Measuring and modeling the Galactic synchrotron emission distribution with the GLEAM survey

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SPARCS VII
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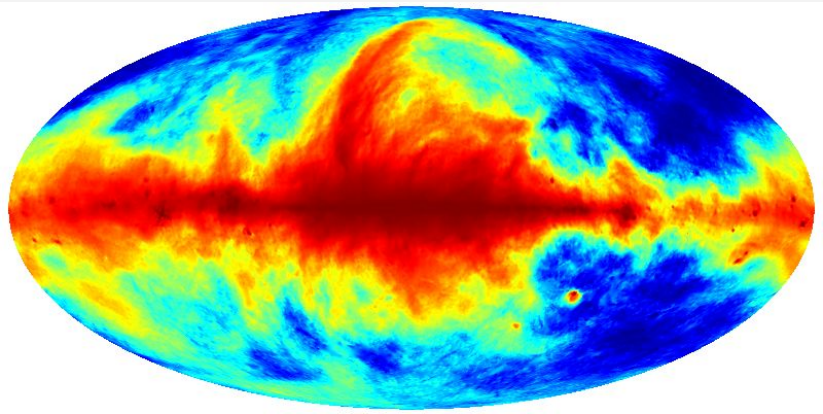
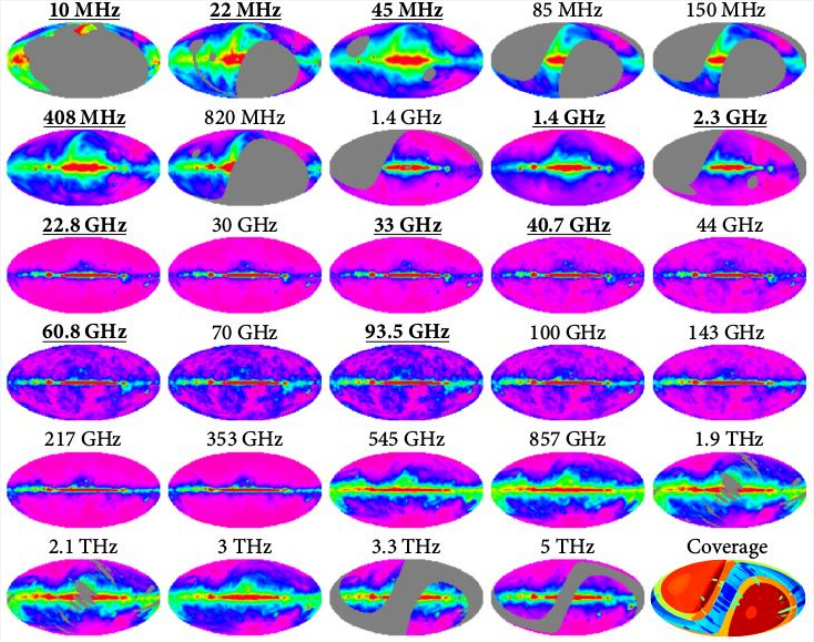
Haslam map of the Milky Way at 408 MHz



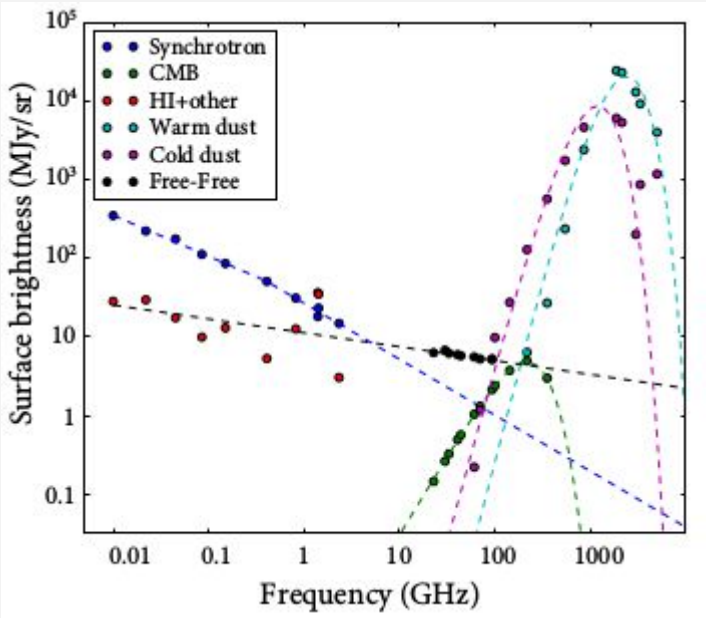
dominated by synchrotron emission

Maps of the Milky Way



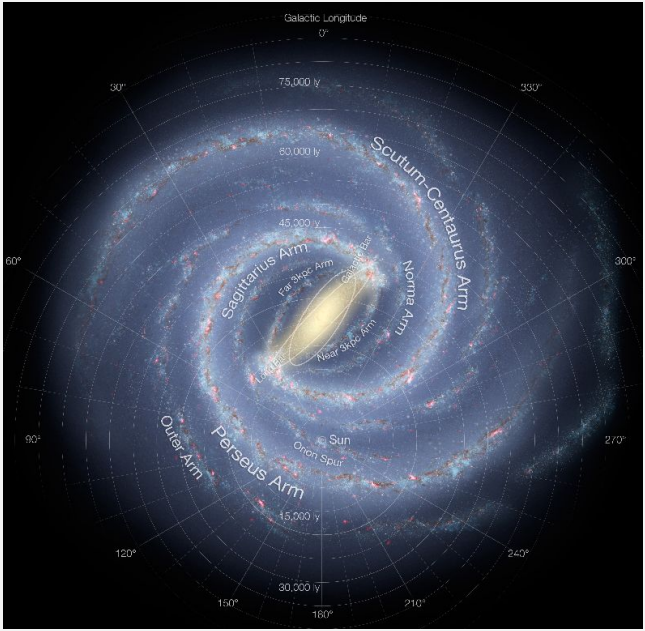
Zheng+16

Six component spectra



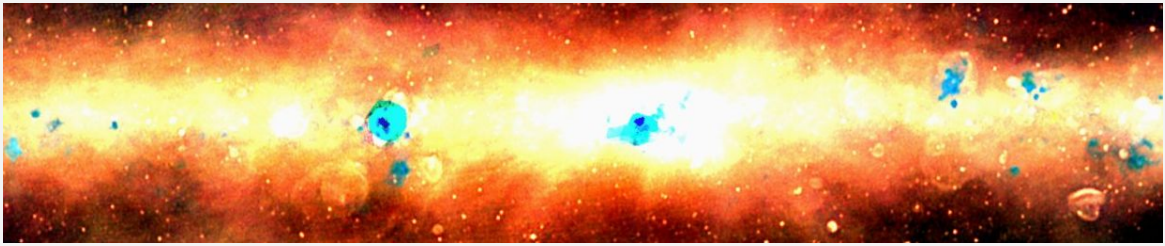
Zheng+16

Artist concept of the Milky Way



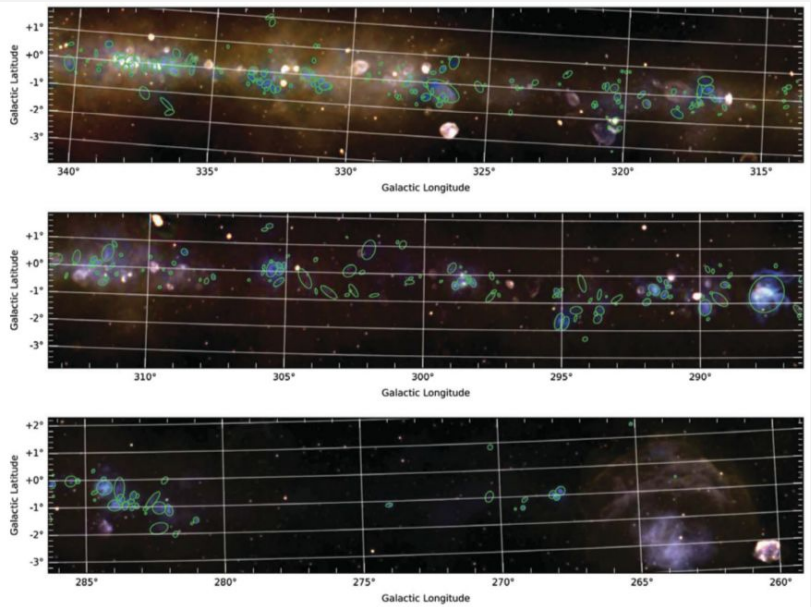
Credit: NASA/JPL-Caltech

GLEAM survey with HII region absorption



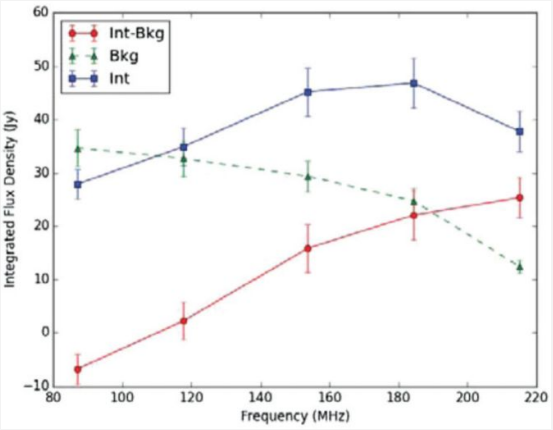
Credit: N. Hurley-Walker
http://gleamoscope.icrar.org

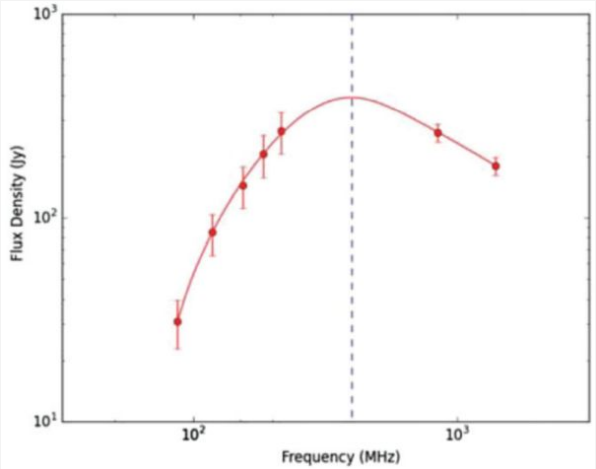
HII region catalog from the GLEAM survey (DEC -55 region)



306 HII regions
Hindson+16

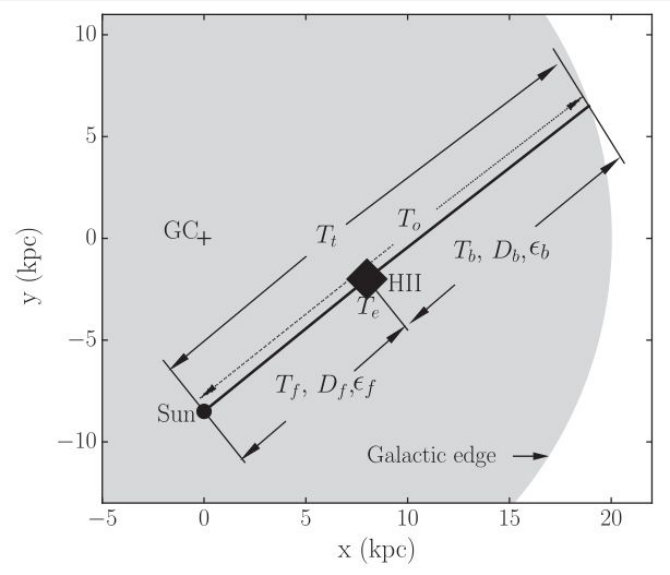
Spectral energy distribution of an HII region





Hindson+16

HII region absorption

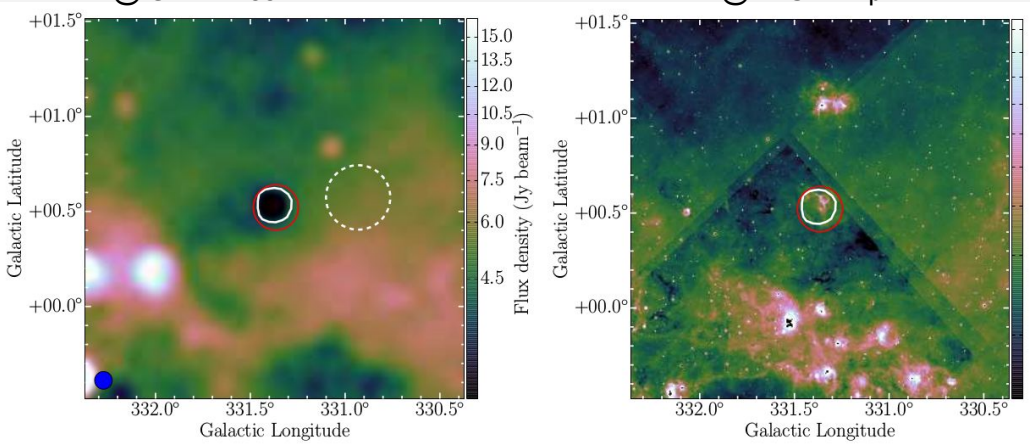


Su+17

Galactic HII region absorption feature from the GLEAM survey

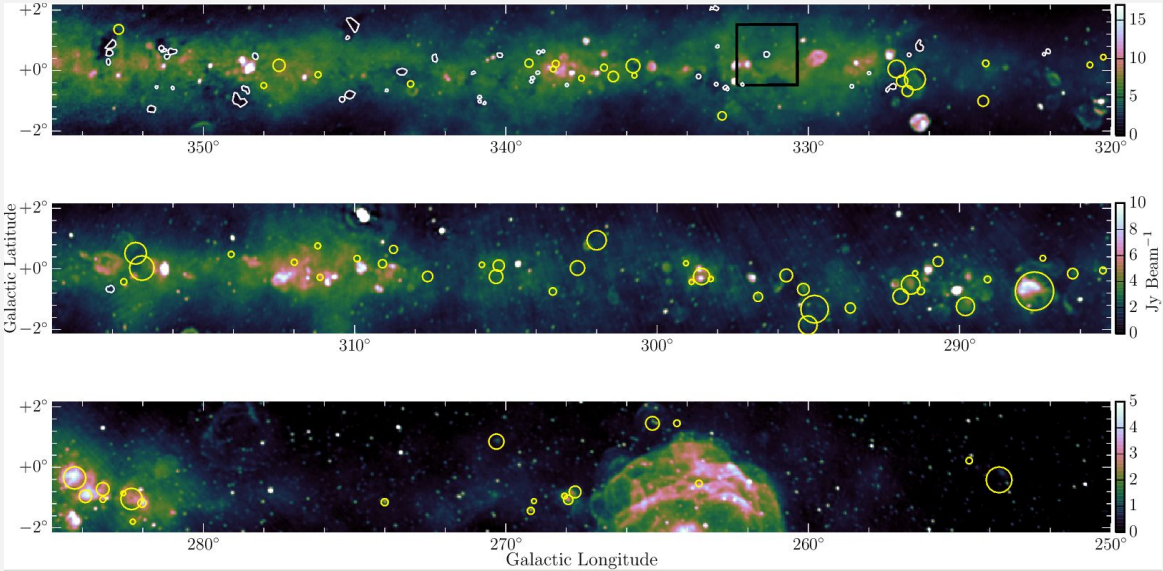
HII region absorption
@ GLEAM 88 MHz

HII region emission
@ WISE 12 μm



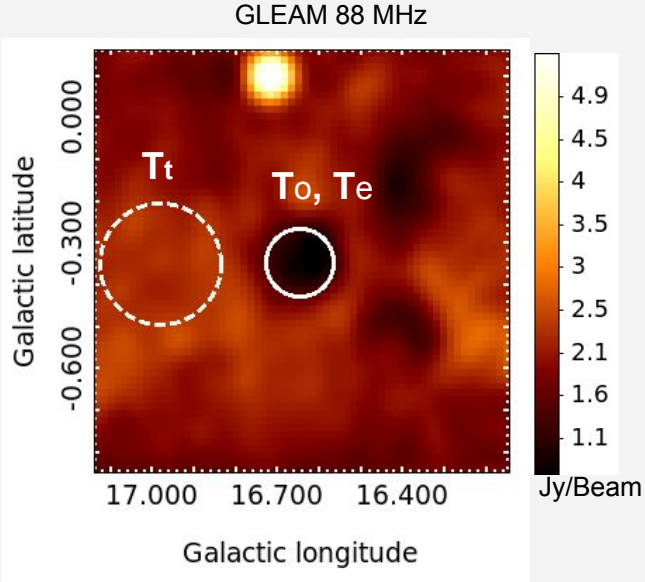
Su+17

Galactic HII regions absorption from the GLEAM survey



Su+17

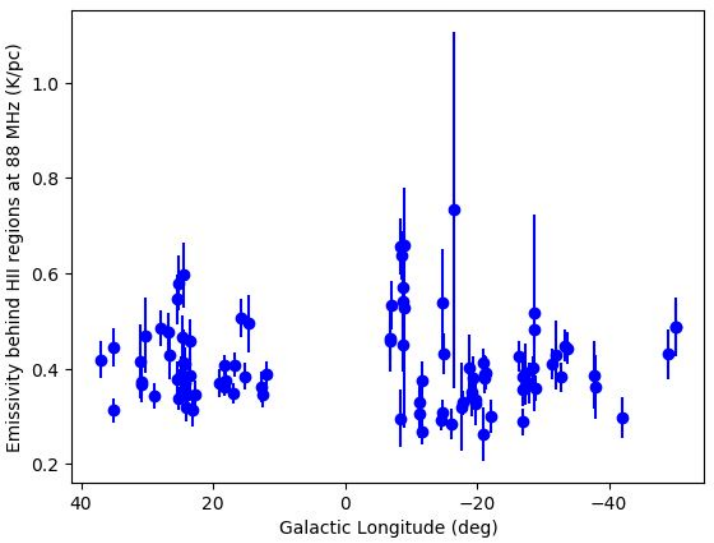
HII region absorption



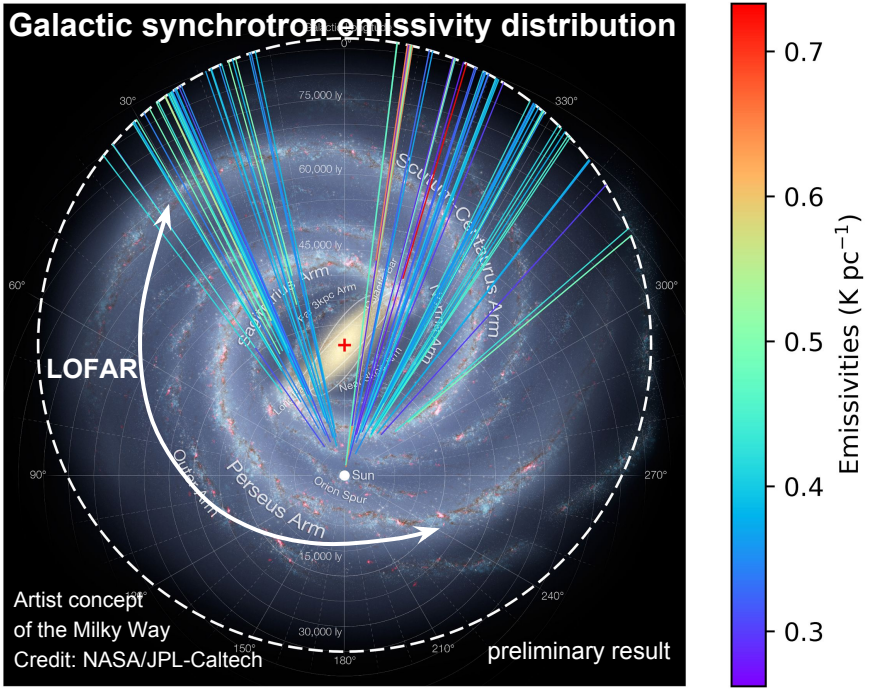
$$\epsilon_b = T_b / D_b = (T_t - T_o + T_e)/D_b$$

Nord+06; Su+17

Emissivity distribution



preliminary result


Galactic synchrotron emissivity distribution
LOFAR
Artist concept
of the Milky Way
Credit: NASA/JPL-Caltech
preliminary result
Sun
Perseus Arm
Outer Arm
Orion Spur
Scutum-Centaurus Arm
Norma Arm
3kpc Arm
Near 3kpc arm
Far 3kpc arm
Molecular ring
Galactic Center
0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
15,000 ly
30,000 ly
45,000 ly
60,000 ly
75,000 ly
0.7
0.6
0.5
0.4
0.3
Emissivities (K pc^{-1})

Modeling

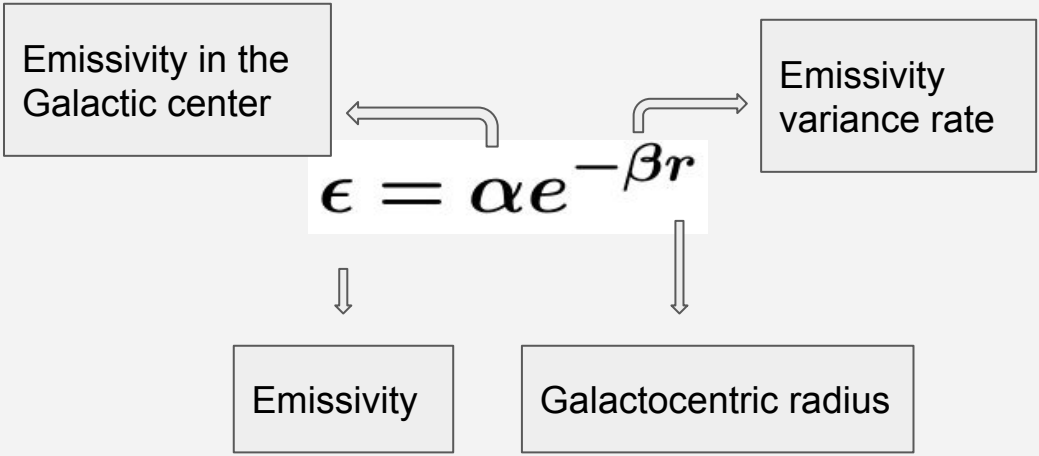
Synchrotron distribution

Galactic magnetic field
Cosmic-ray electrons

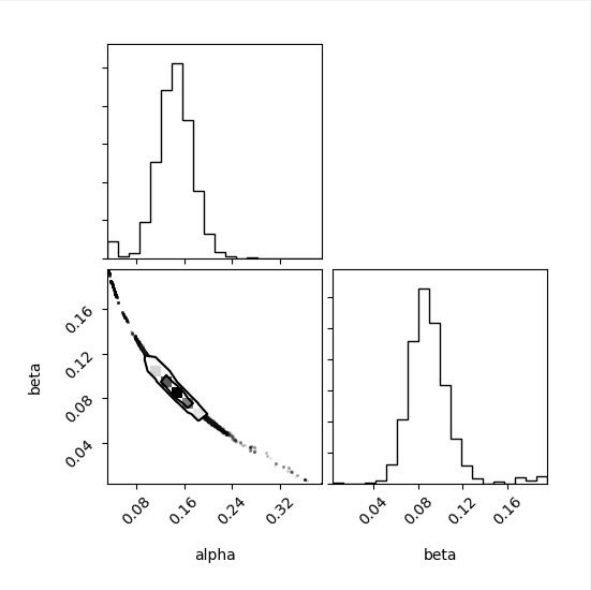
Guess 1 Exponential distribution

$$\epsilon \propto e^{-r}$$

Guess 1 Exponential distribution

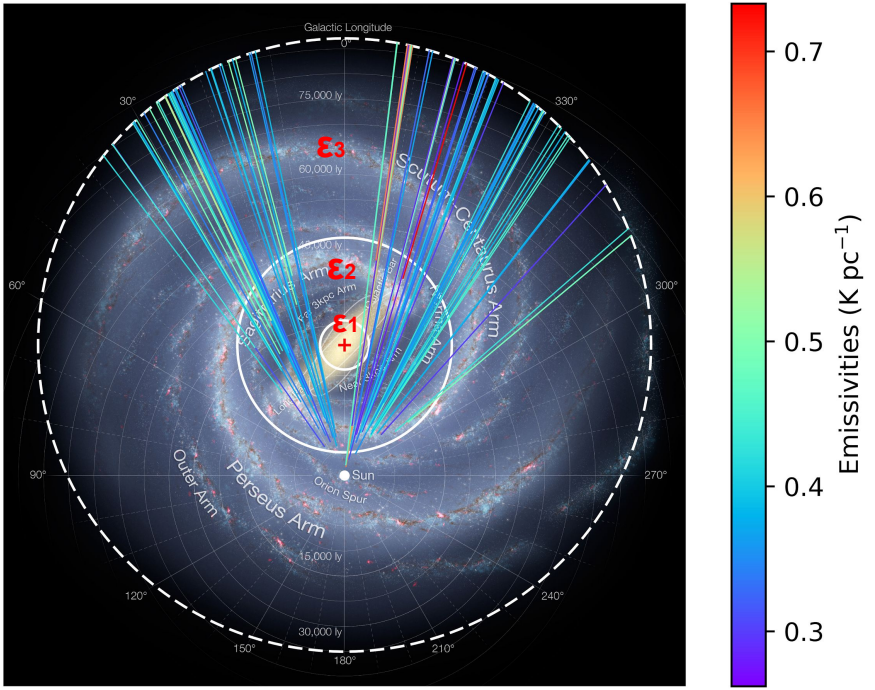


Guess 1 Exponential distribution

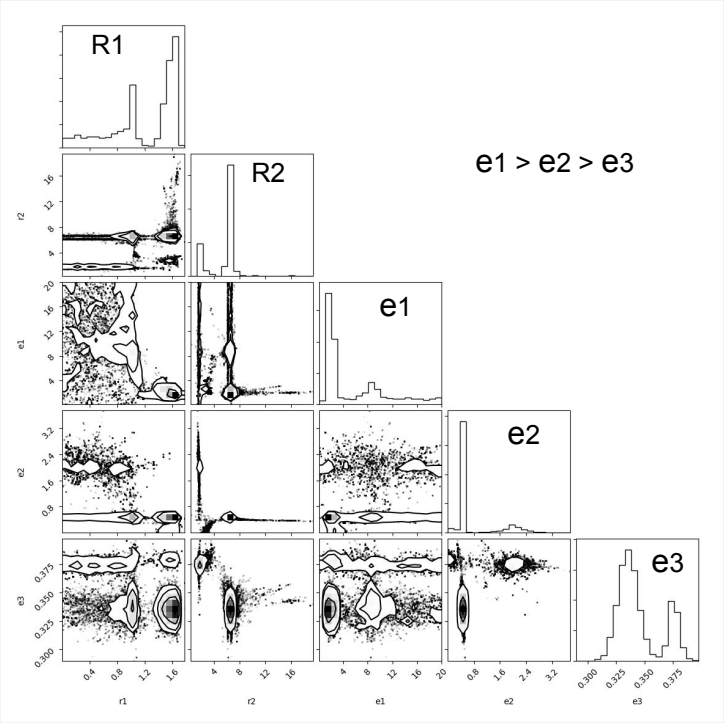


Guess 2

Two-circle distribution

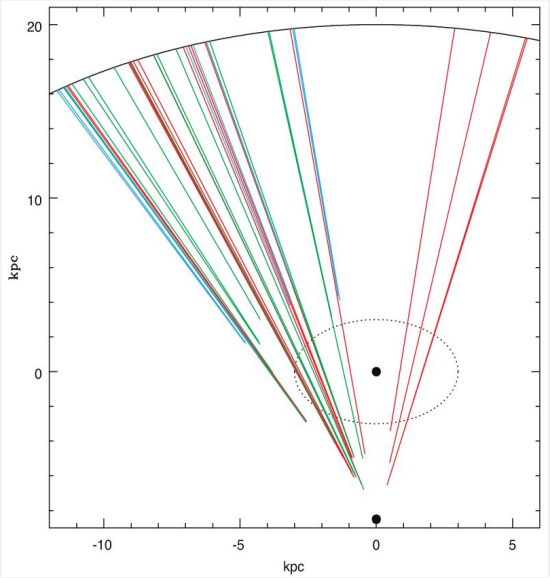


Best parameters of the
Two-circle distribution

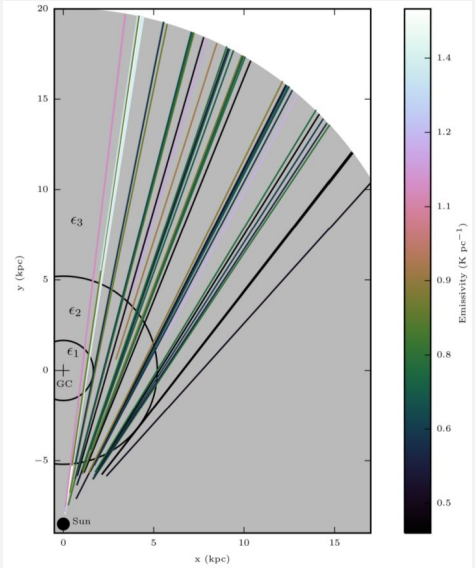


preliminary result

Contrary conclusions

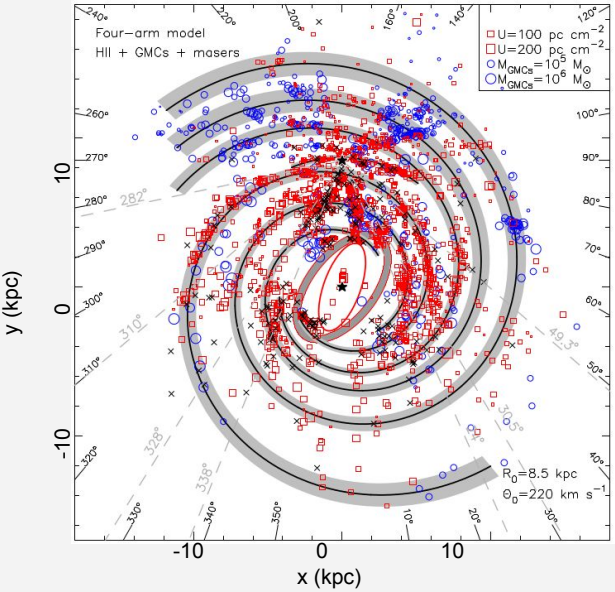


Nord+06



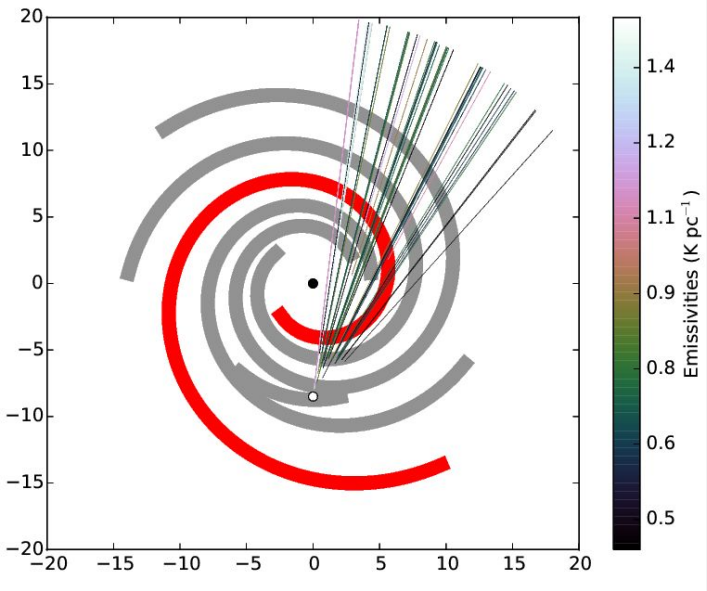
Su+17

Guess 3 Spiral arm distribution

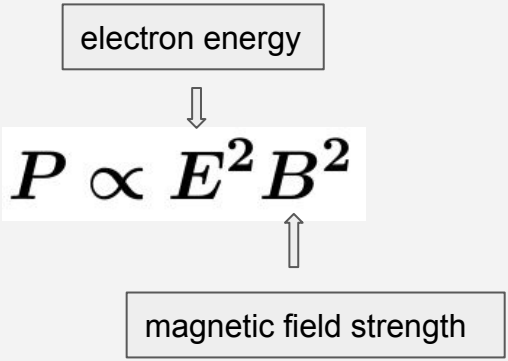


Hou & Han (2014)

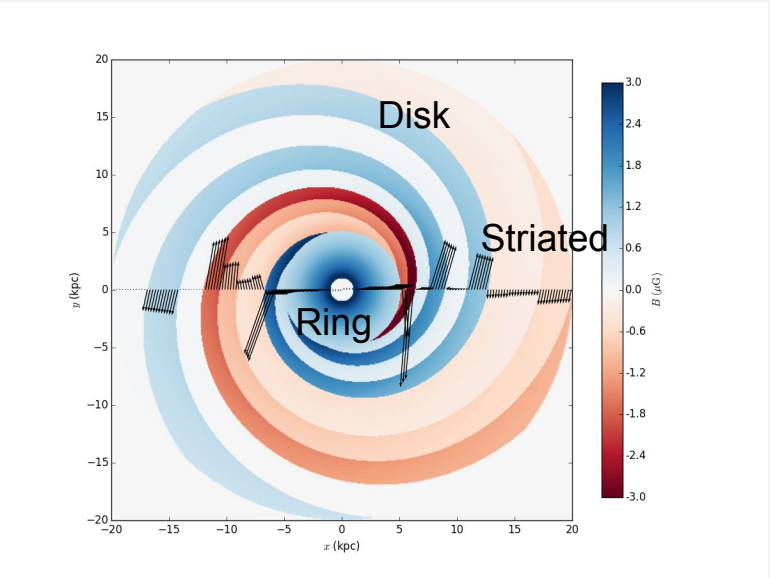
Guess 3 Spiral arm distribution



Total power of an electron

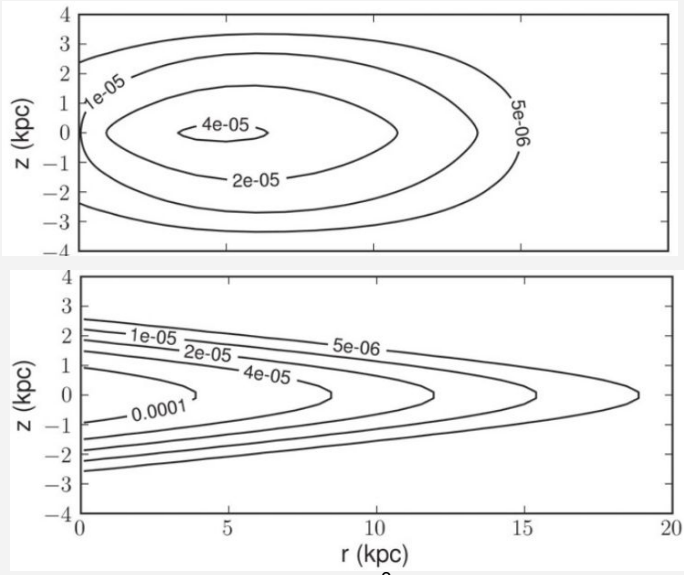


Galactic B-field model



Jansson+12

Spatial distribution of relativistic electrons



from GALPROP
https://galprop.stanford.edu

based on SNRs

from WMAP

r: exp
z: sech

The contour units are cm^{-3} for 10 GeV electrons

GALPROP input parameters

Energetic and Spatial Grids (6)

CR Propagation (14)

CR Sources (8)

Gamma-Ray and synchrotron Emission (2)

Nuclear Abundances (77)

GALPROP input parameters

Energetic and Spatial Grids (6)
CR Propagation (14)
CR Sources (8)
Gamma-Ray and synchrotron Emission (2)
Nuclear Abundances (77)

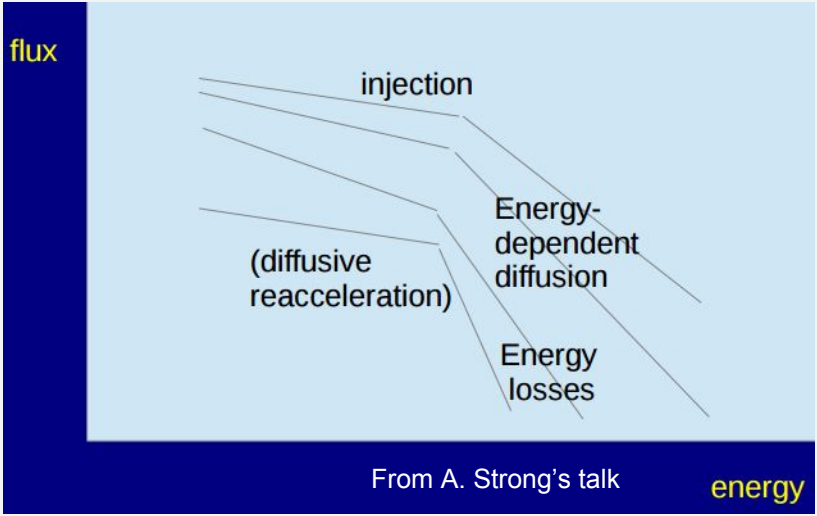
+ Magnetic field (22) from Jansson+12

What parameters can we confine?

Electron injection spectrum index

Electron spatial diffusion coefficient

What are these parameters?



Summary

- Measured ~100 synchrotron emissivities from HII region absorptions
- The emissivity is high near the Galactic center, decreasing with the radius.
- The emissivity distribution may relate with the spiral arms.
- Measured emissivities can confine the B-field and the relativistic electrons.