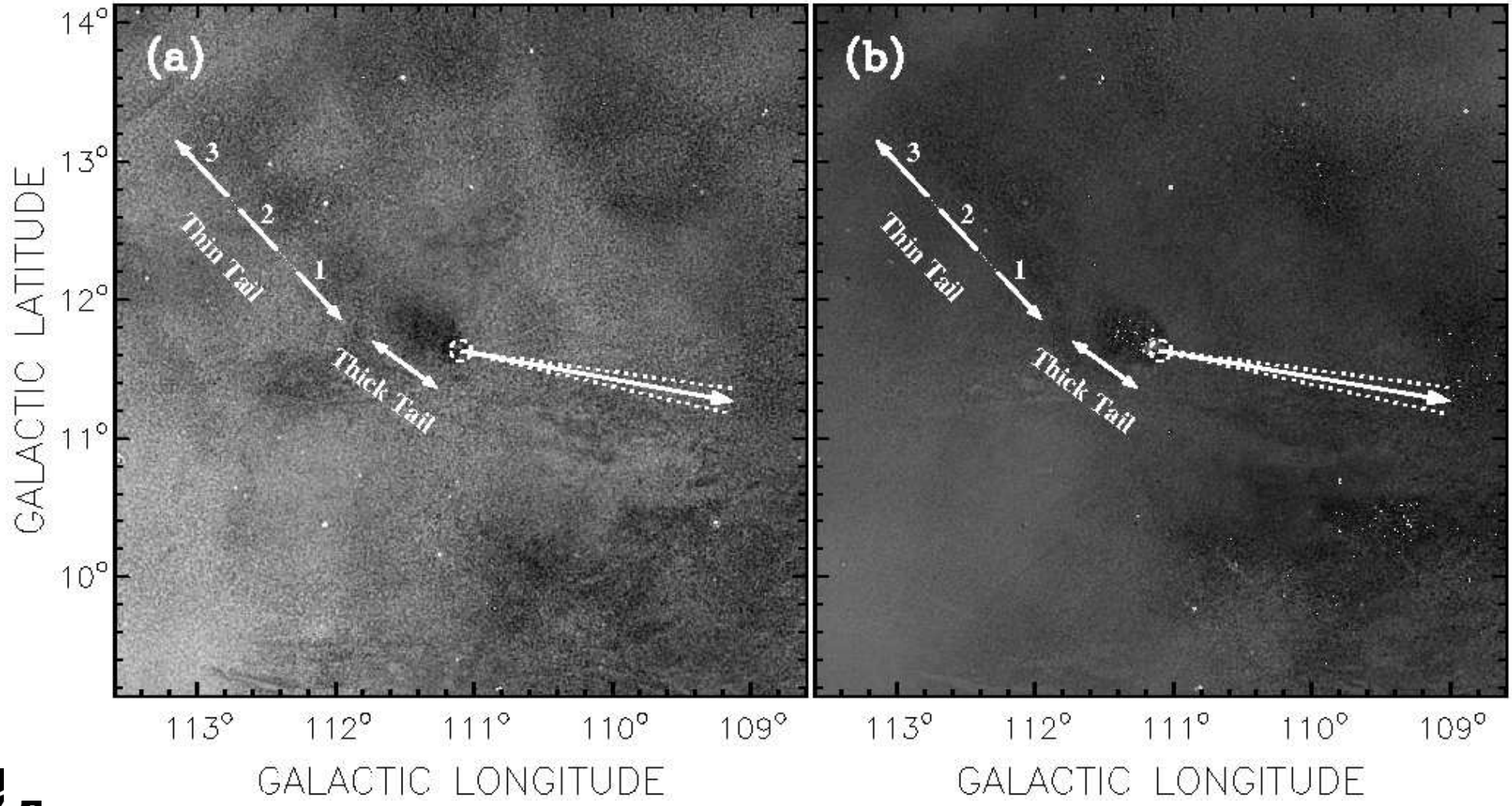

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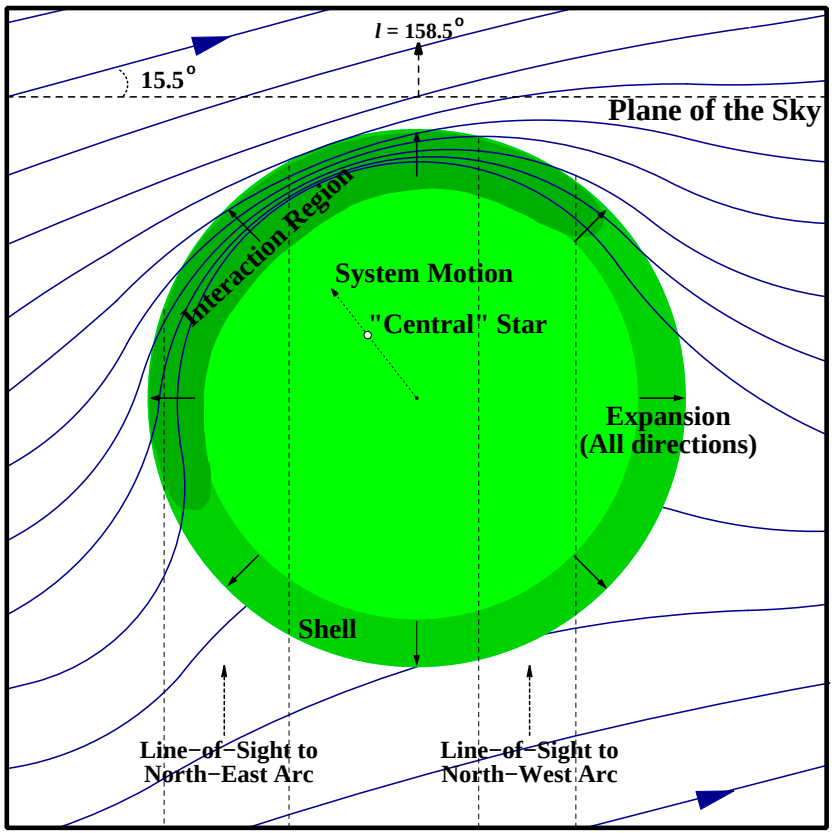
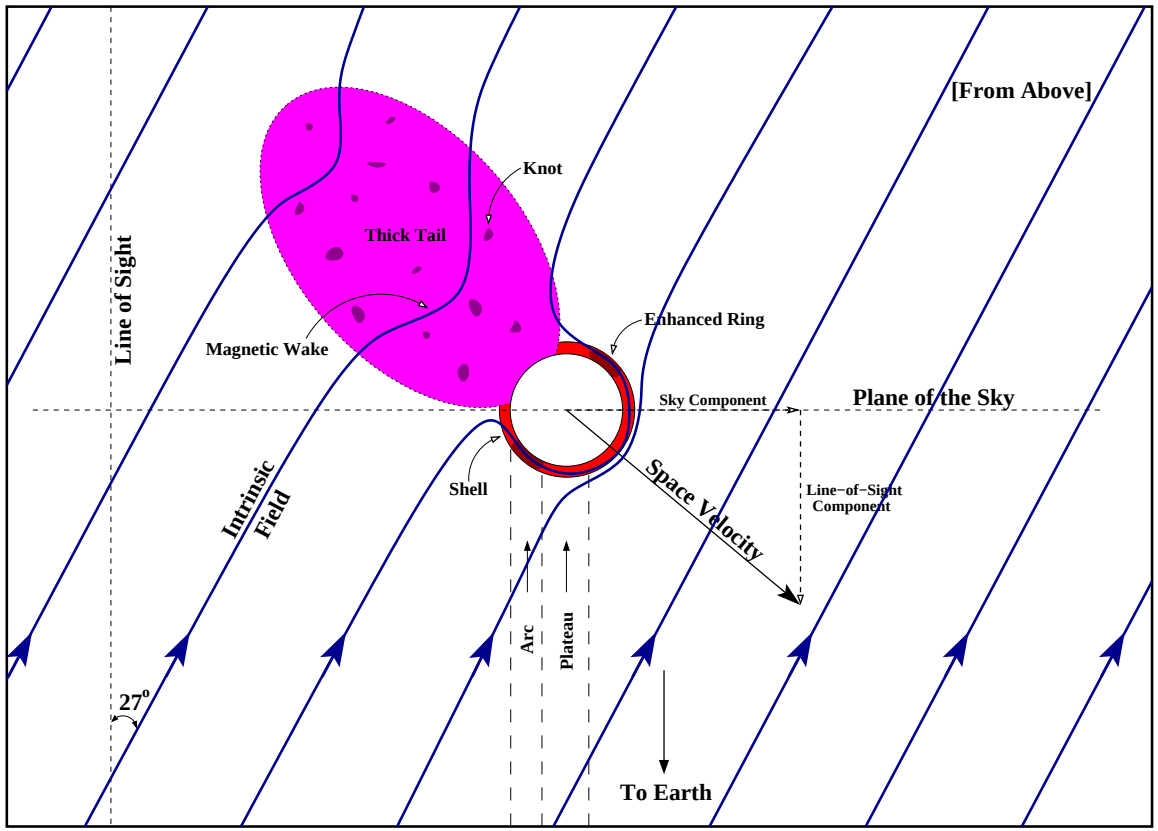
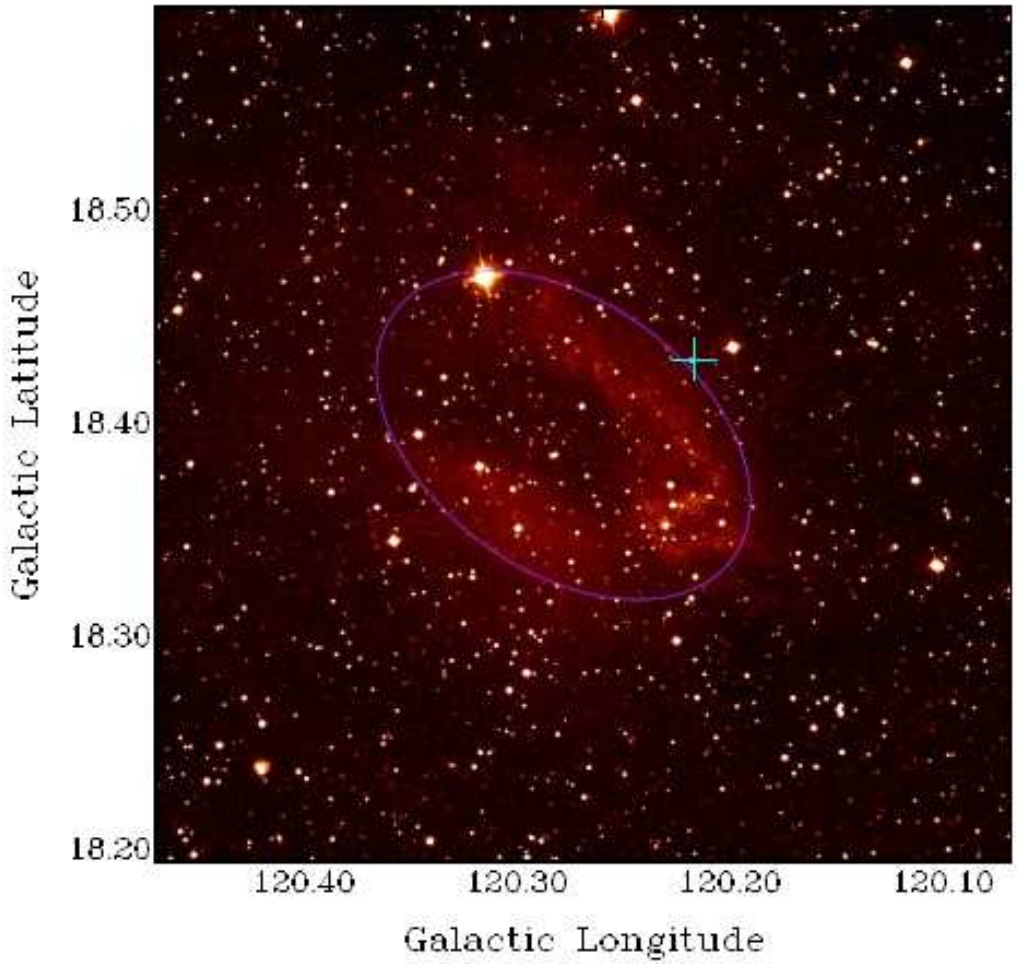
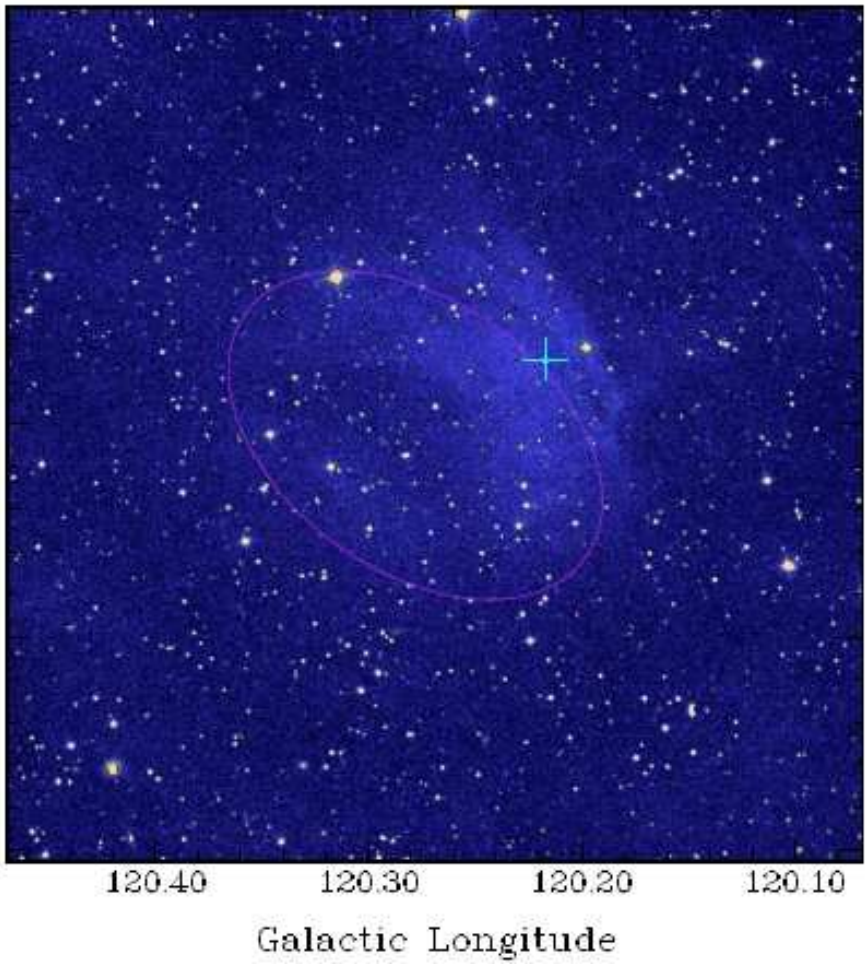




Planetary Nebula Sh 2-174

Ransom, Kothes, Geisbüsch, Reich, & Landecker, 2014, submitted:





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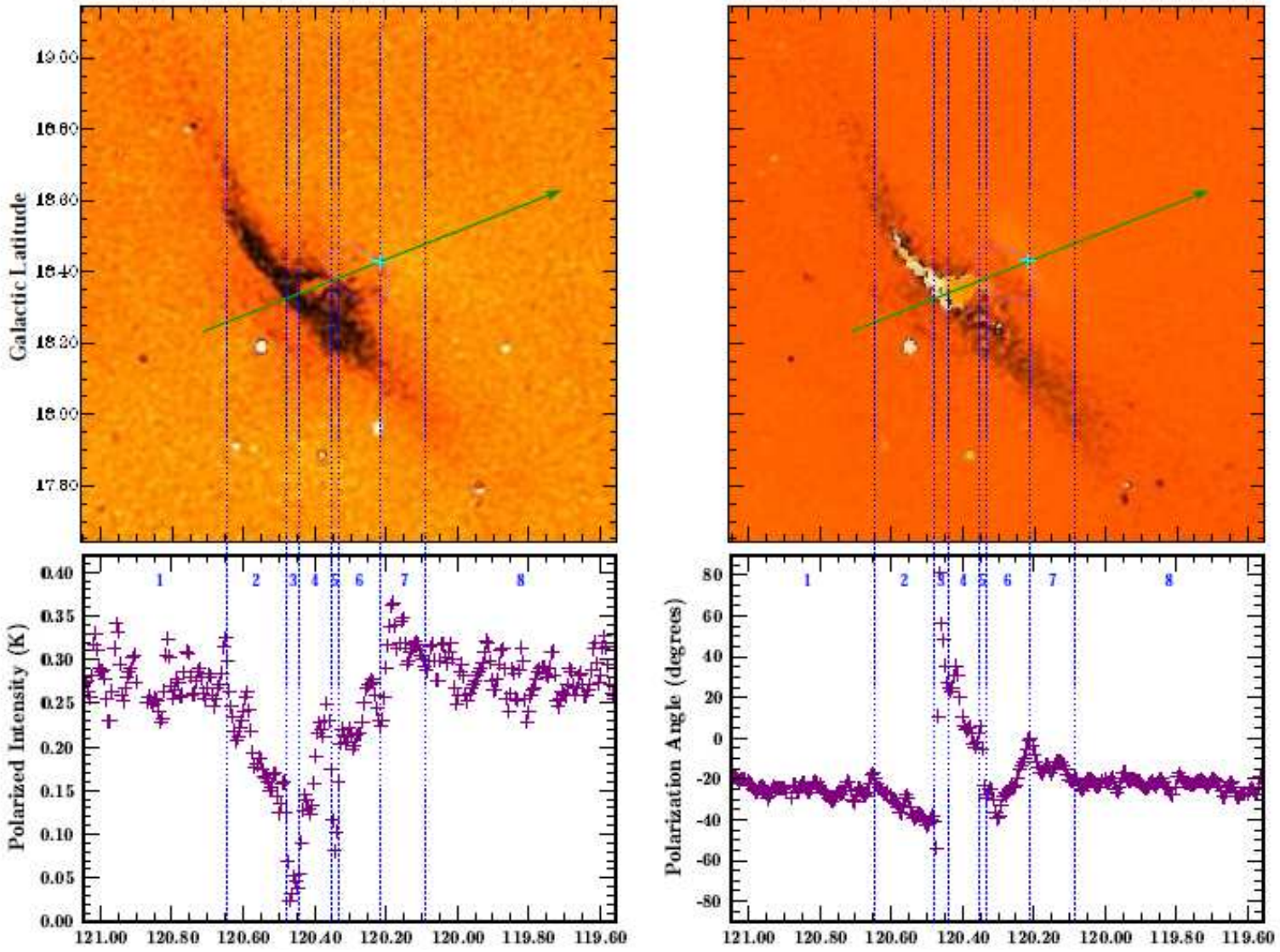

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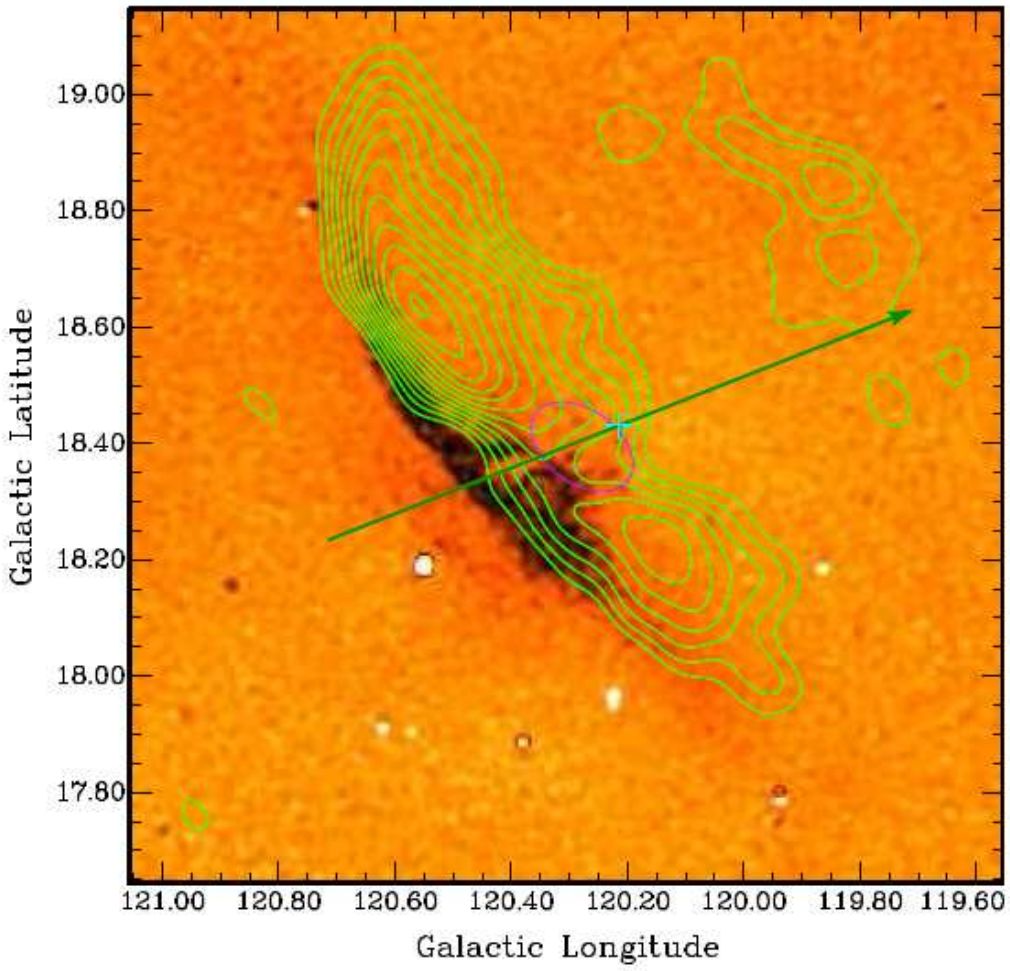

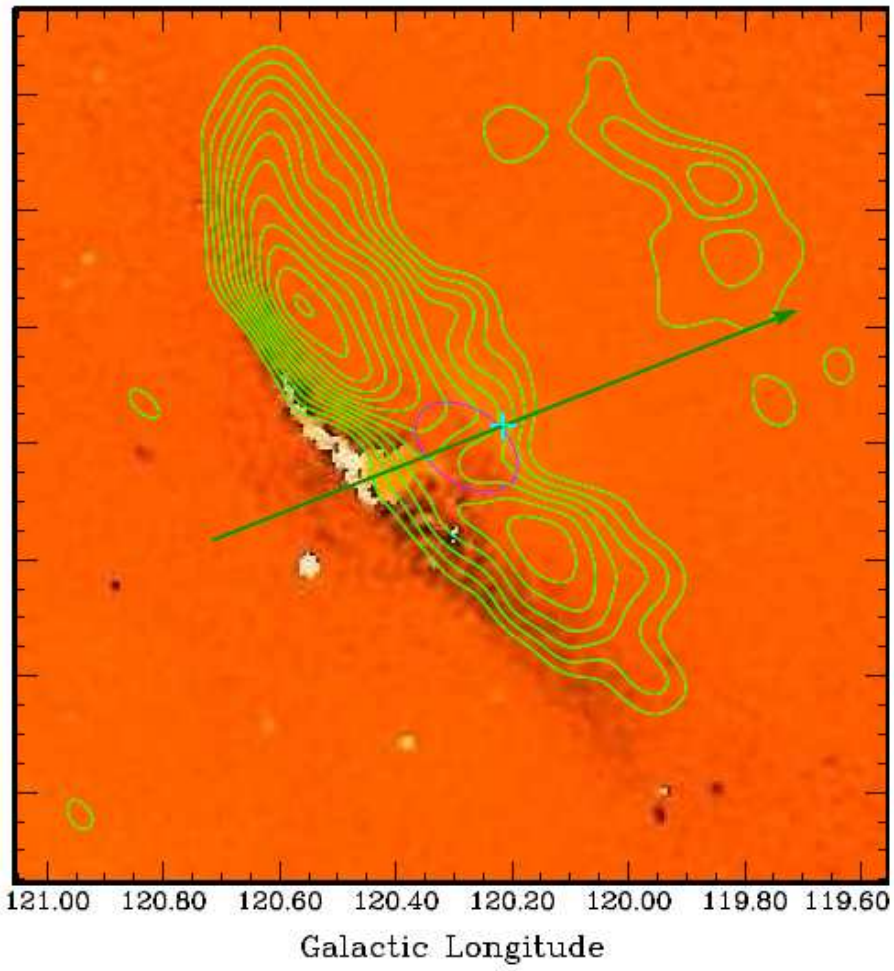

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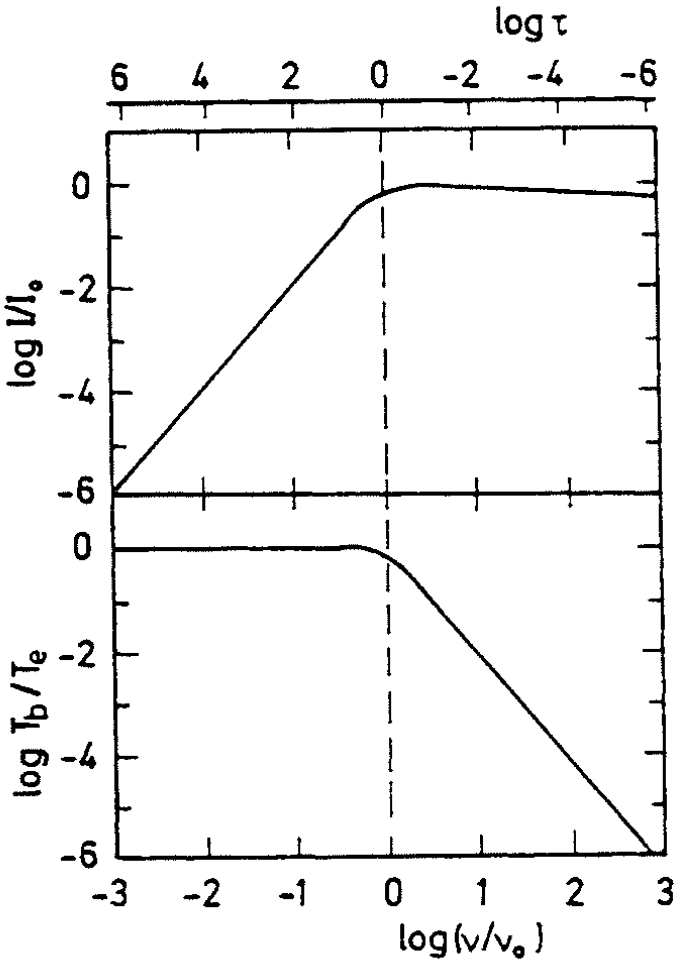
- We should be able to identify resolved PNe by their structure and optically thin thermal spectrum
- We could study their structure, their interaction with their environment and their evolution.

H II Regions and their Spectra



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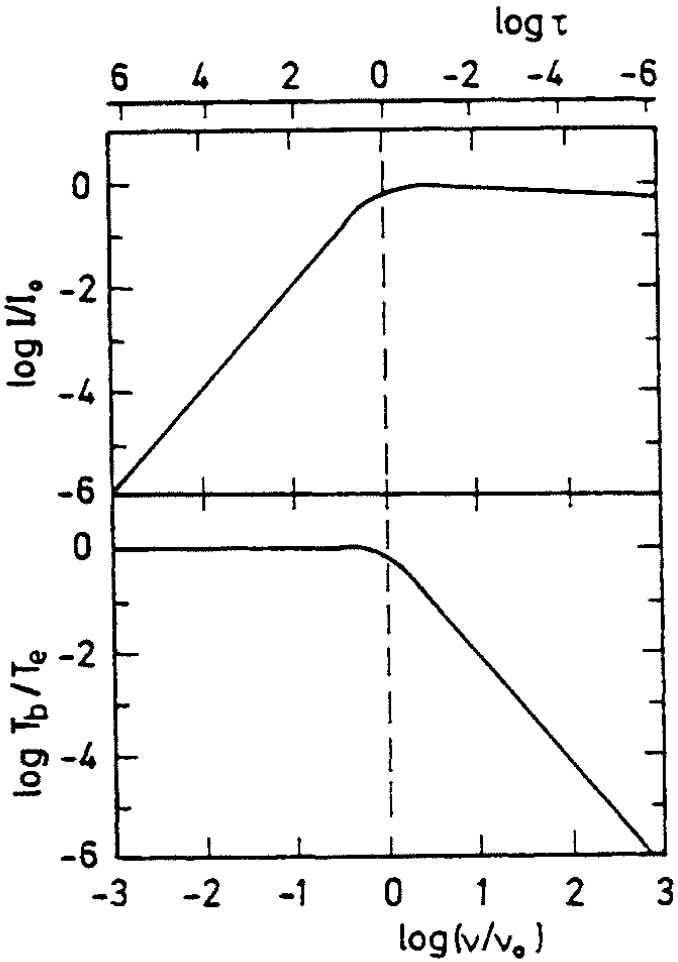

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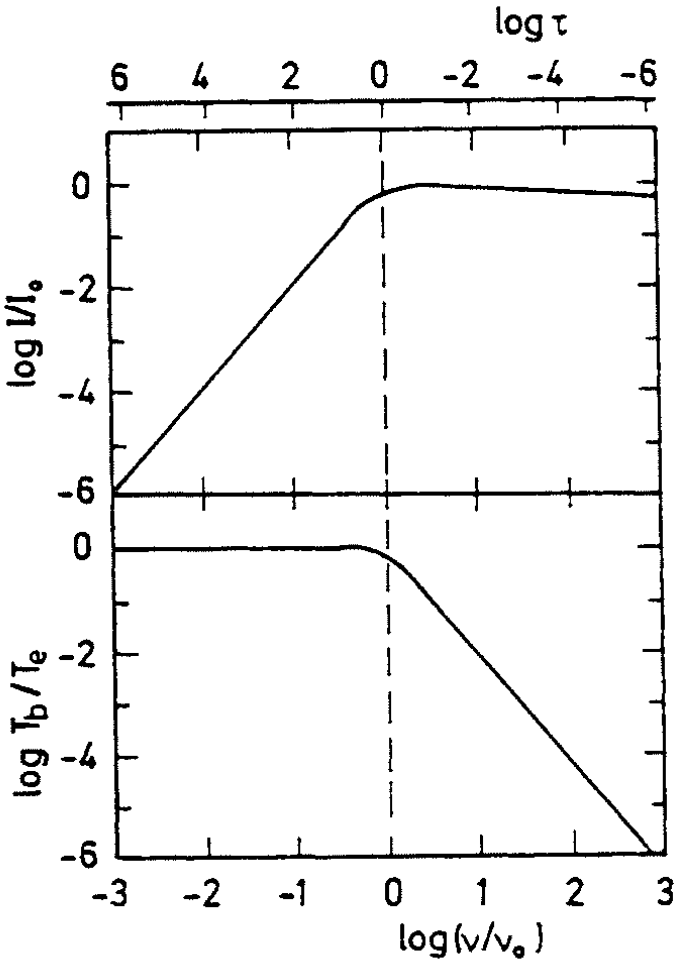

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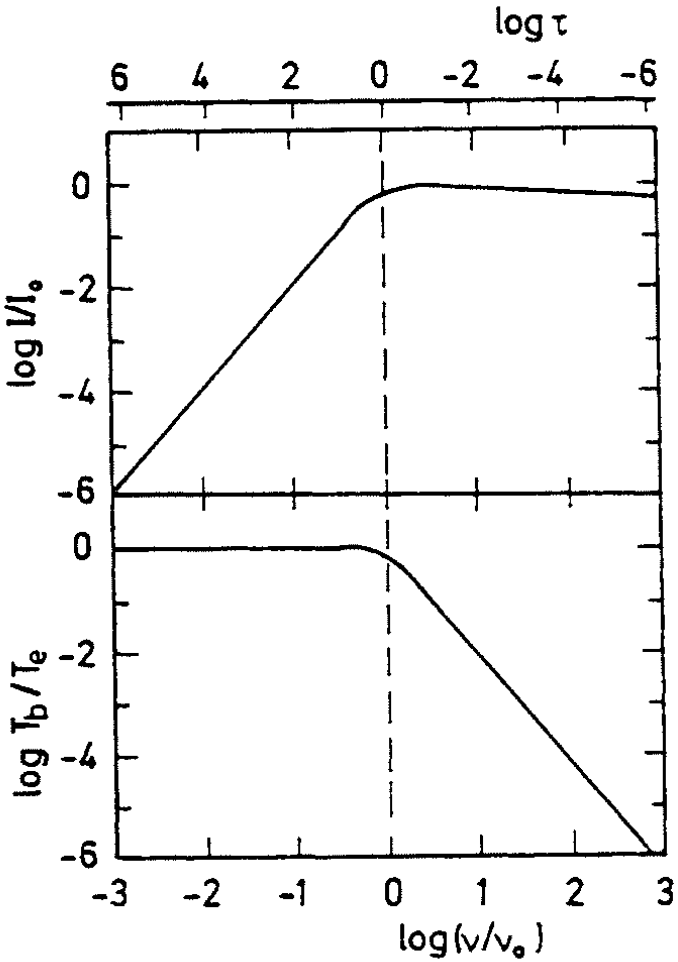

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$$\left(\frac{\nu_0}{\mathrm{GHz}}\right) = 0.3045\left(\frac{T_e}{\mathrm{K}}\right)^{-0.643}\left(\frac{EM}{\mathrm{pc\,cm^{-3}}}\right)^{0.476}$$

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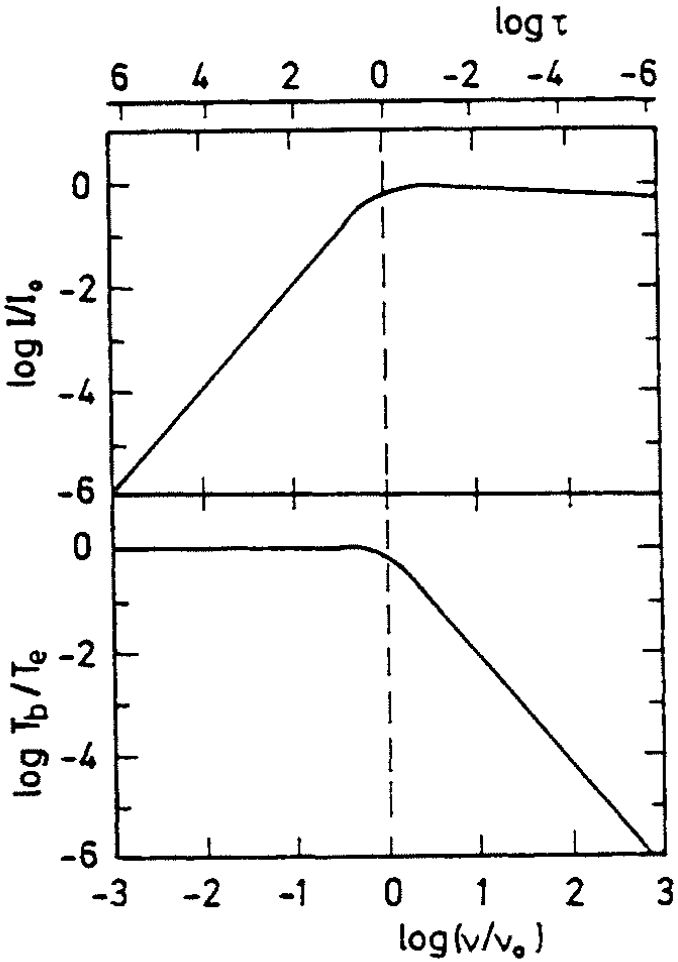

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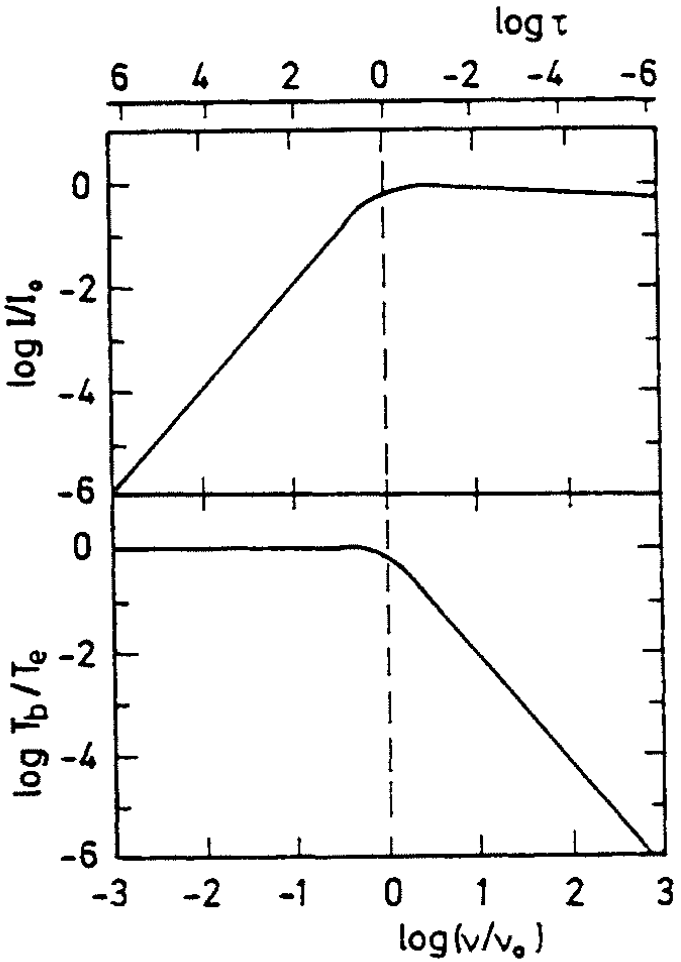

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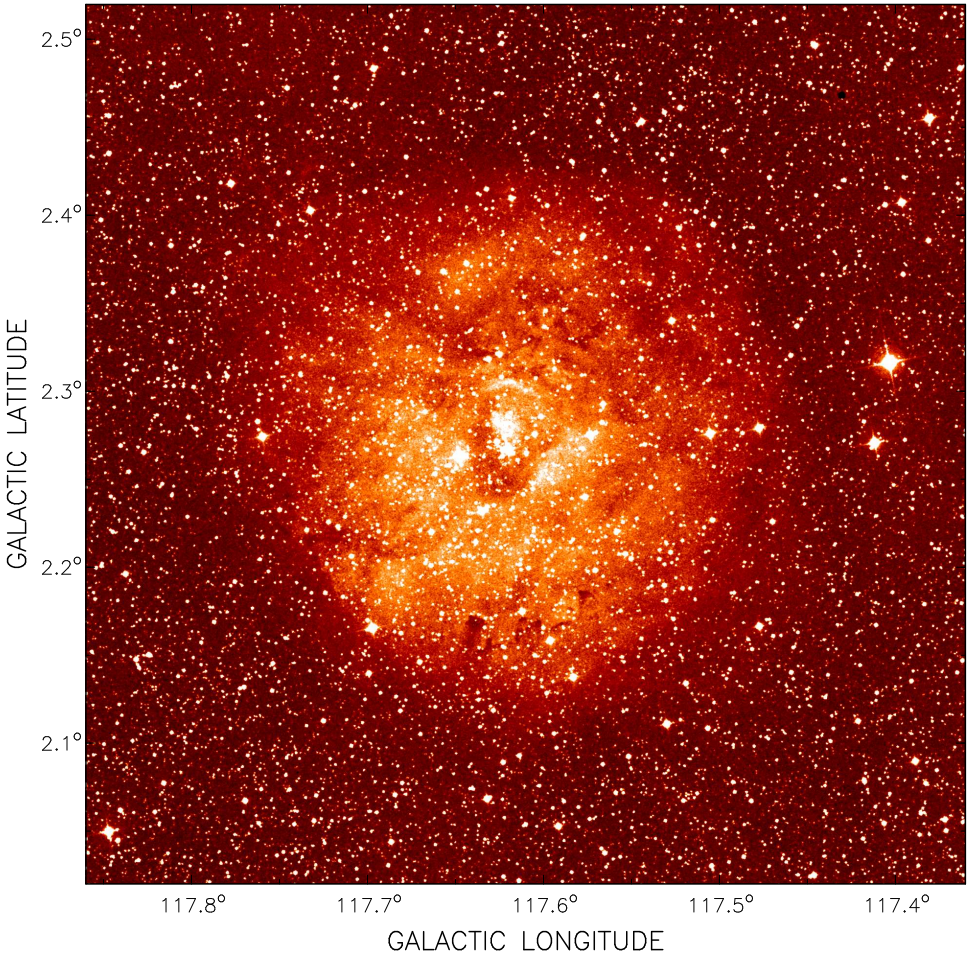
$$8.235 \times 10^{-2}\left(\frac{T_e}{\mathrm{K}}\right)^{-0.35}\left(\frac{\nu}{\mathrm{GHz}}\right)^{-2.1}\left(\frac{EM}{\mathrm{pc\,cm^{-6}}}\right)$$

H II Region Sh 170



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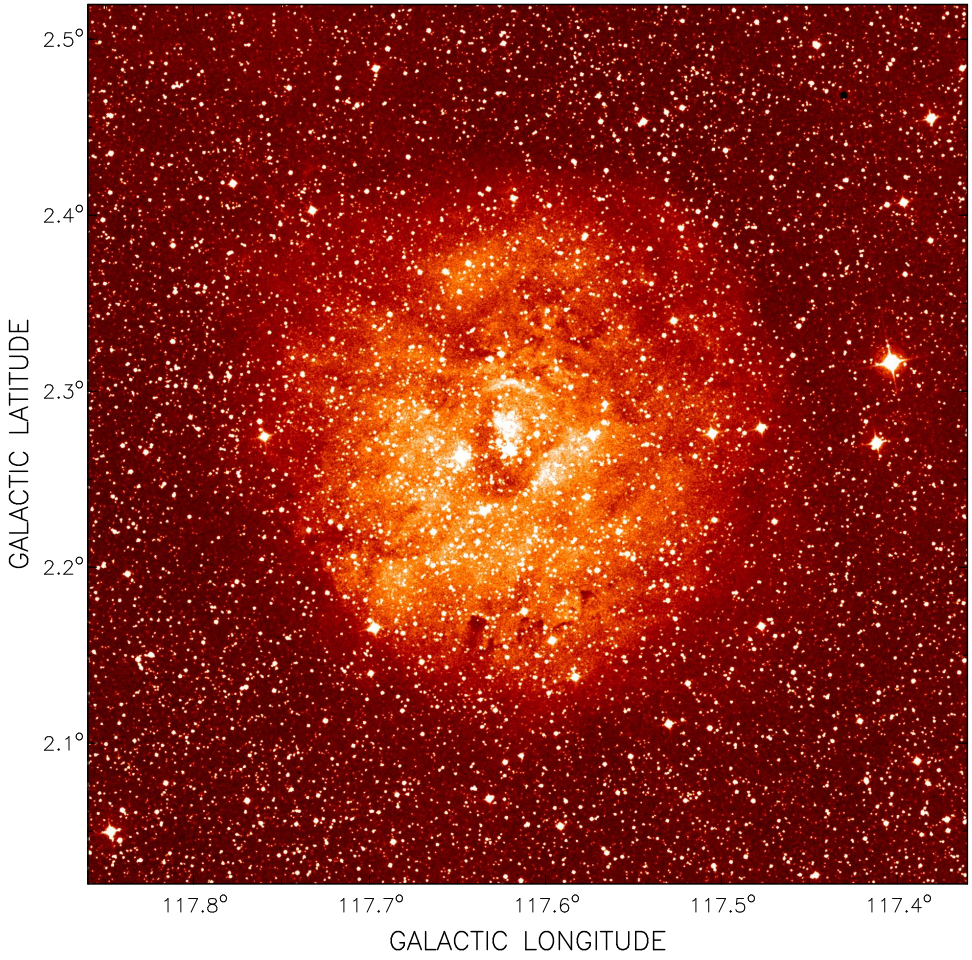

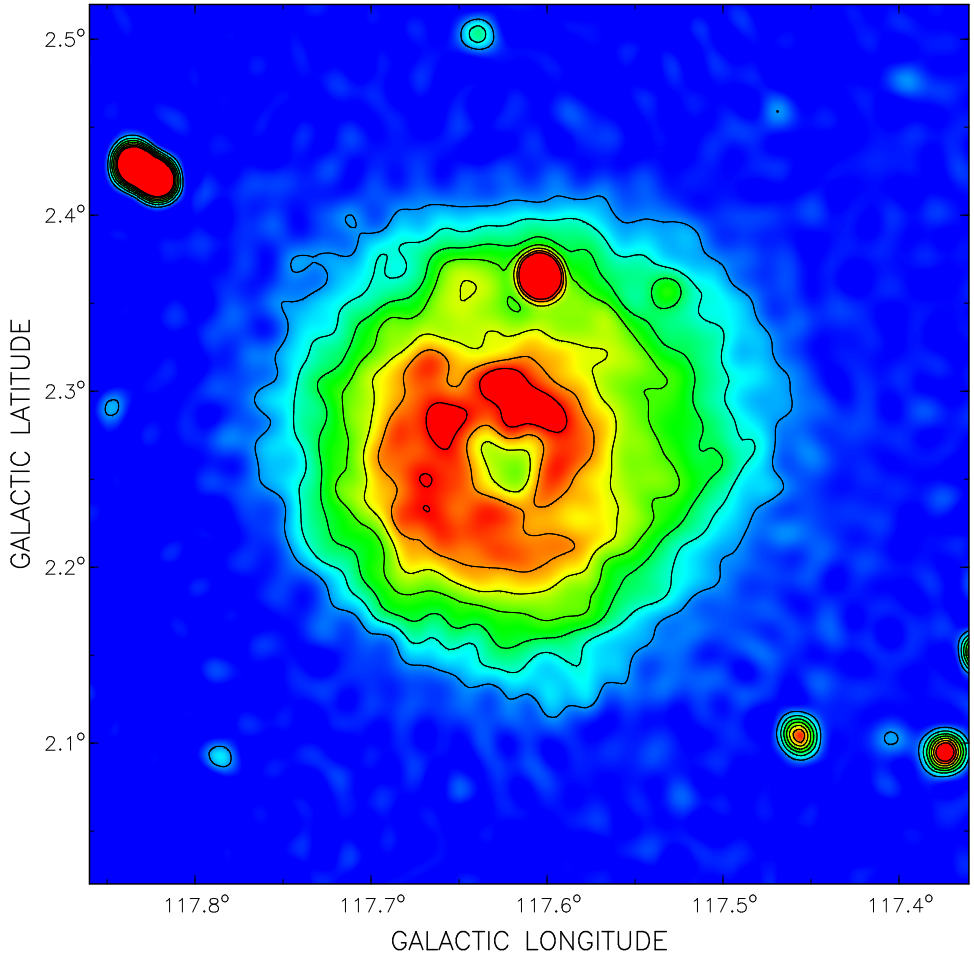

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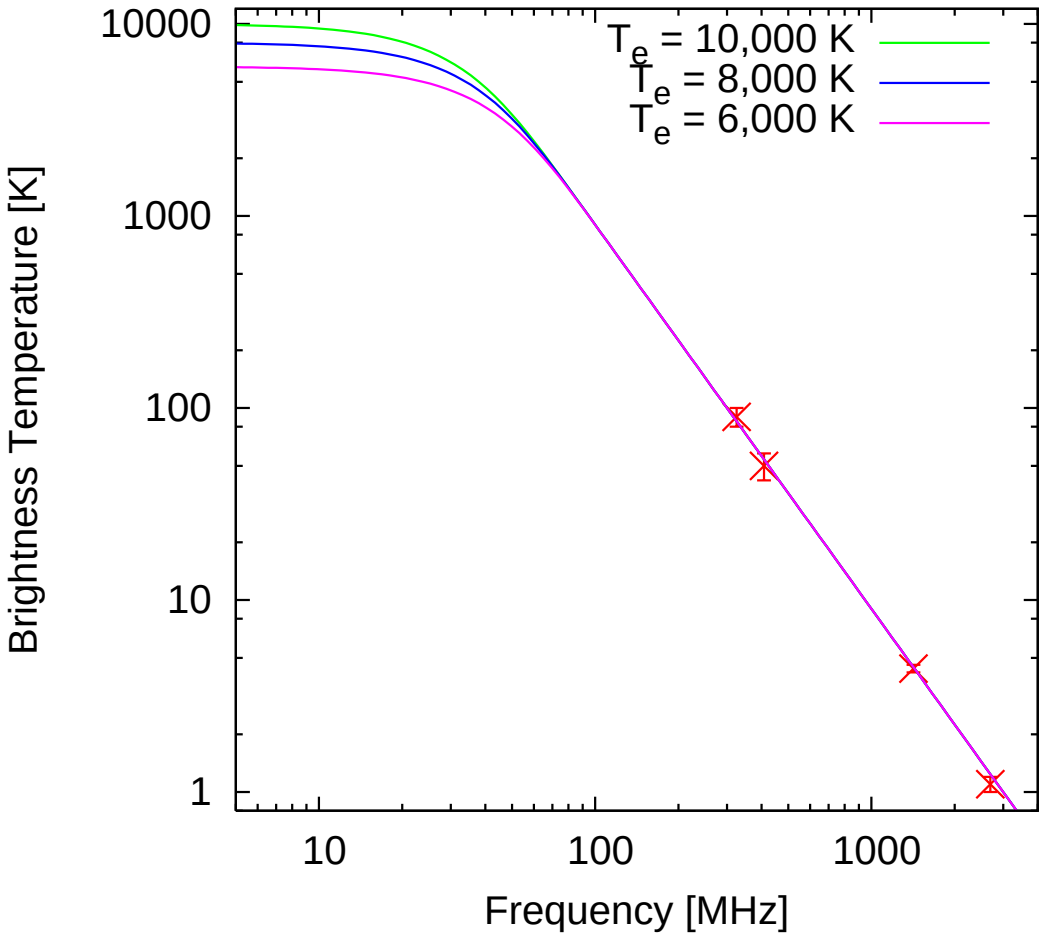

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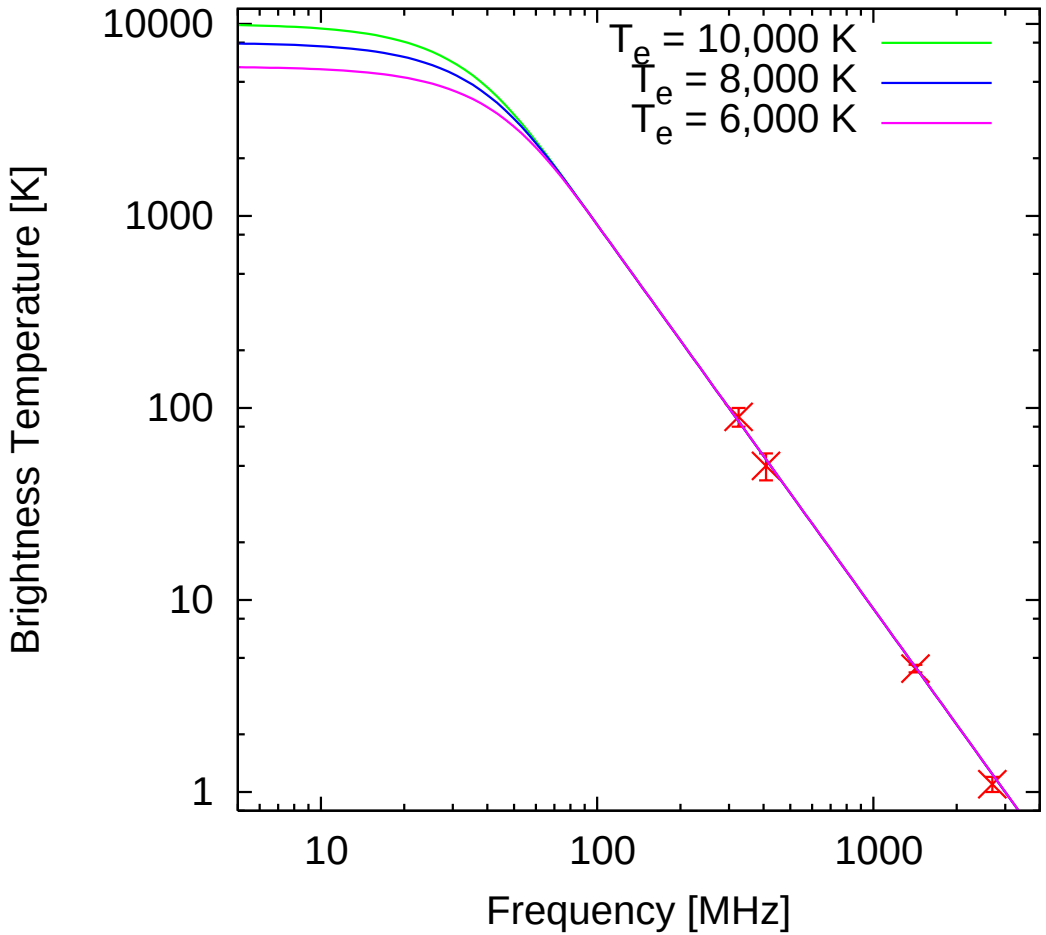


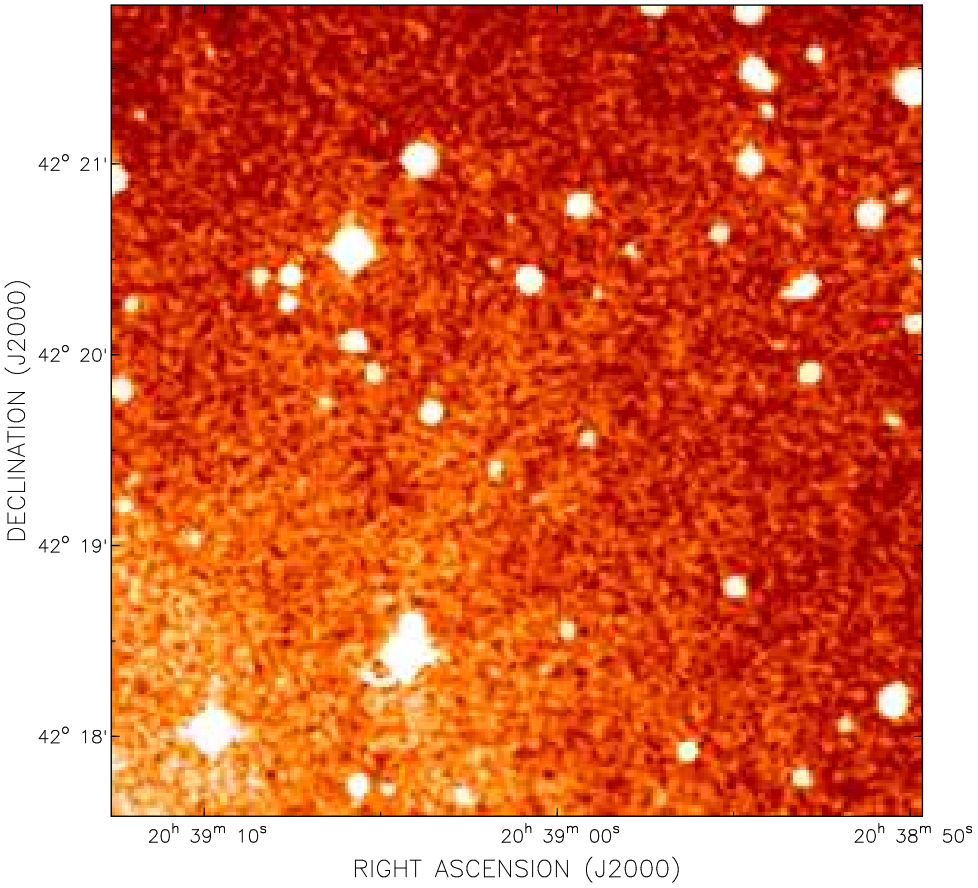
- $d = 2.2$ kpc
- $D = 9.0$ pc

For $T_e = 8,000$ K:

- $EM = 2500\ \mathrm{pc\,cm^{-6}}$
- $N_e = 18\ \mathrm{cm^{-3}}$
- $U = 30.9\ \mathrm{pc\,cm^{-2}}$

  O9.5V star: $U = 30.5\ \mathrm{pc\,cm^{-2}}$

Ultra-Compact H II Region DR 21



DSS Red

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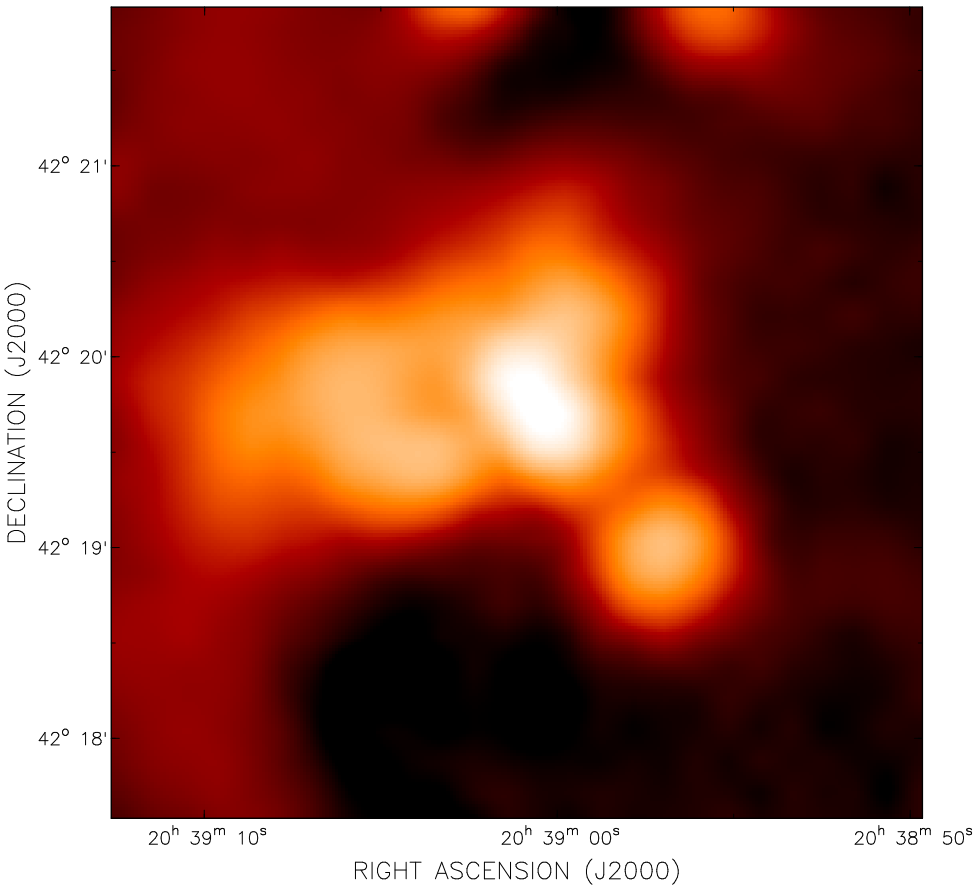

MSX 8 μm

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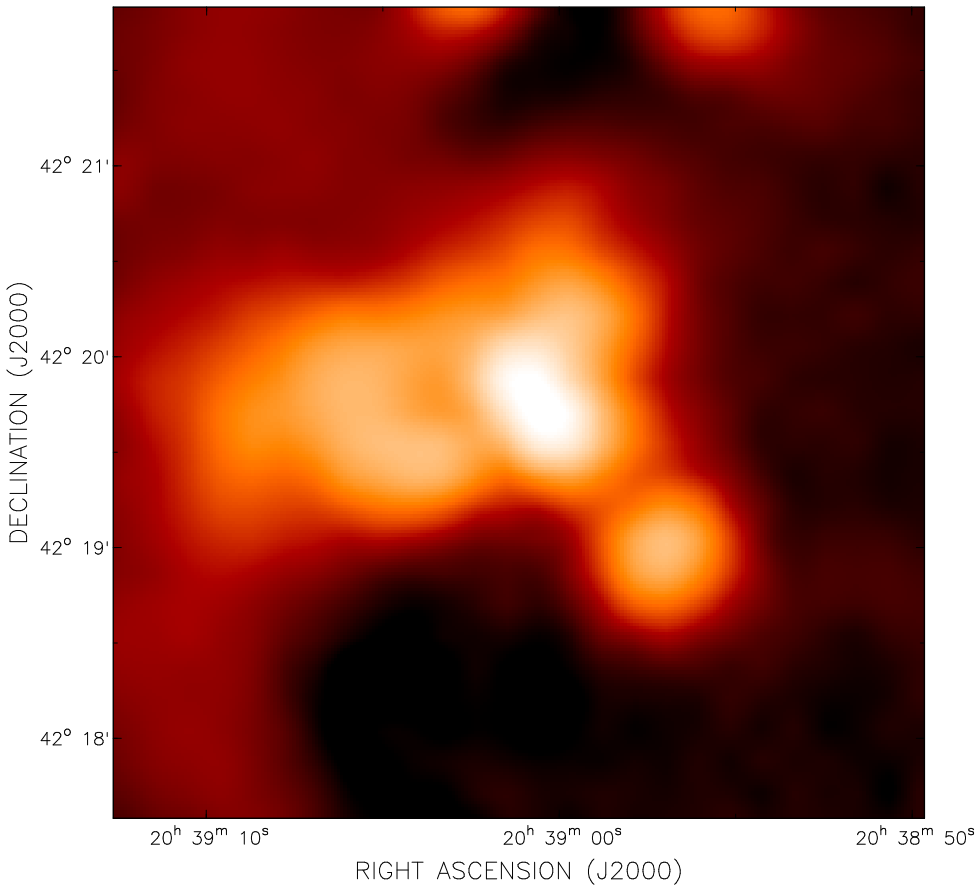

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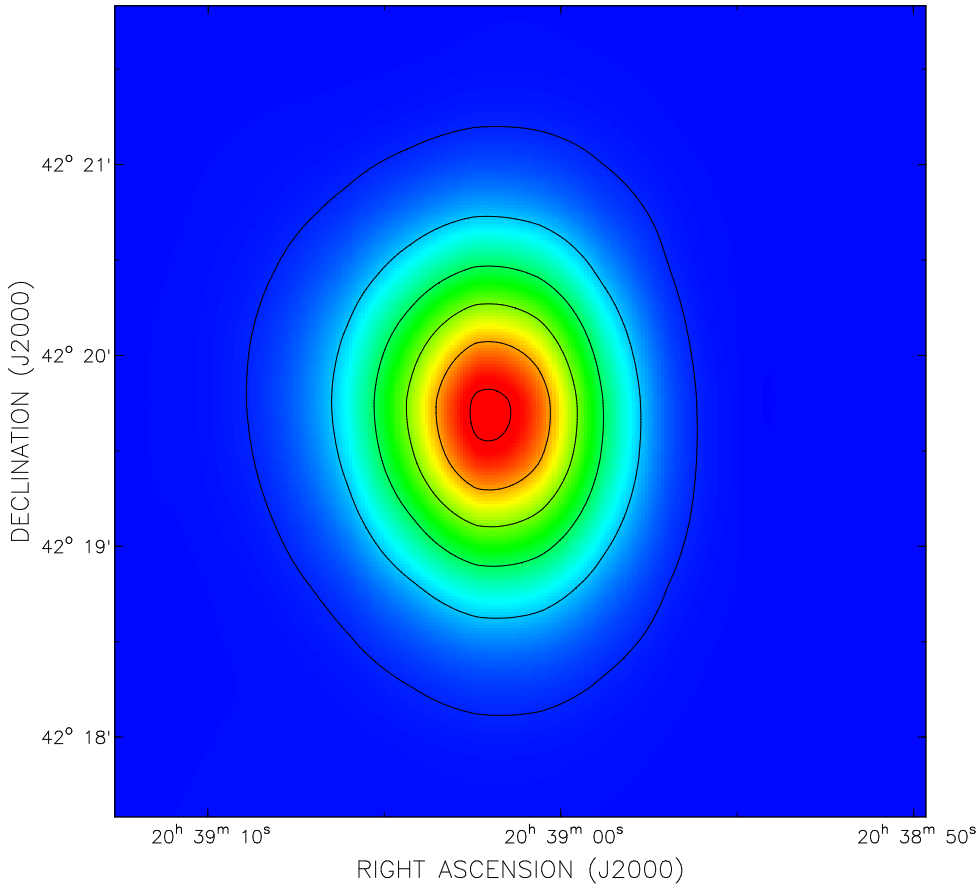

CGPS 1.4 GHz

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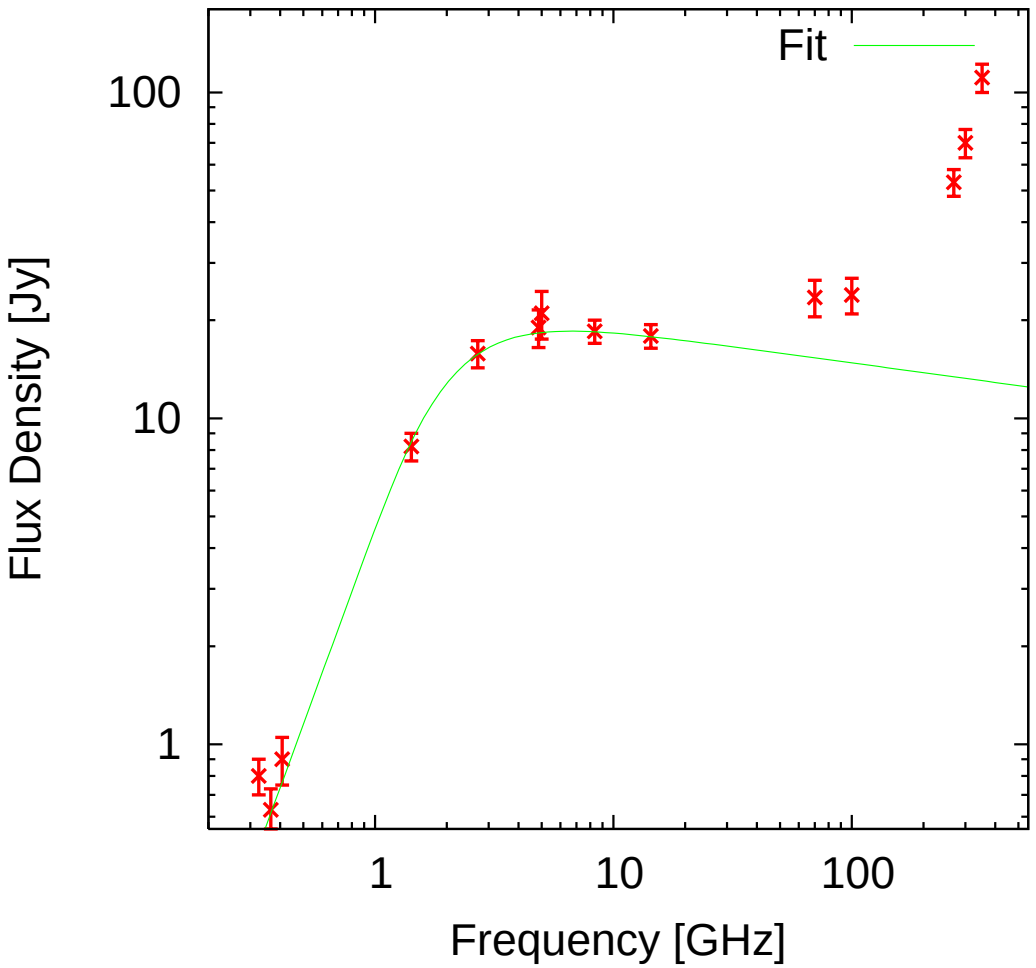

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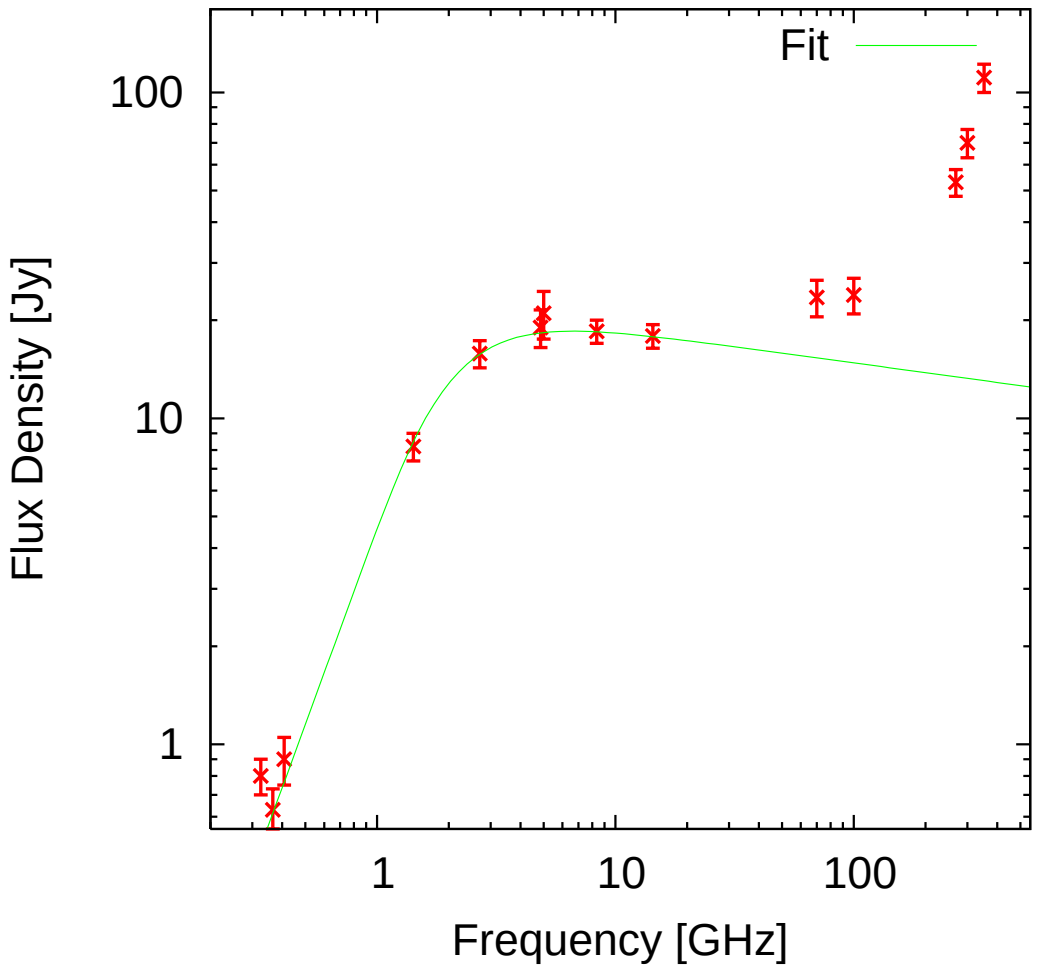

- $T_b^{\mathrm{peak}} = 9,800$ K (optically thick)
- $d = 1.7$ kpc
- $\Theta = 20'' \mathrel{\hat{=}} 0.165$ pc

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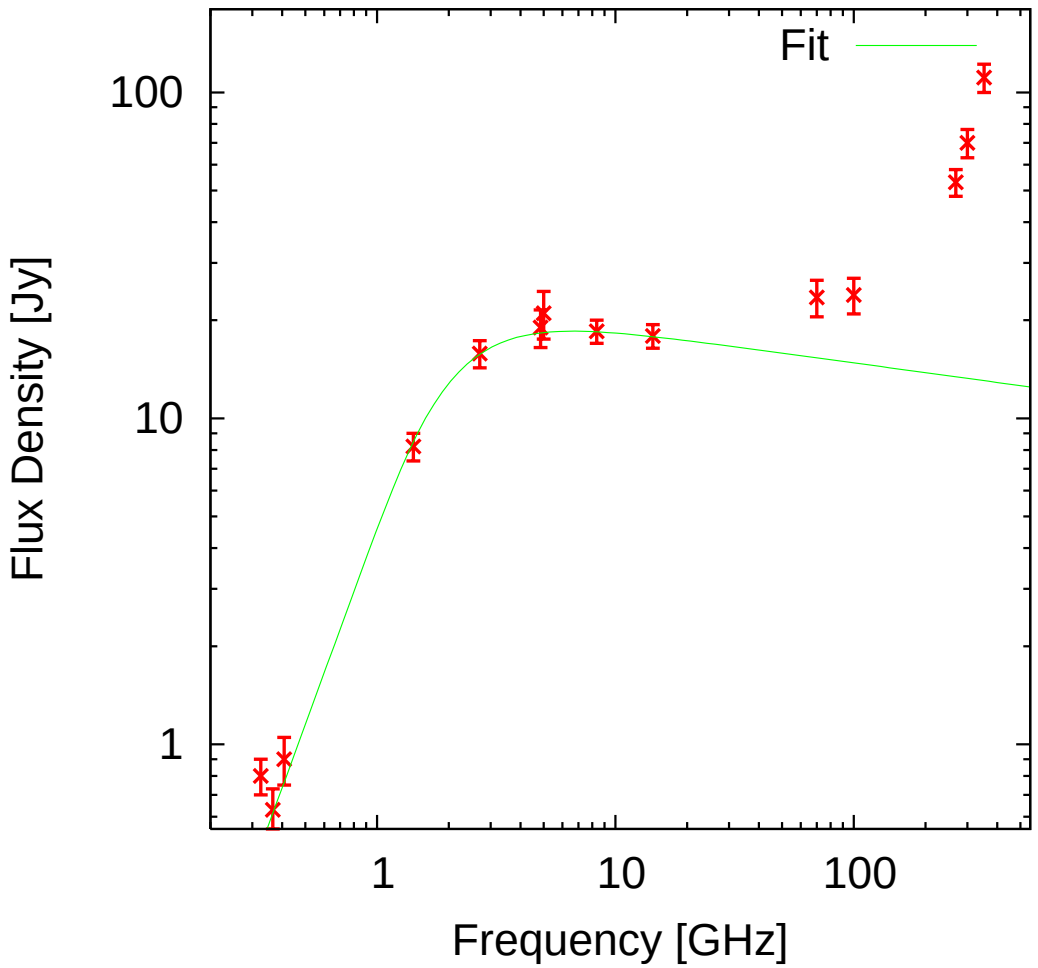

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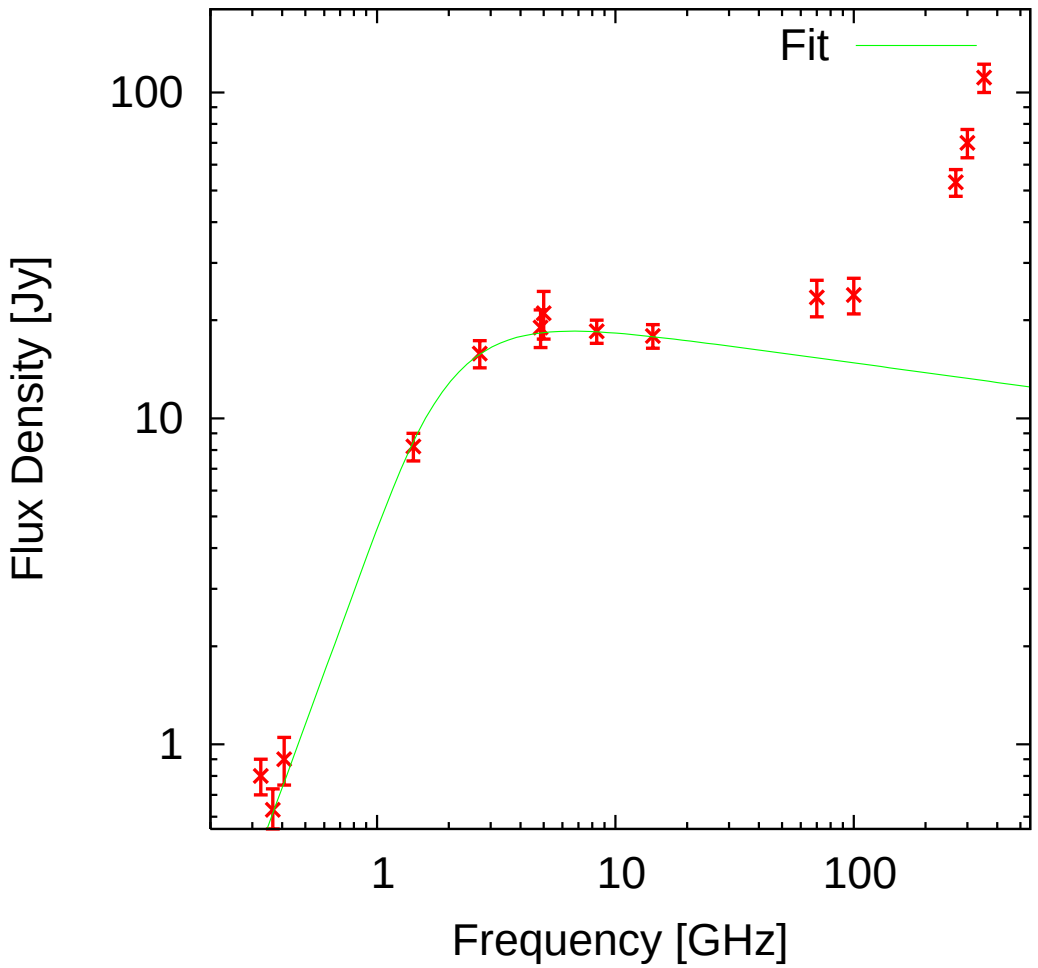

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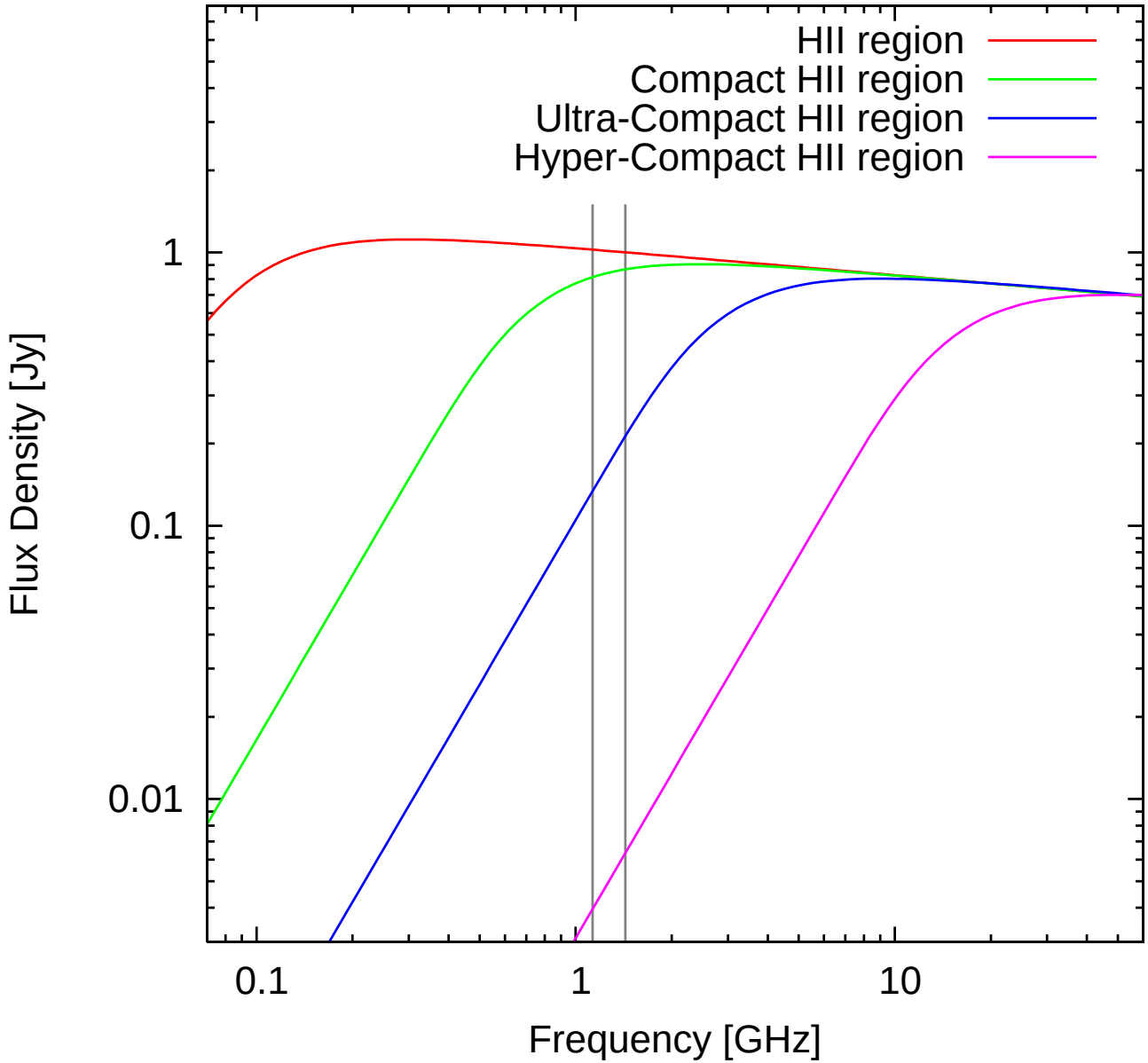
$T_e = 9,800$ K, $\nu_0 = 2.5$ GHz:

- $EM = 1.56\,10^7$ pc cm^{-6}
- $N_e = 9,700\,$cm^{-3}, $M = 0.66\,M_\odot$
- $U = 37.5$ pc cm^{-2}
  O9V star: $U = 36.2$ pc cm^{-2}
  O8ZAMS star: $U = 37.4$ pc cm^{-2}

H II Regions and EMU

Introduction
Planetary Nebulae
H II Regions



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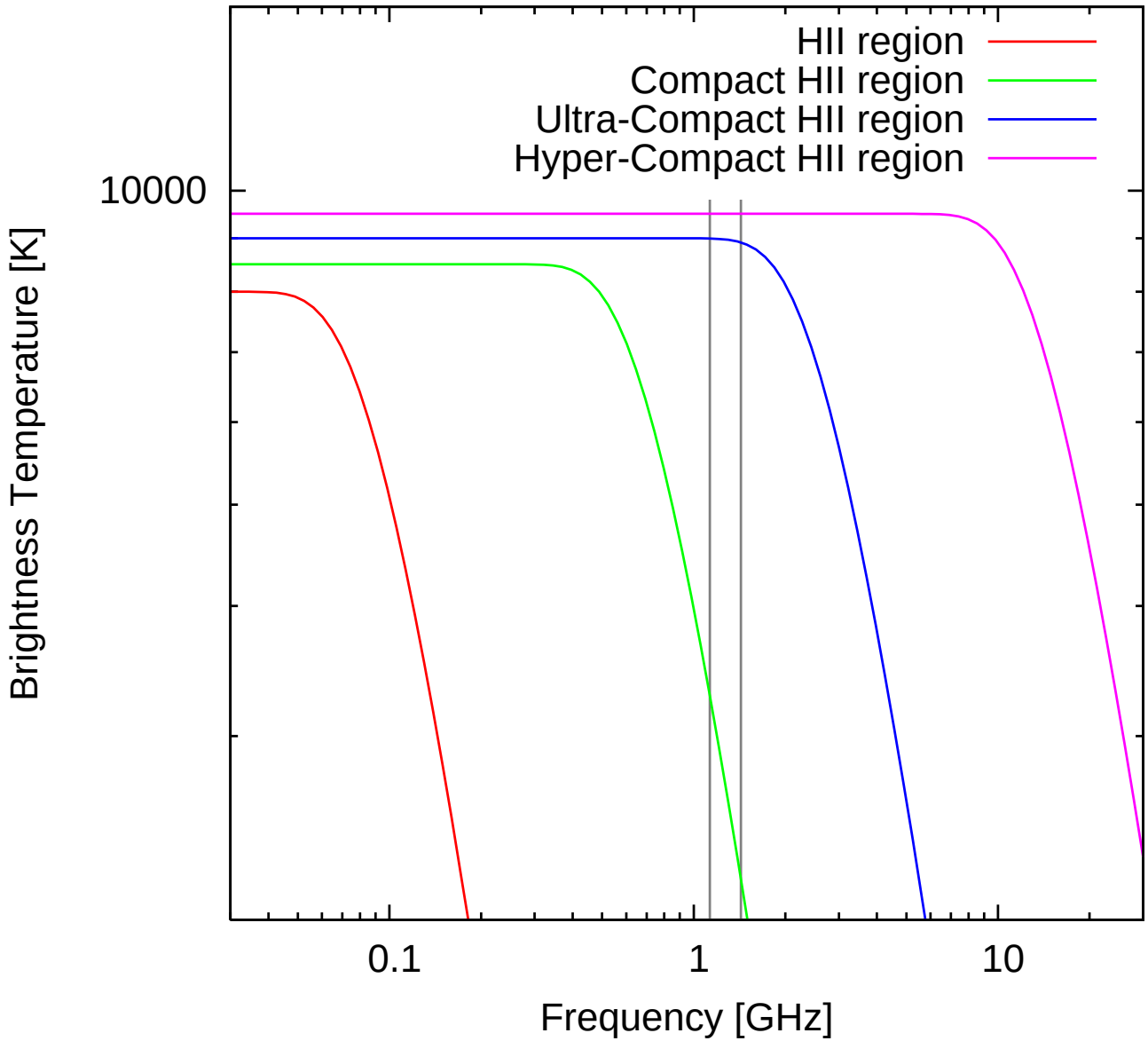

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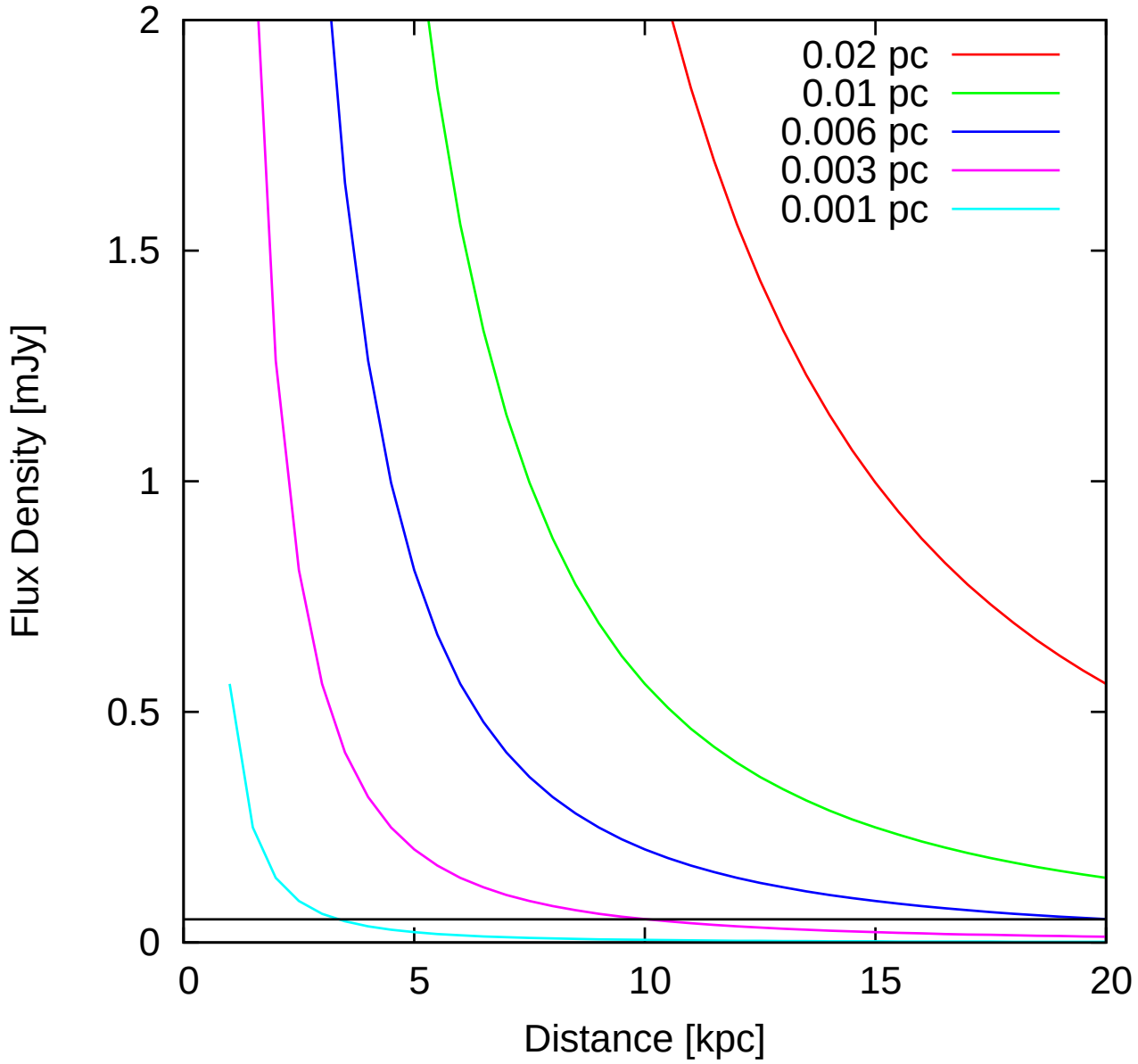

Compact Galactic Sources in EMU

Introduction
Planetary Nebulae
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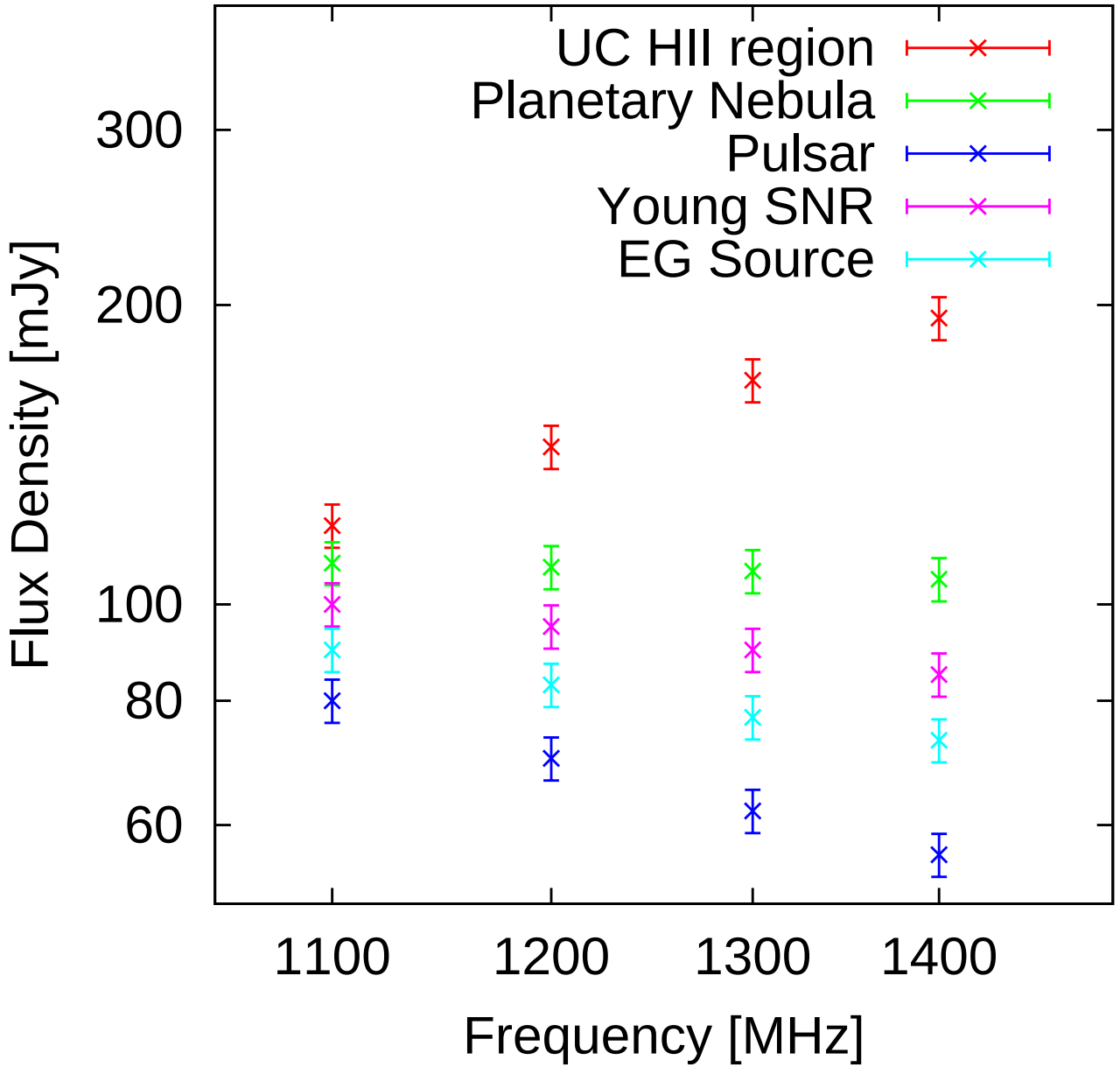

Normal HII region and ASKP surveys

- optically thin + T_b
- assuming $T_e = 8000$ K $\Rightarrow$
  - τ
  - EM
- radial velocity from Wallaby $\Rightarrow$
  - d
  - R
  - N_e
  - U

UC and HC HII region and ASKP surveys

- optically thick + T_b
- assuming $T_e = 10000$ K $\Rightarrow$
  - R ['']
- radial velocity from Wallaby $\Rightarrow$
  - d
  - R [pc]
  - lower limits for EM, N_e, and U

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- We should be able to detect ALL UC HII regions in the Galactic plane covered by EMU.
- We can make thorough studies of HII region characteristics based on ASKAP data alone.