Low frequency radio recombination lines in the Galactic plane with LOFAR

Pedro Salas

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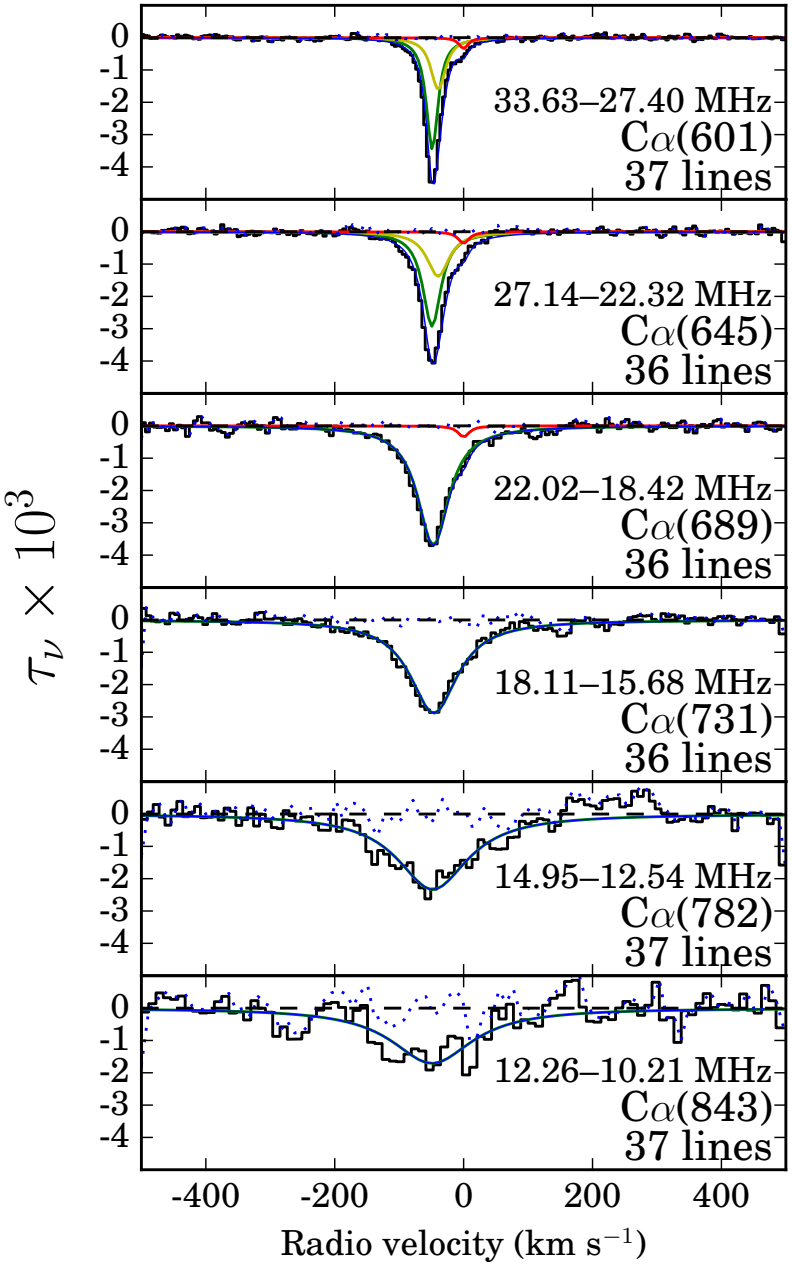
Zandvoort aan zee, 6th April 2016

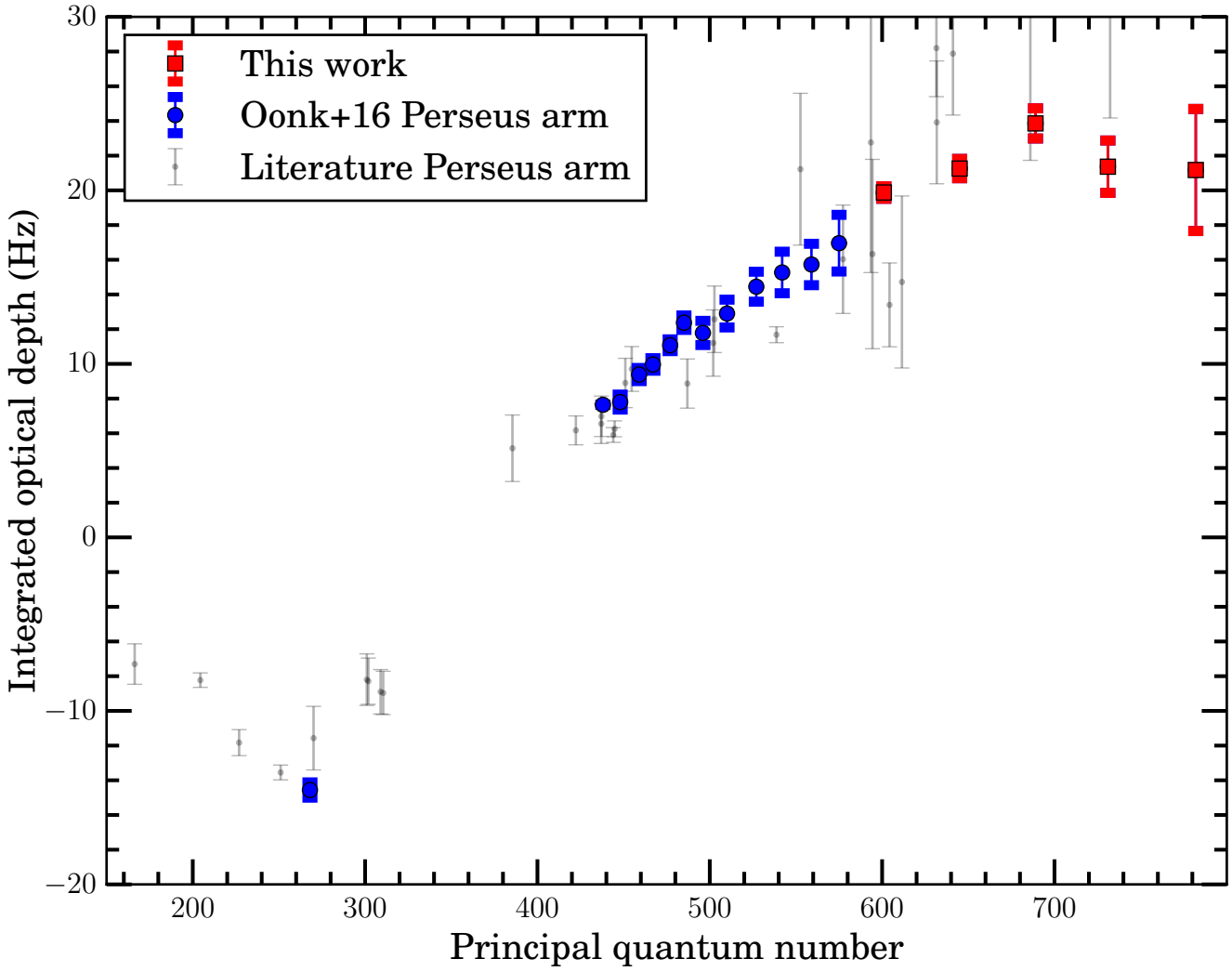
What can we learn from the low frequencies?



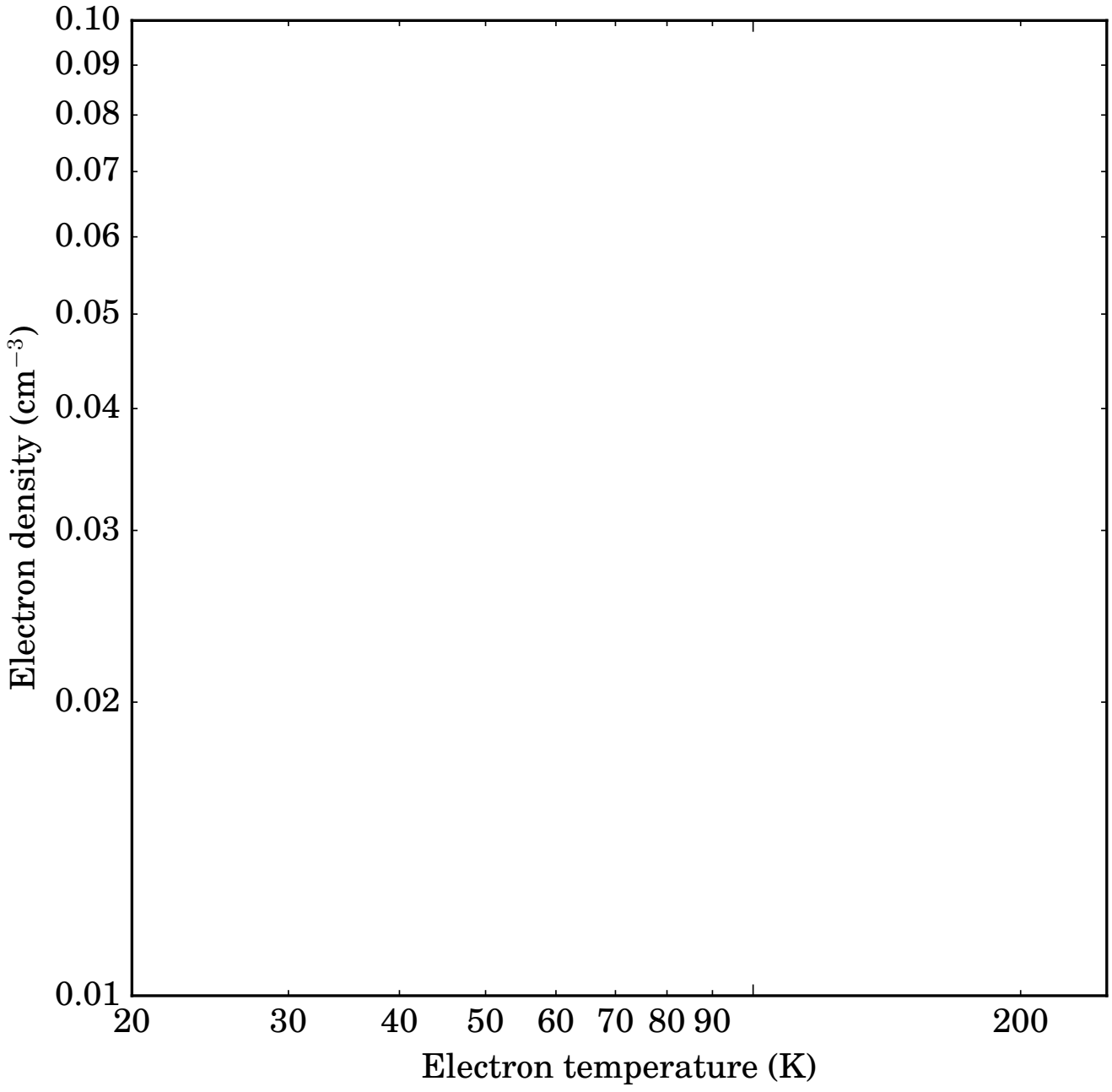
The lines get broadened by the presence of a radiation field and collisions with electrons.

$$\Delta v \propto T_{rad} n^{5.8} + n_e T_e n^{\gamma_c},$$
$$4.28 \leq \gamma_c \leq 5.48$$

What can we learn from the low frequencies?



At low frequencies, the lines are in collisional equilibrium and the level population can be described as in LTE.


0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
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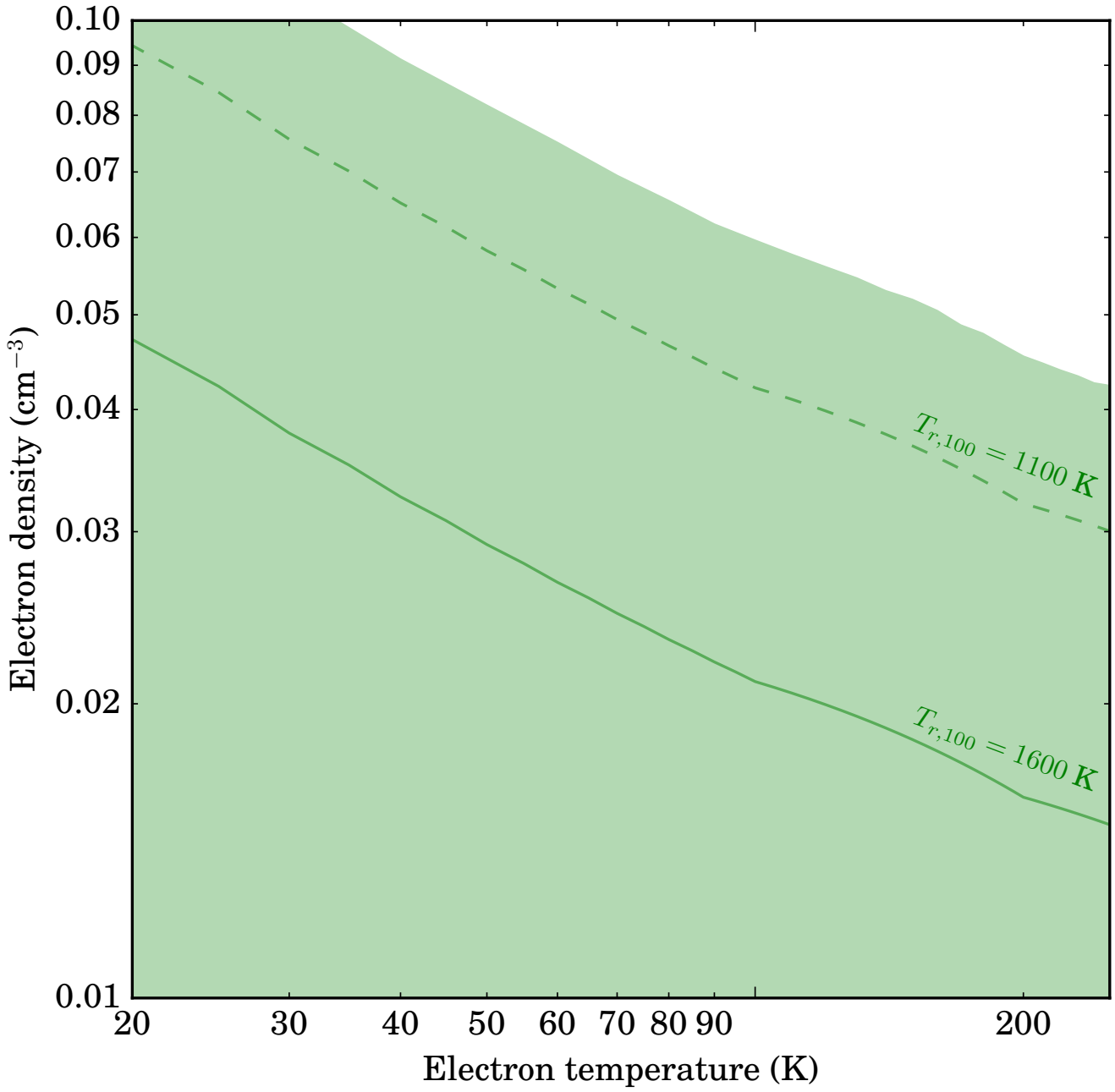
0.01
Electron density (cm^{-3})
20
30
40
50
60
70
80
90
200
Electron temperature (K)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Electron temperature (K)
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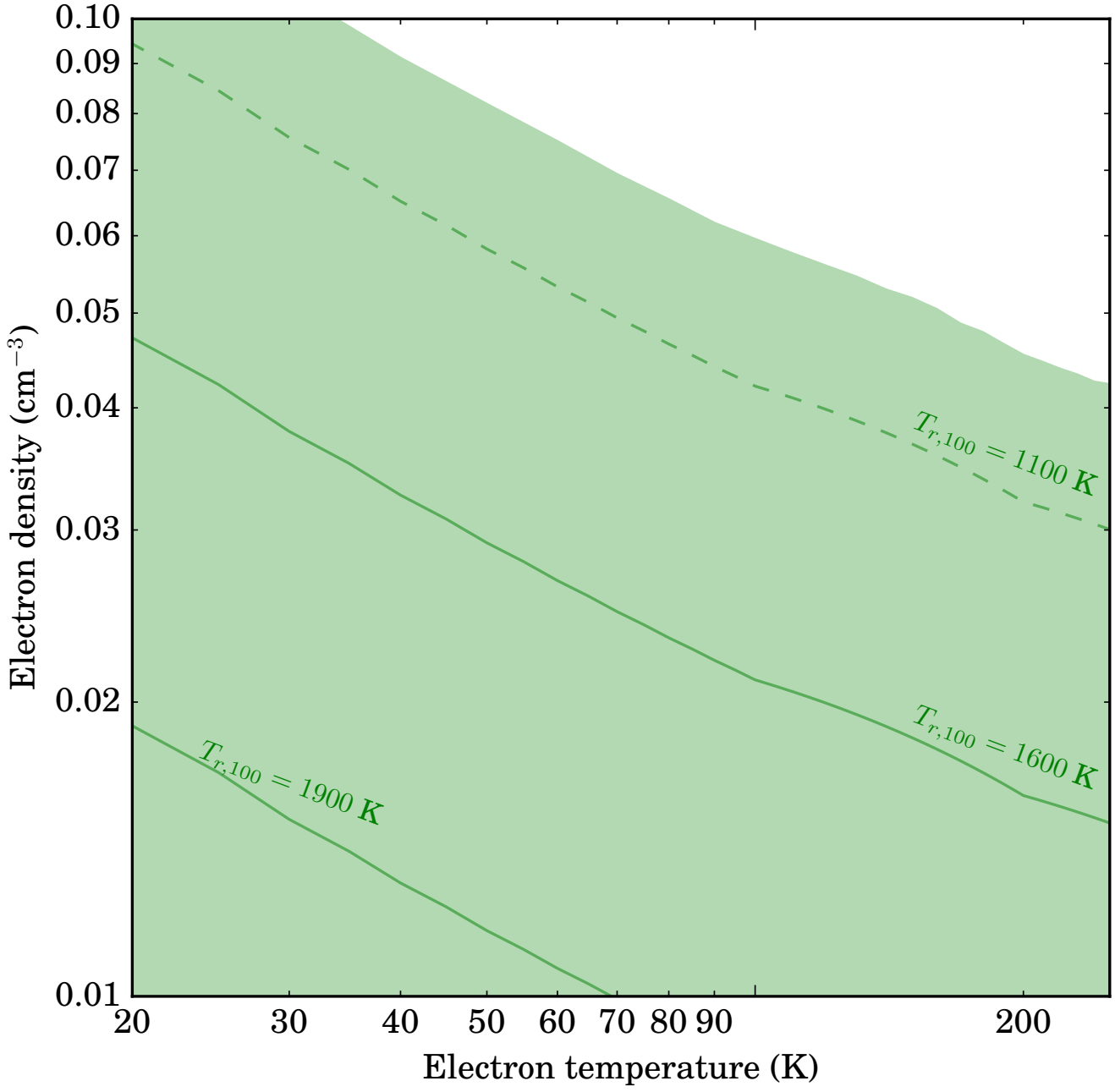
$T_{r,100} = 1600\ K$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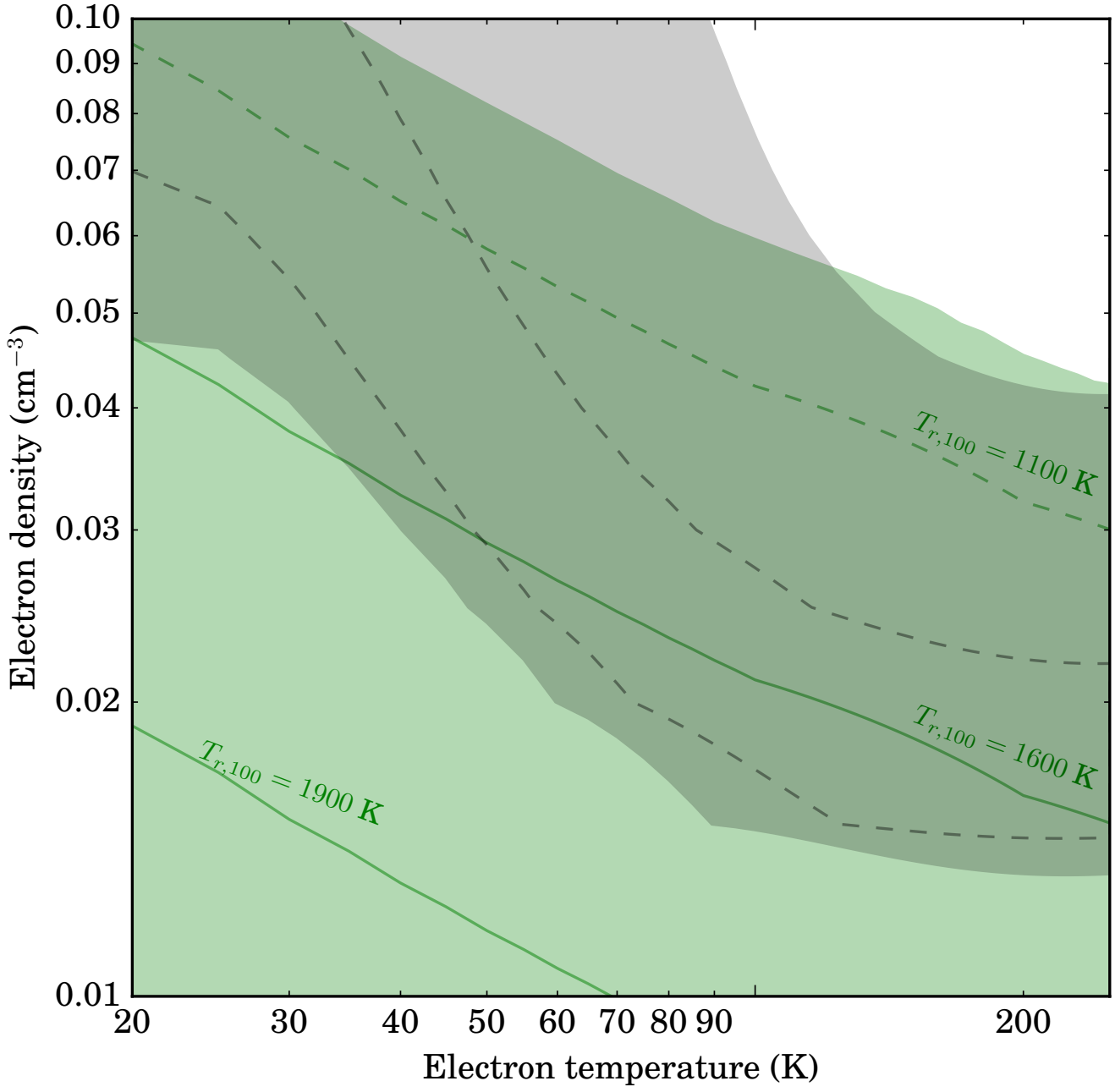
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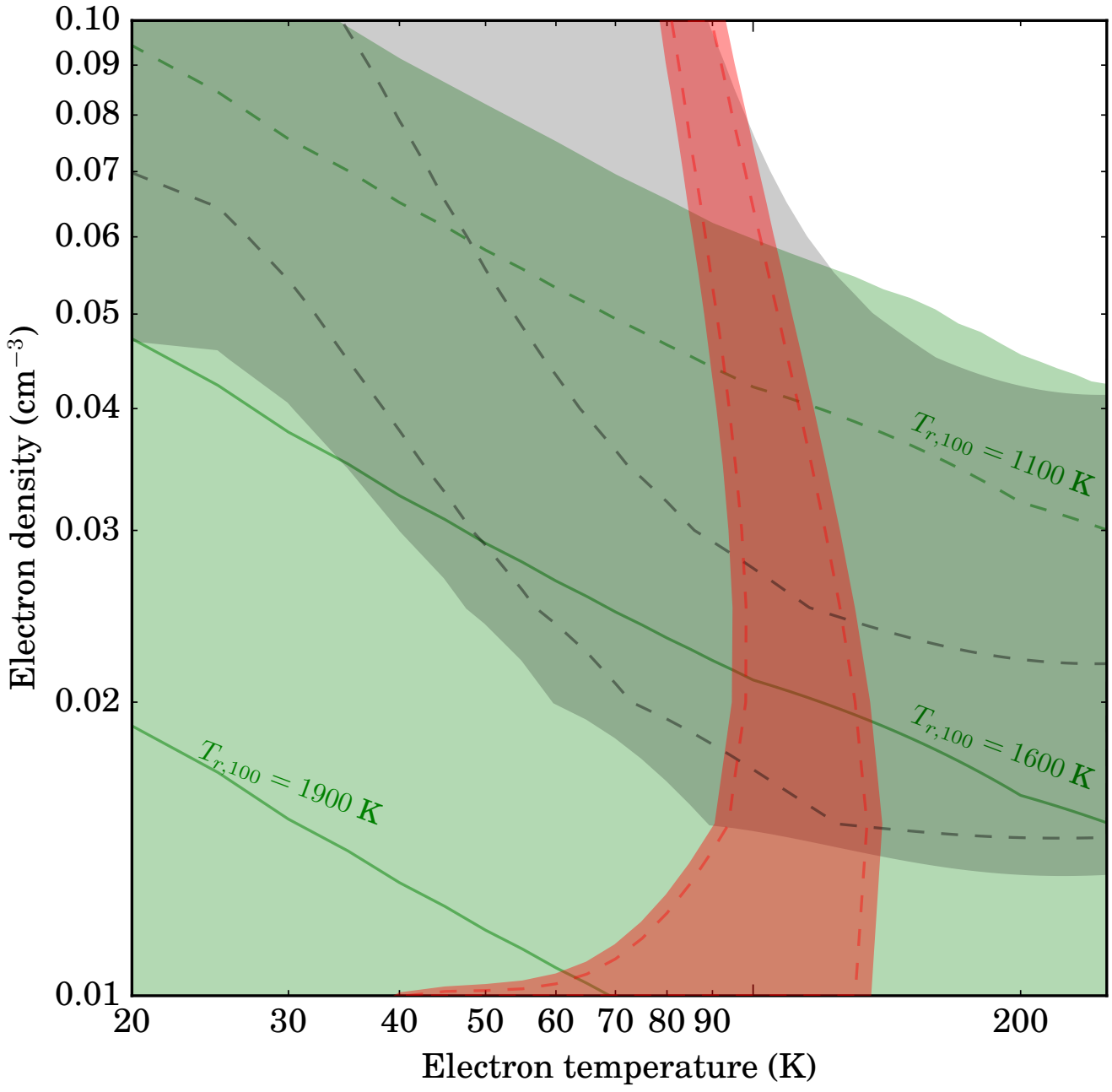
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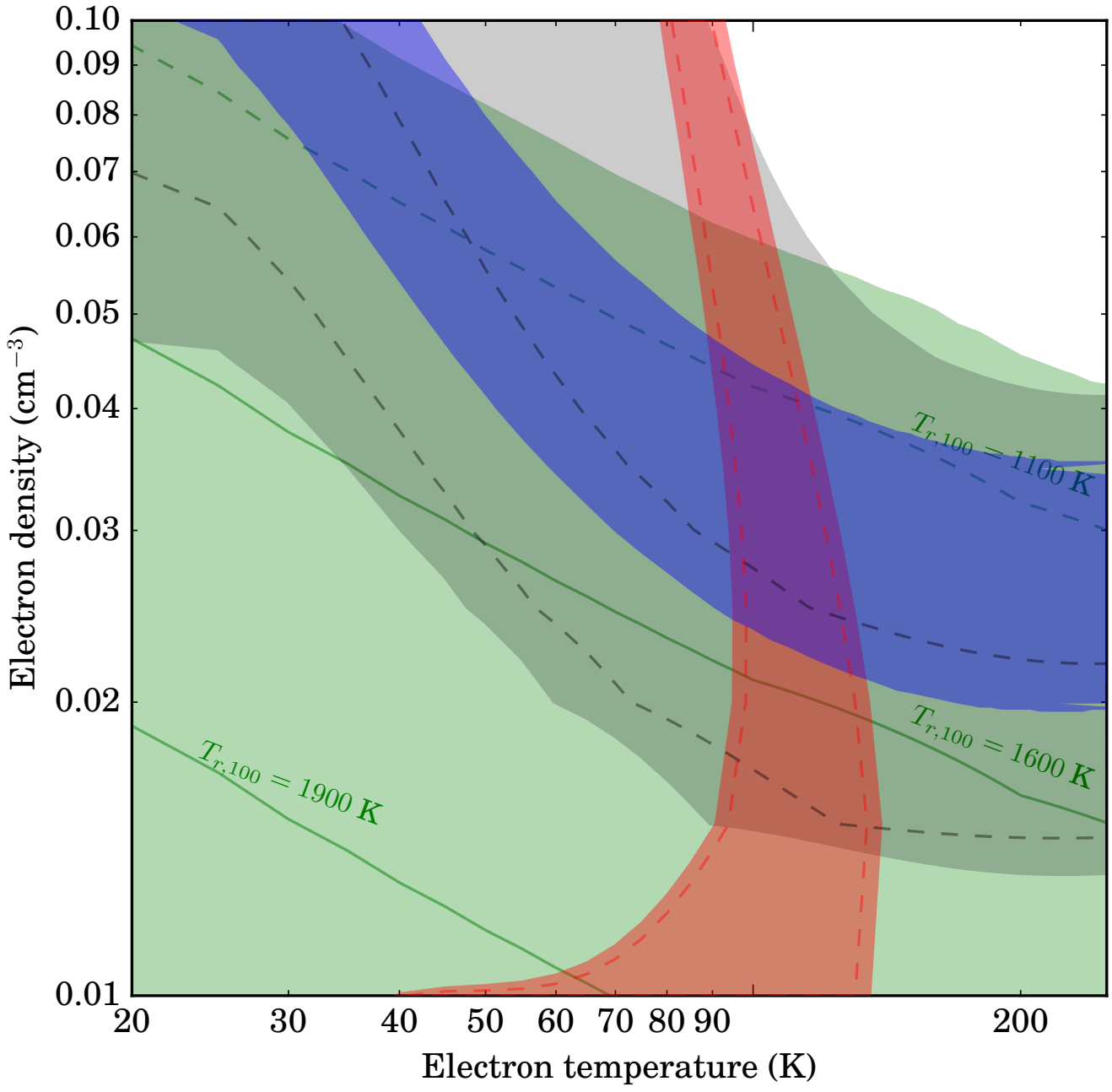
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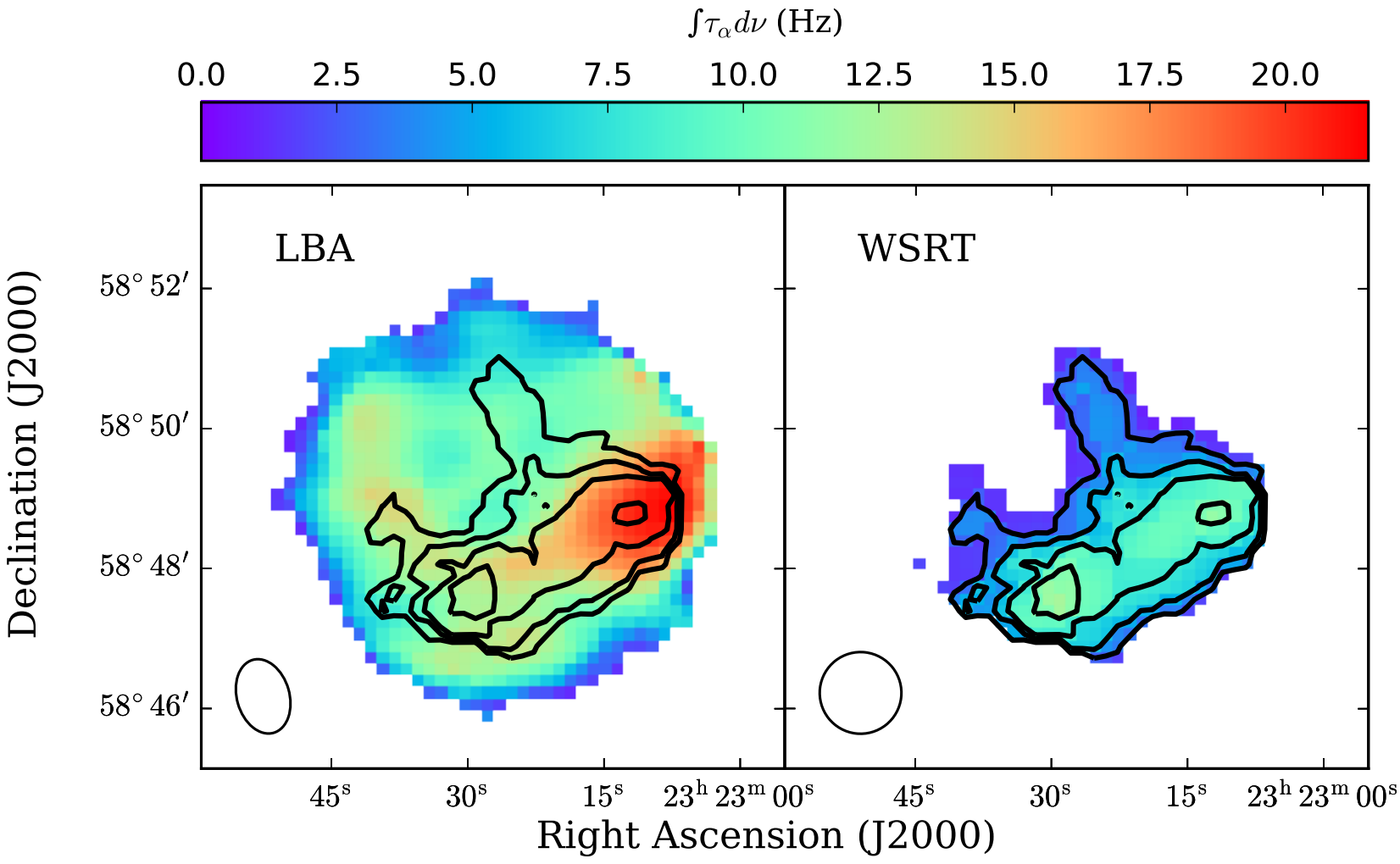
CRRLs with an interferometer



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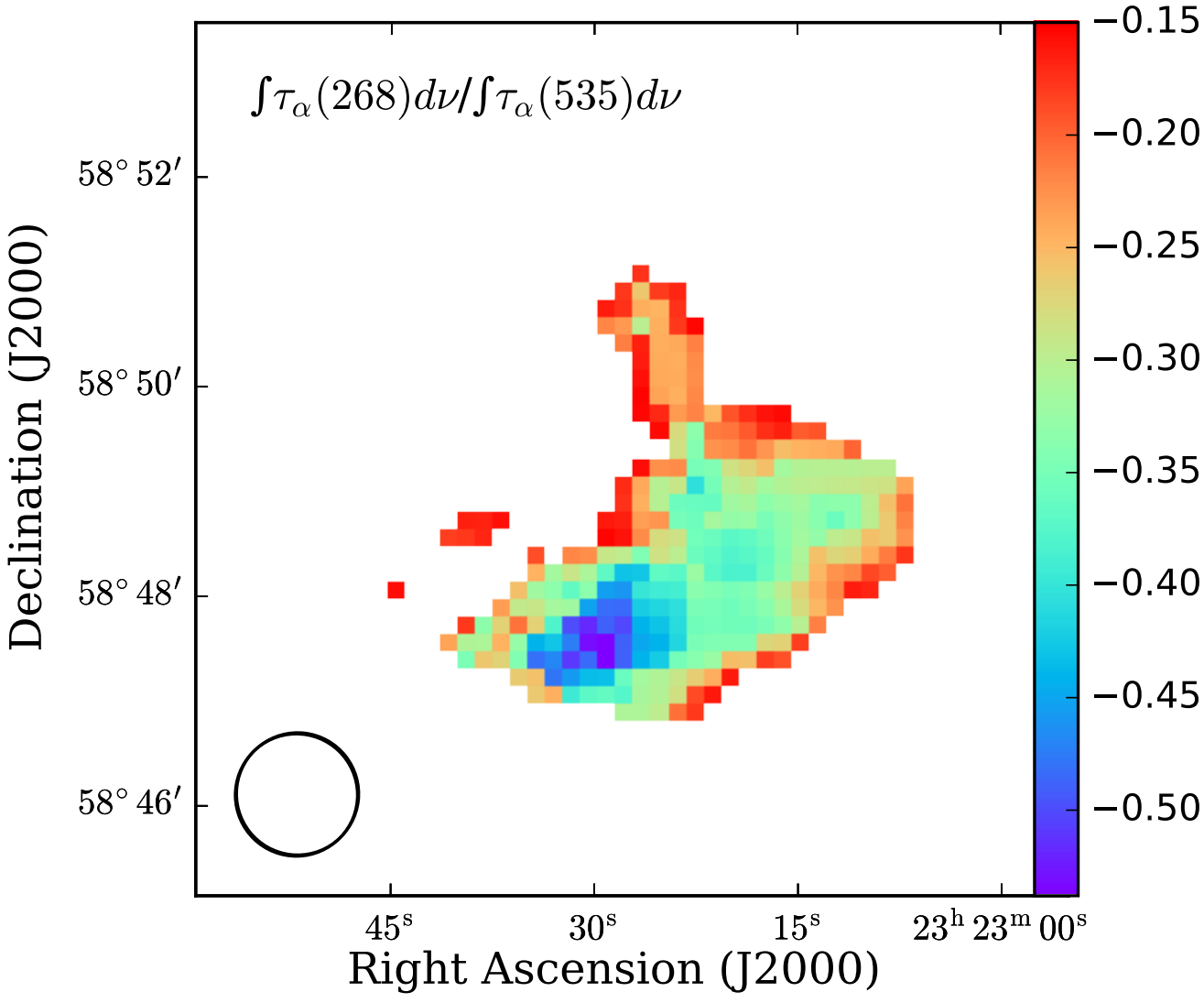
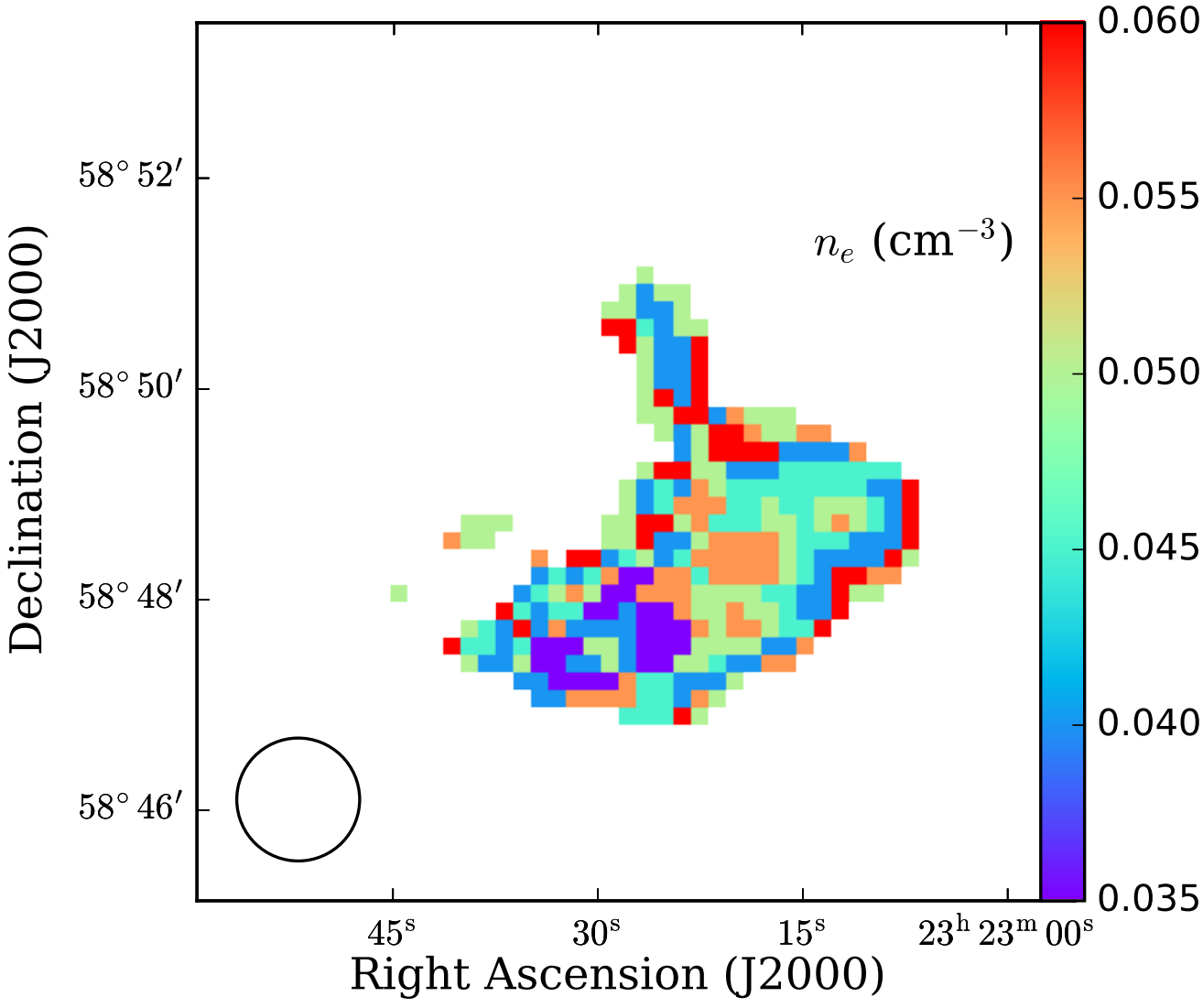
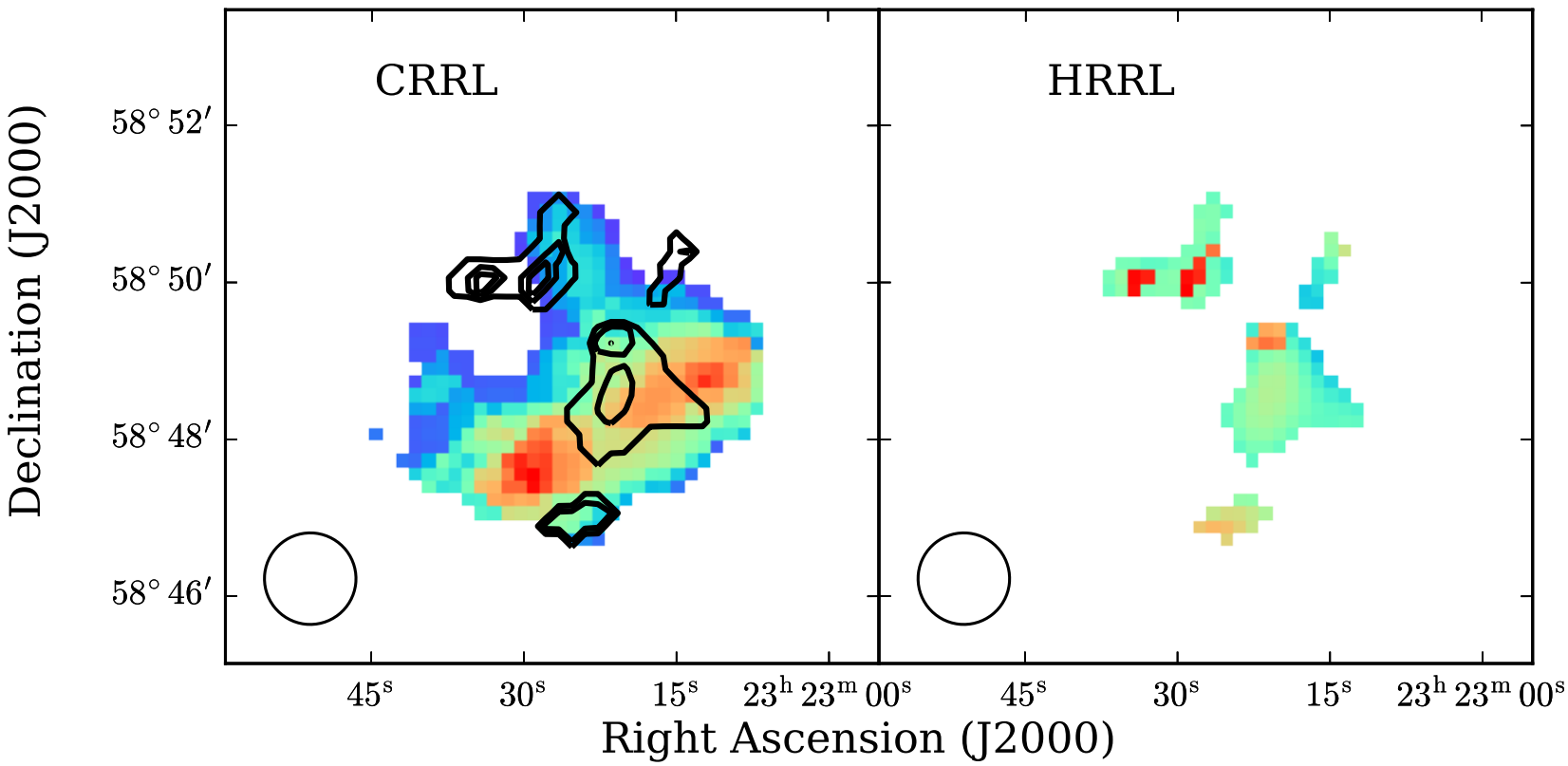
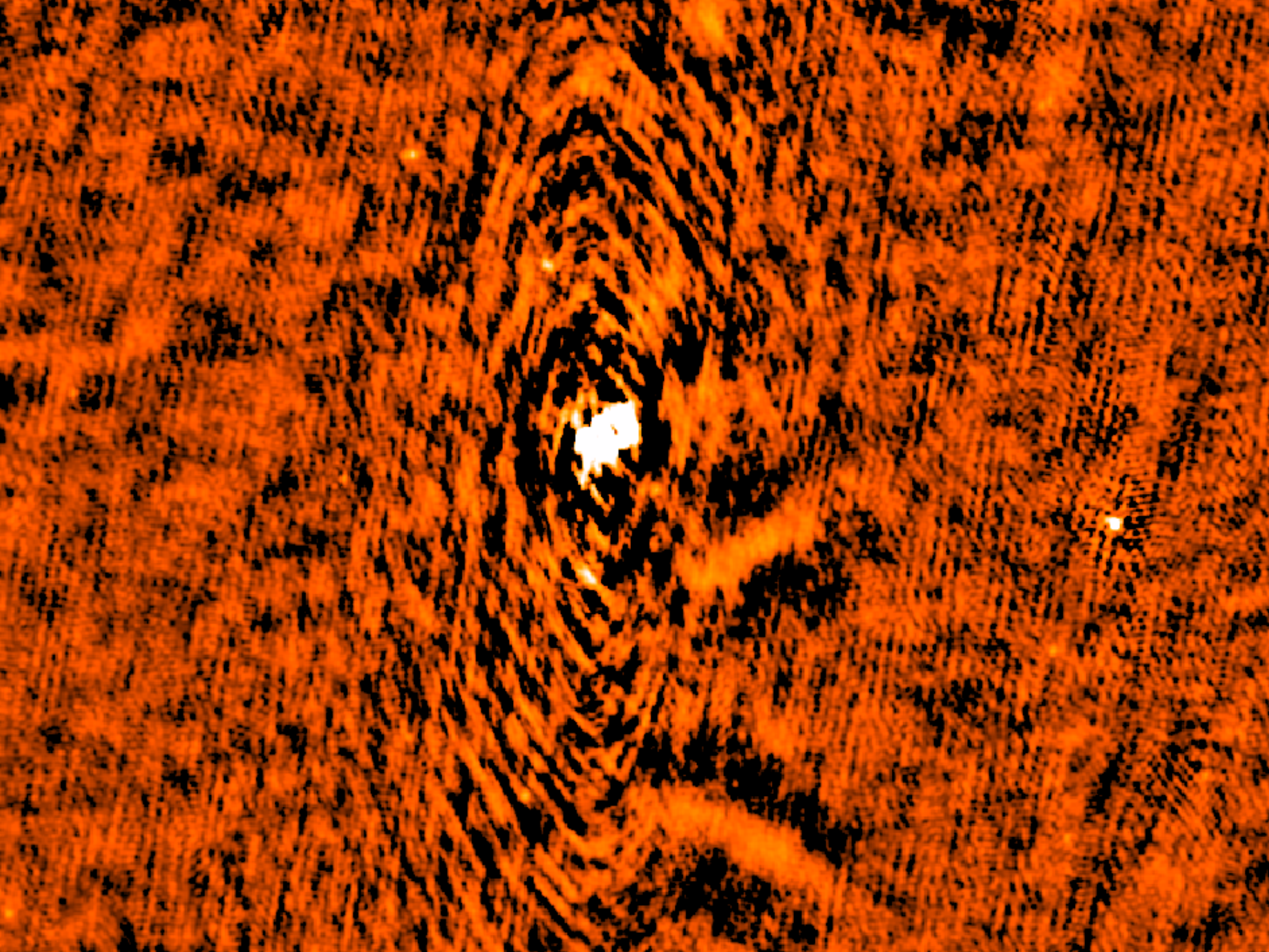


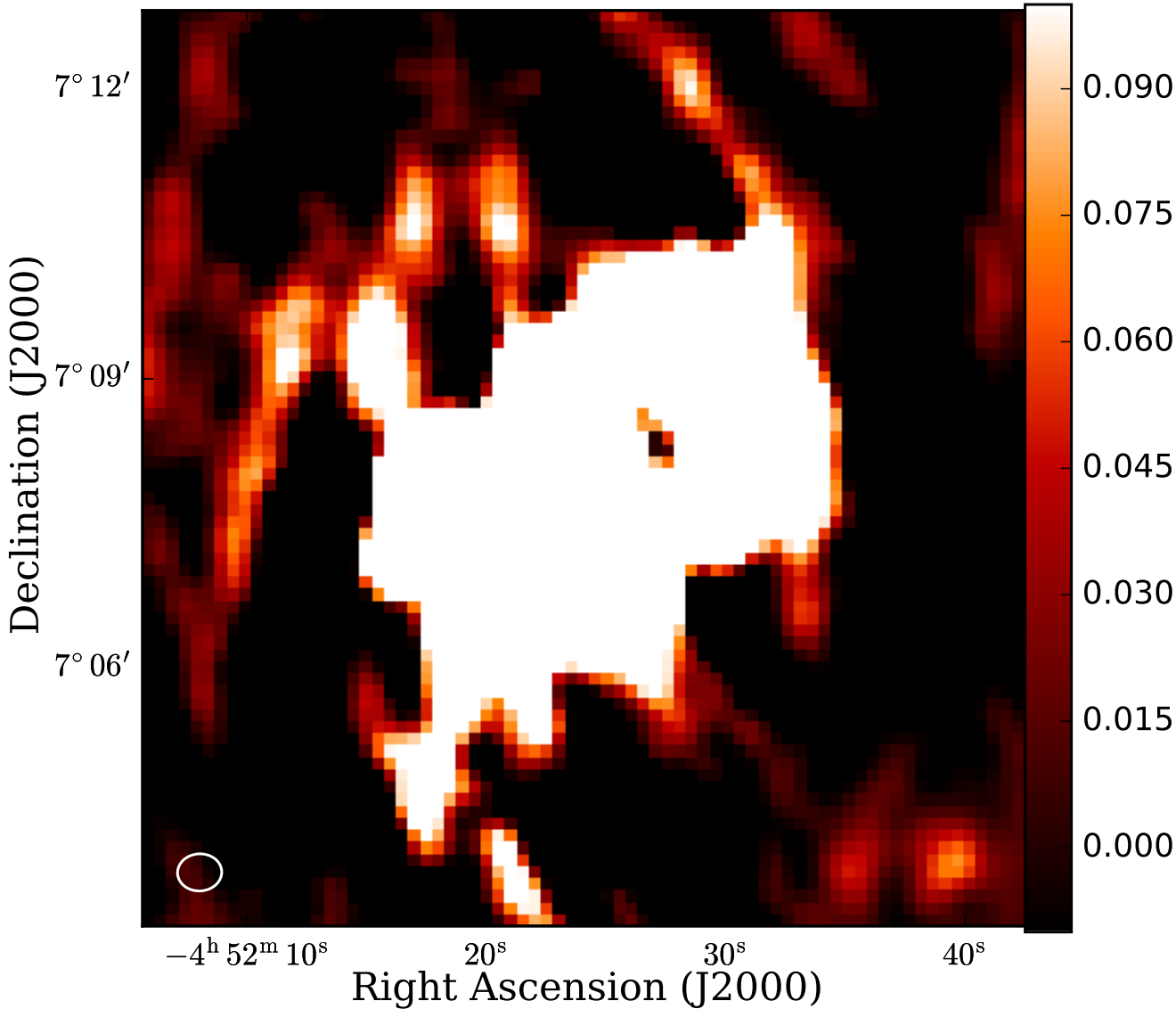
CRRLs with an interferometer

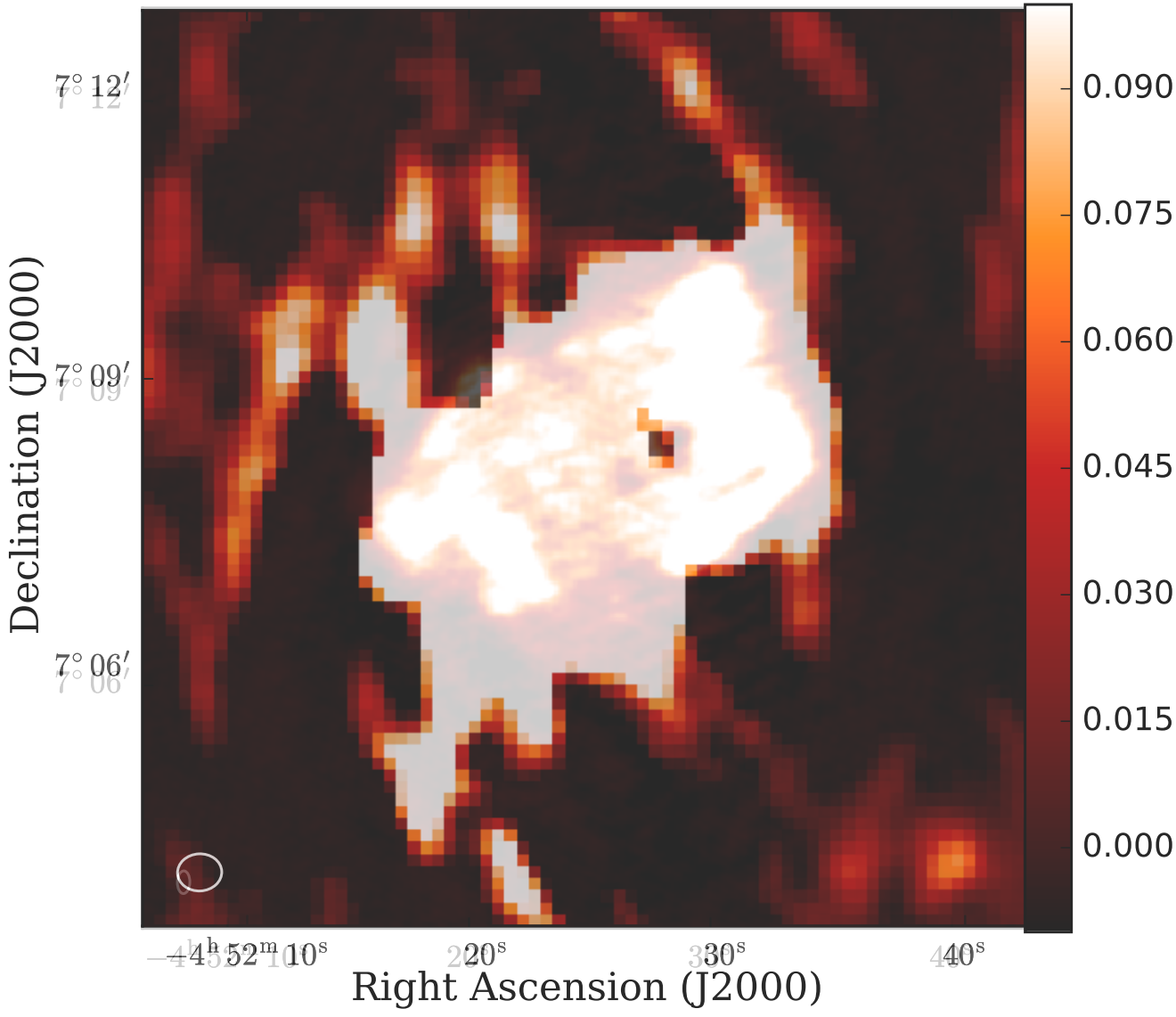


Bonus: hydrogen RRLs






7° 12′
7° 09′
7° 06′
Declination (J2000)
−4h 52m 10s
20s
30s
40s
Right Ascension (J2000)
0.090
0.075
0.060
0.045
0.030
0.015
0.000


Declination (J2000)
7° 12′
7° 09′
7° 06′
4h 52m 10s
20s
30s
40s
Right Ascension (J2000)
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0.060
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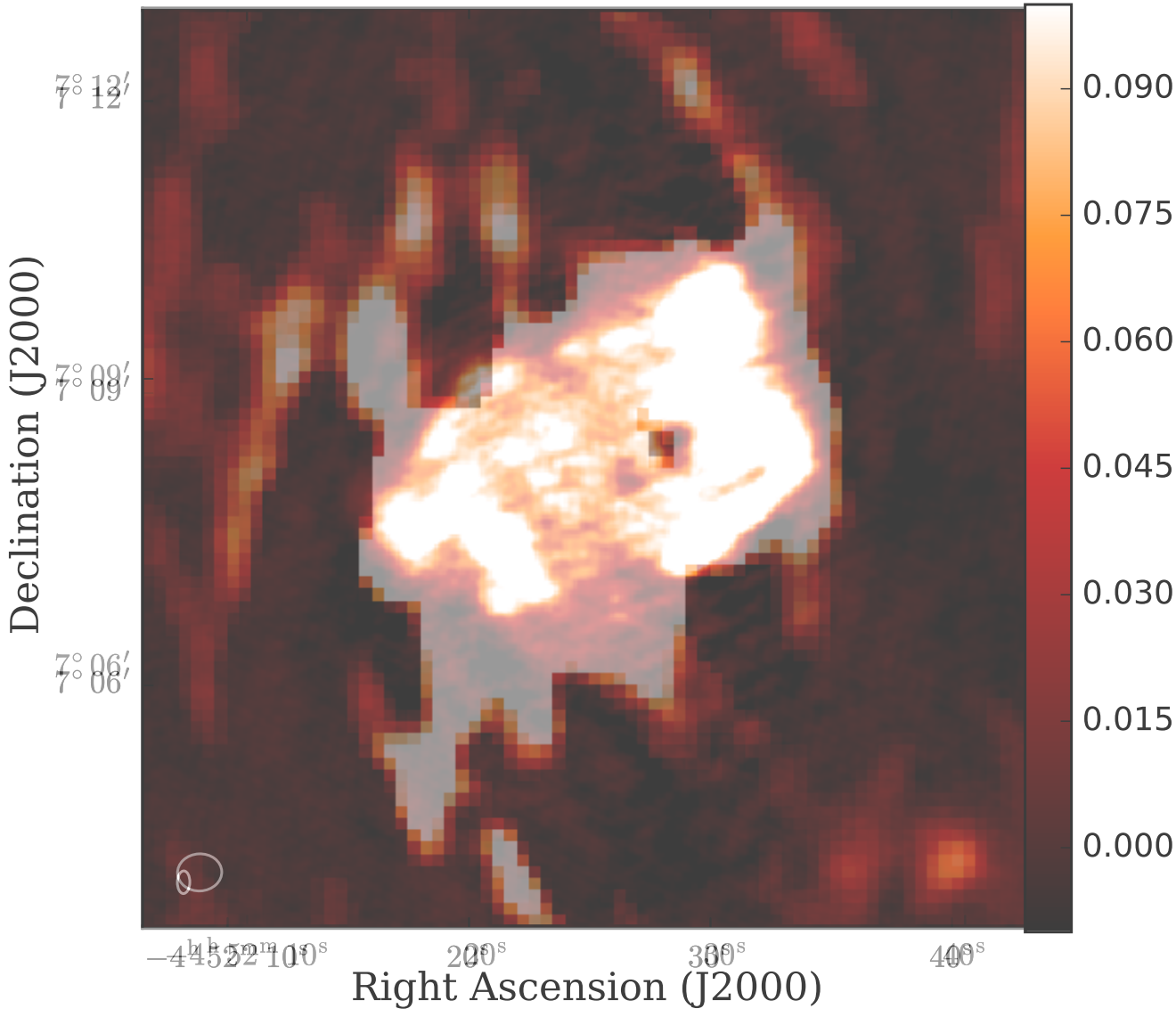
Declination (J2000)
7° 12′
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Right Ascension (J2000)
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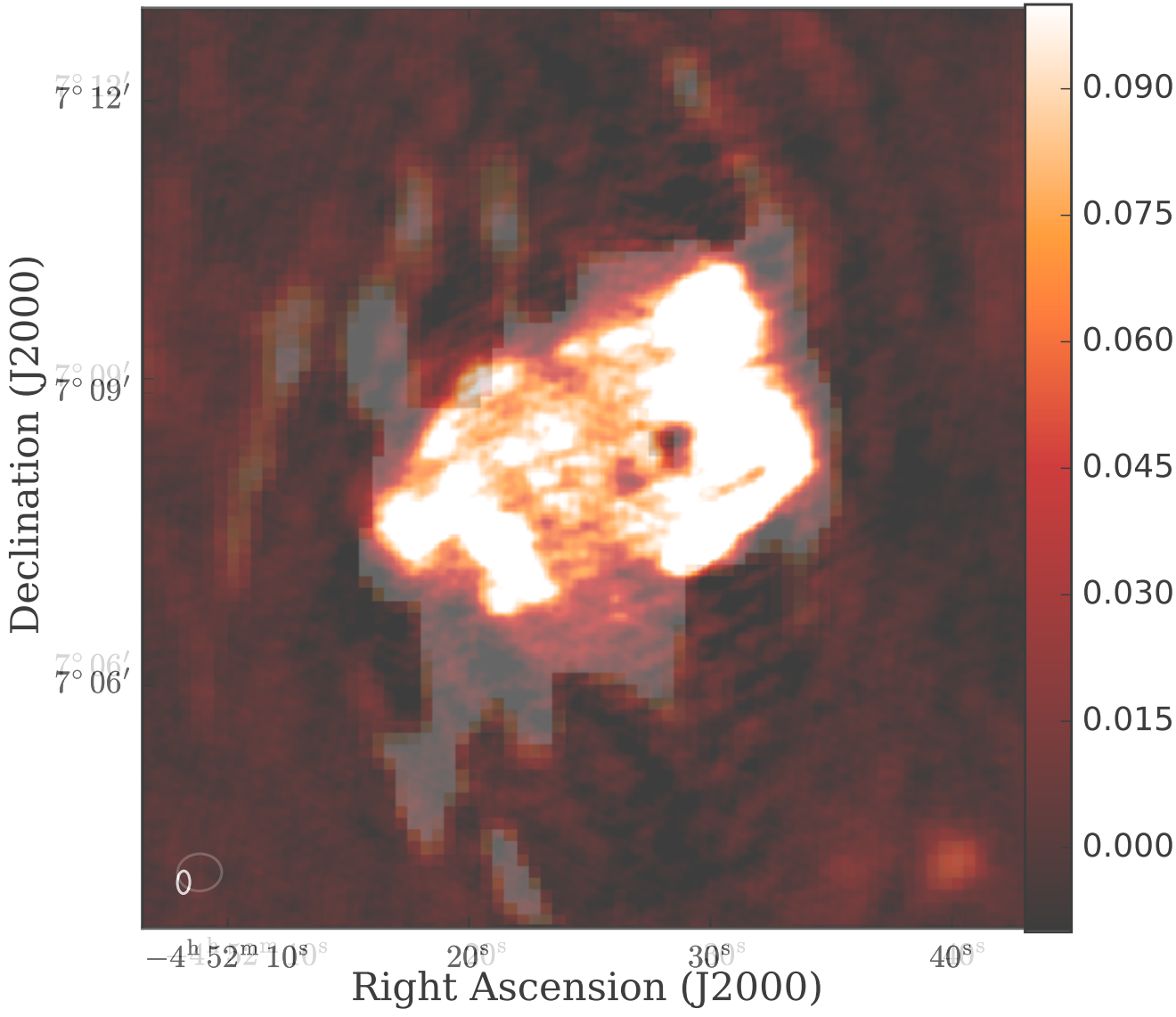
7° 12′
7° 09′
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Declination (J2000)
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−4h 52m 10s
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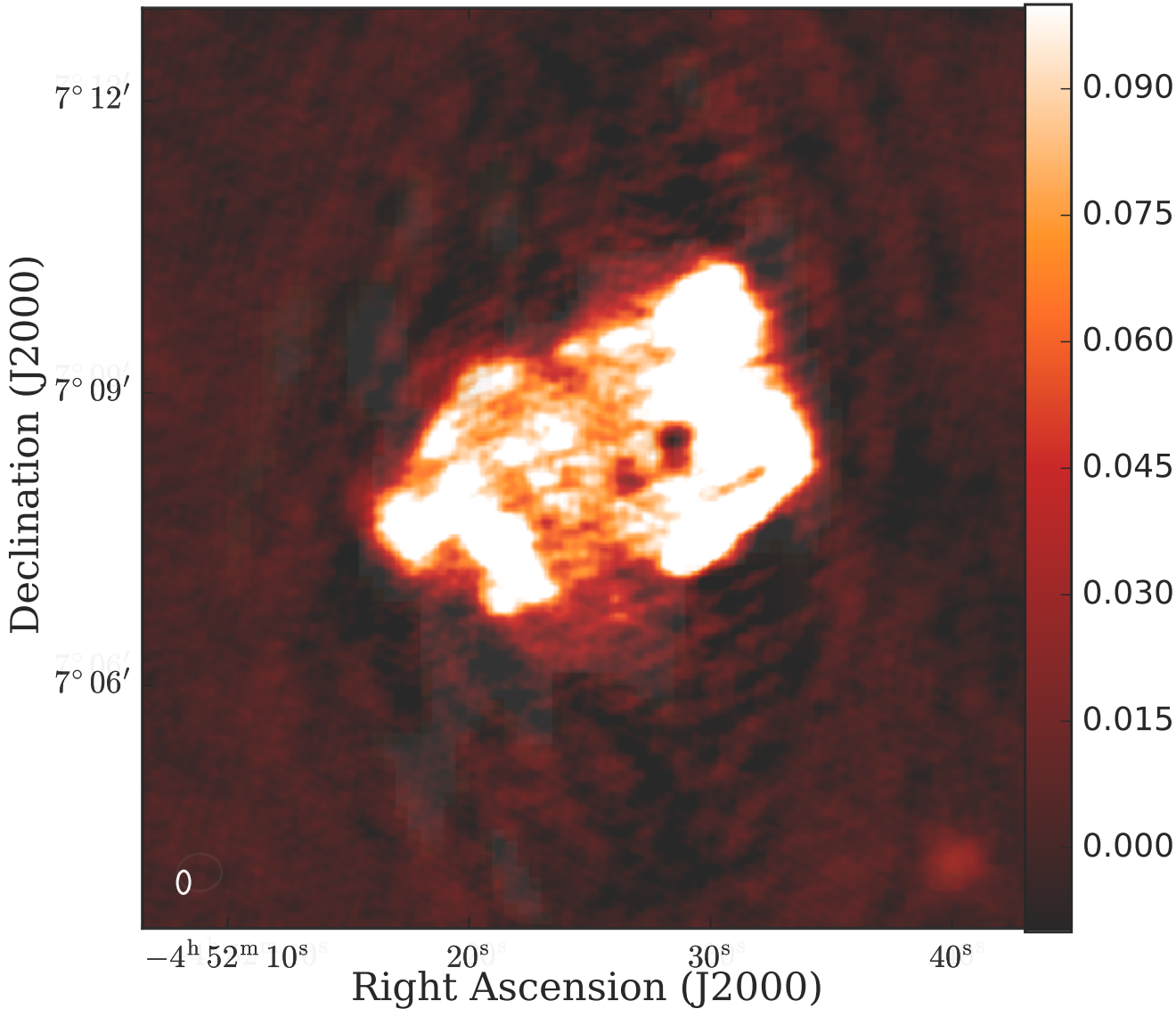
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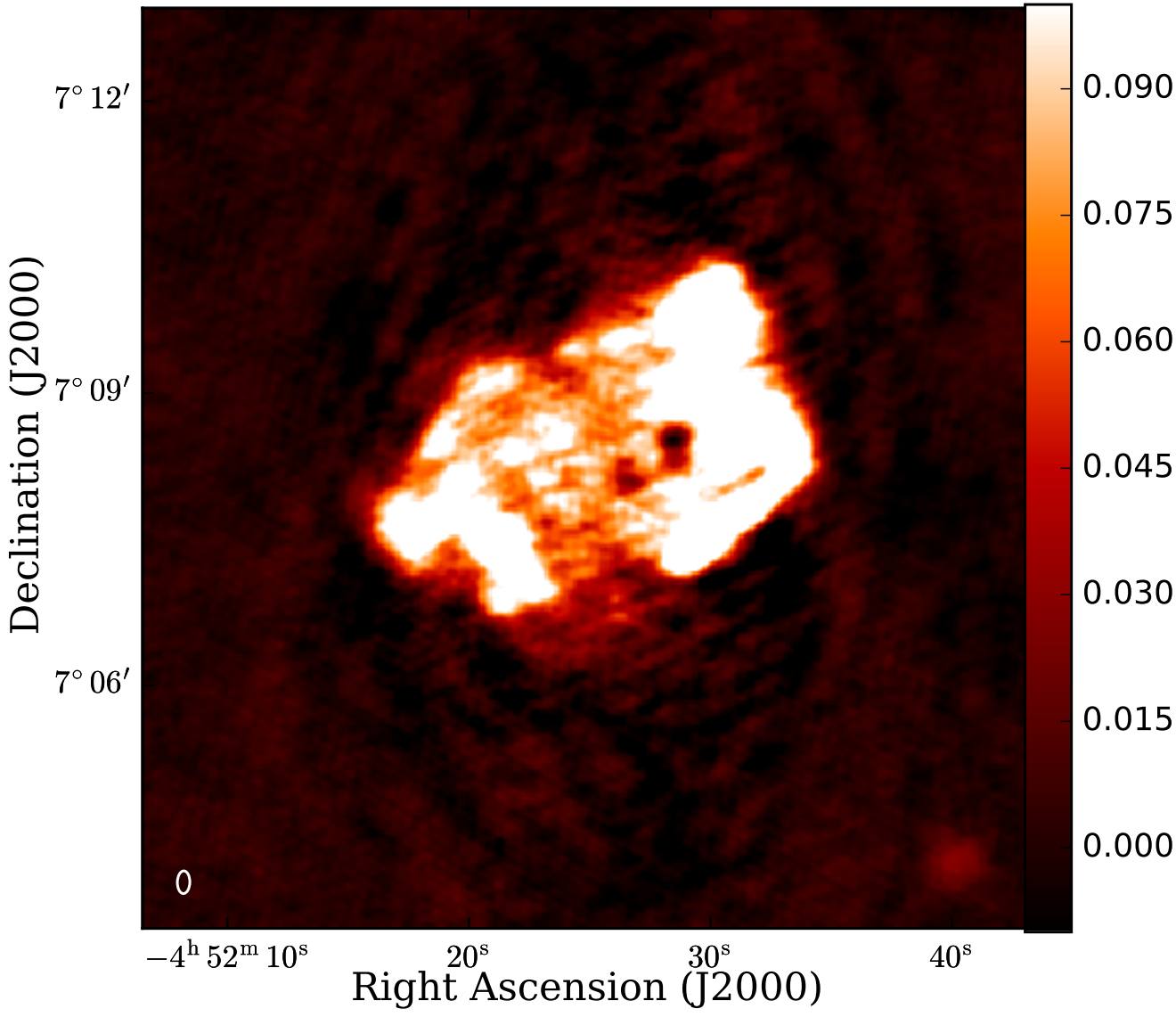
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Declination (J2000)
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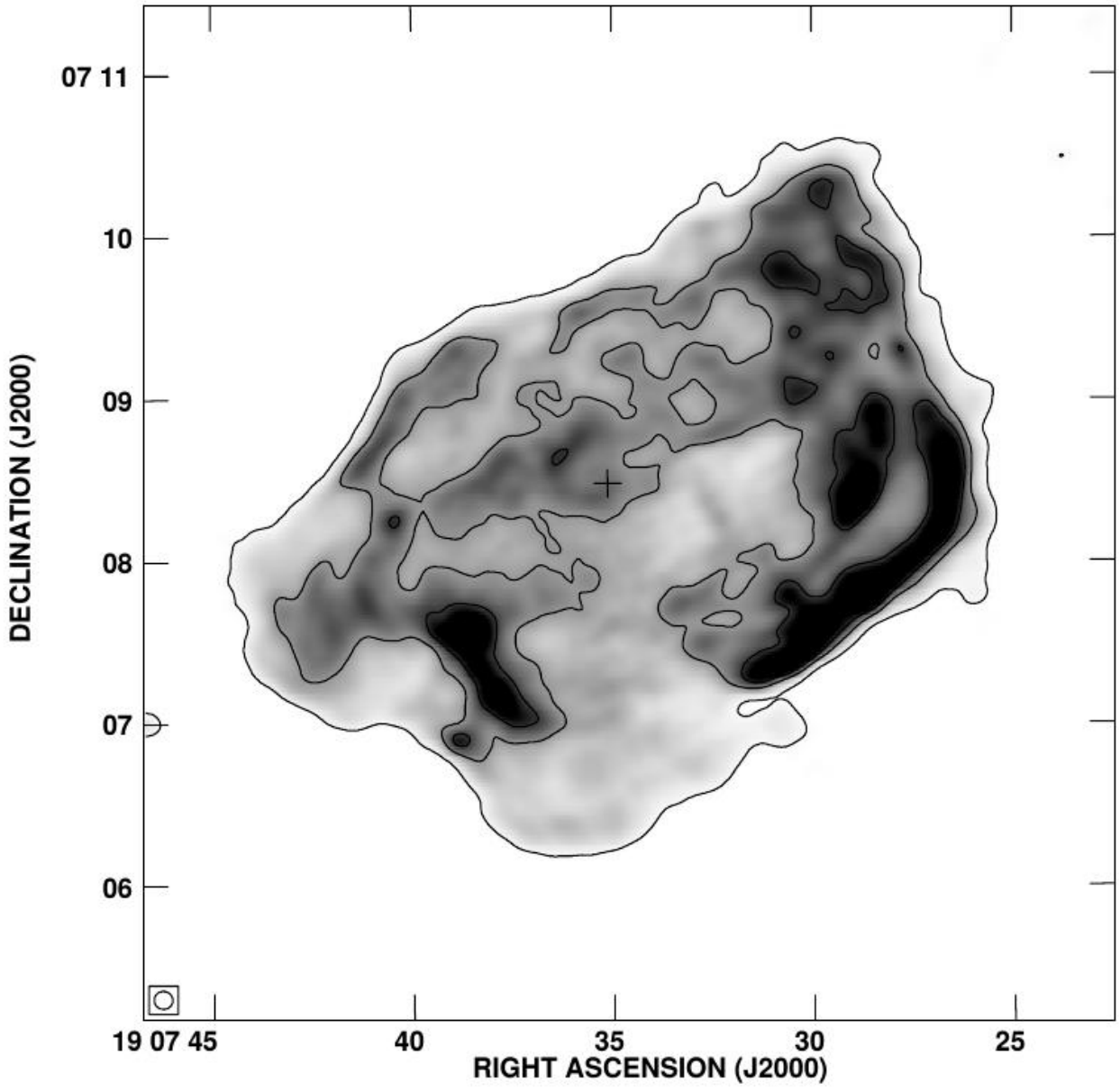
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DECLINATION (J2000)
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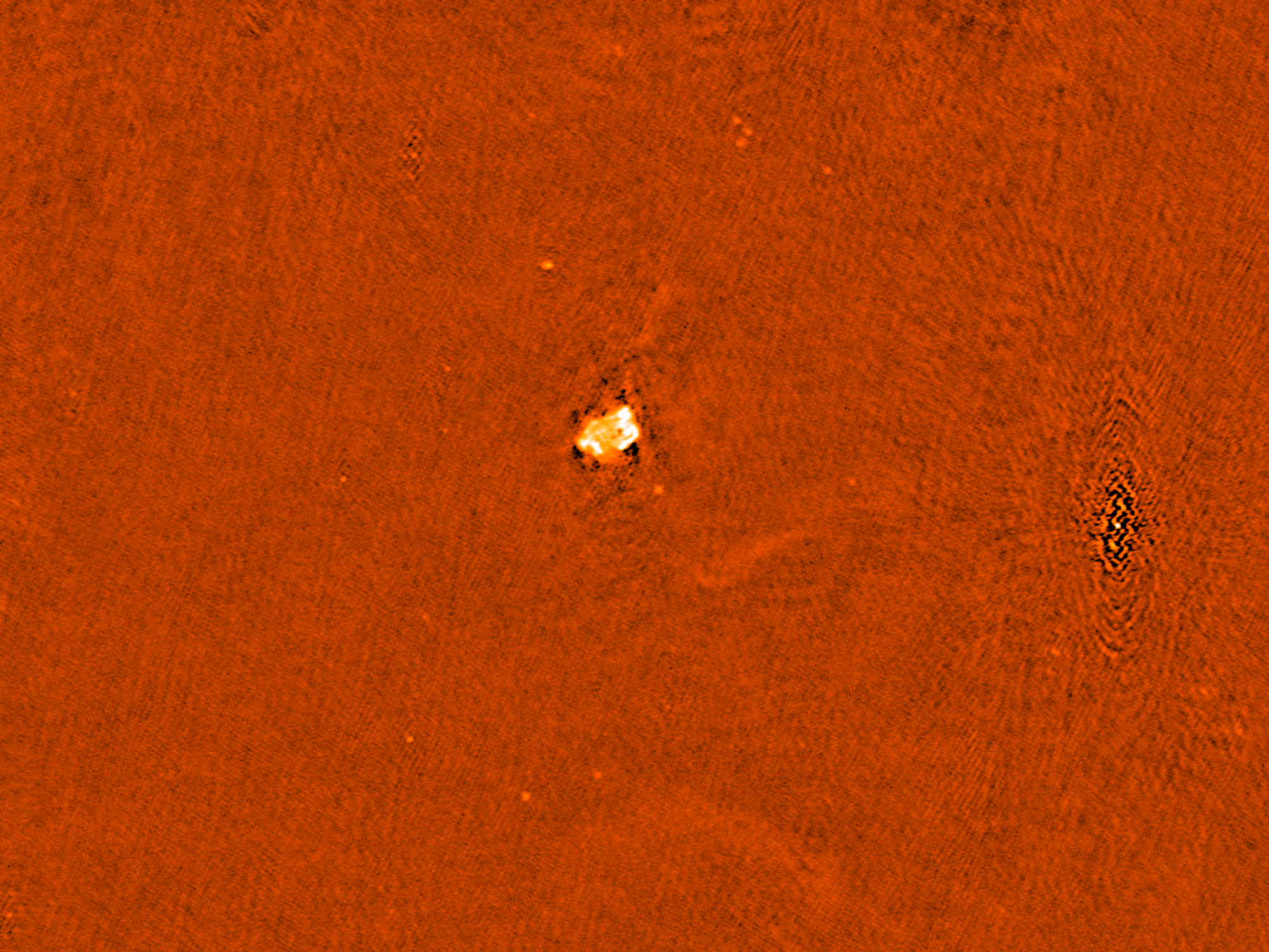
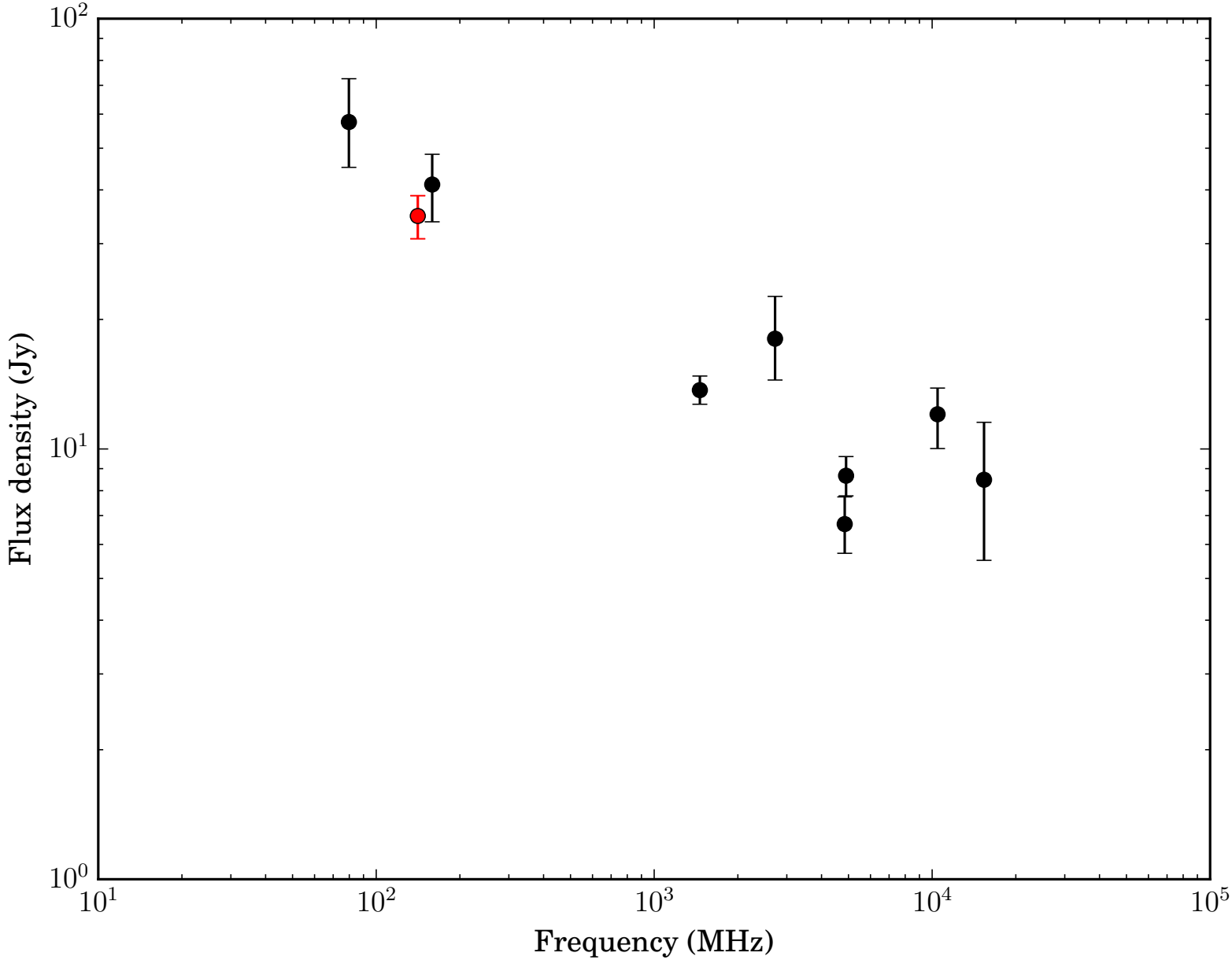
RIGHT ASCENSION (J2000)





Adapted from Dyer & Reynolds (1991)

Summary

- LOFAR is a unique telescope for low frequency RRL observations.
- Maps of RRLs will probe the gas properties on arcminute scales against bright sources.
- Initial tests of facet calibration on the Galactic plane show promising results.

Thanks!

Specially to the people making this possible.