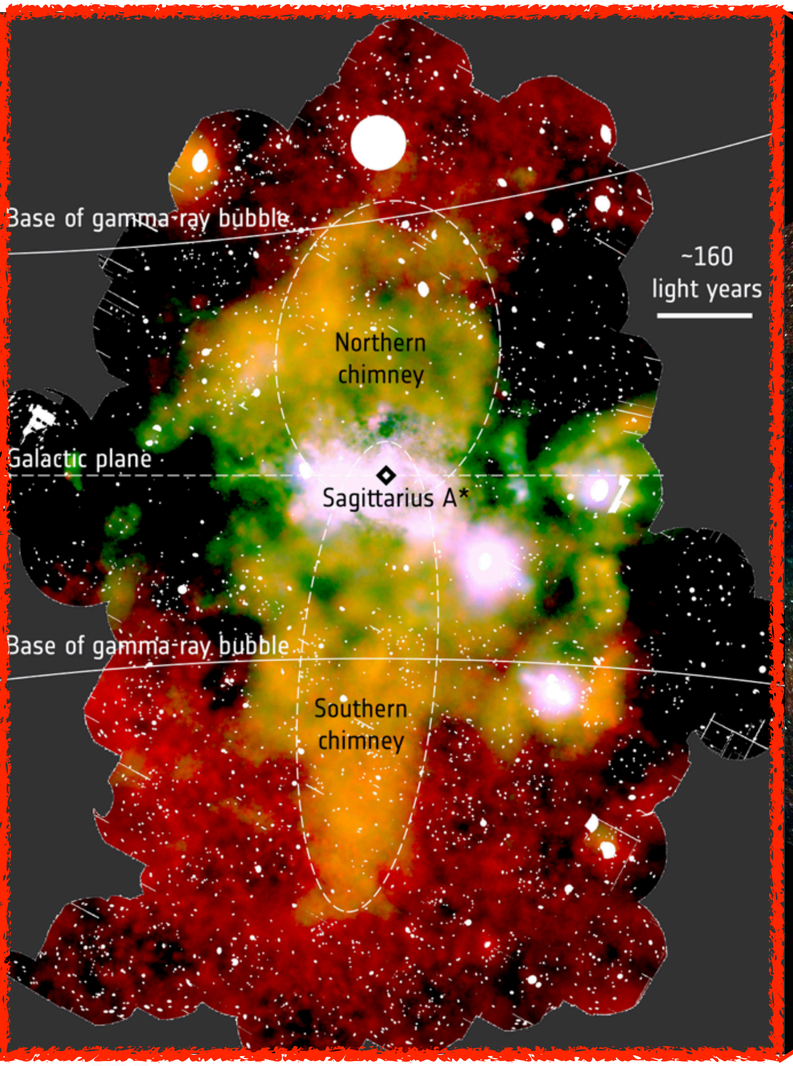
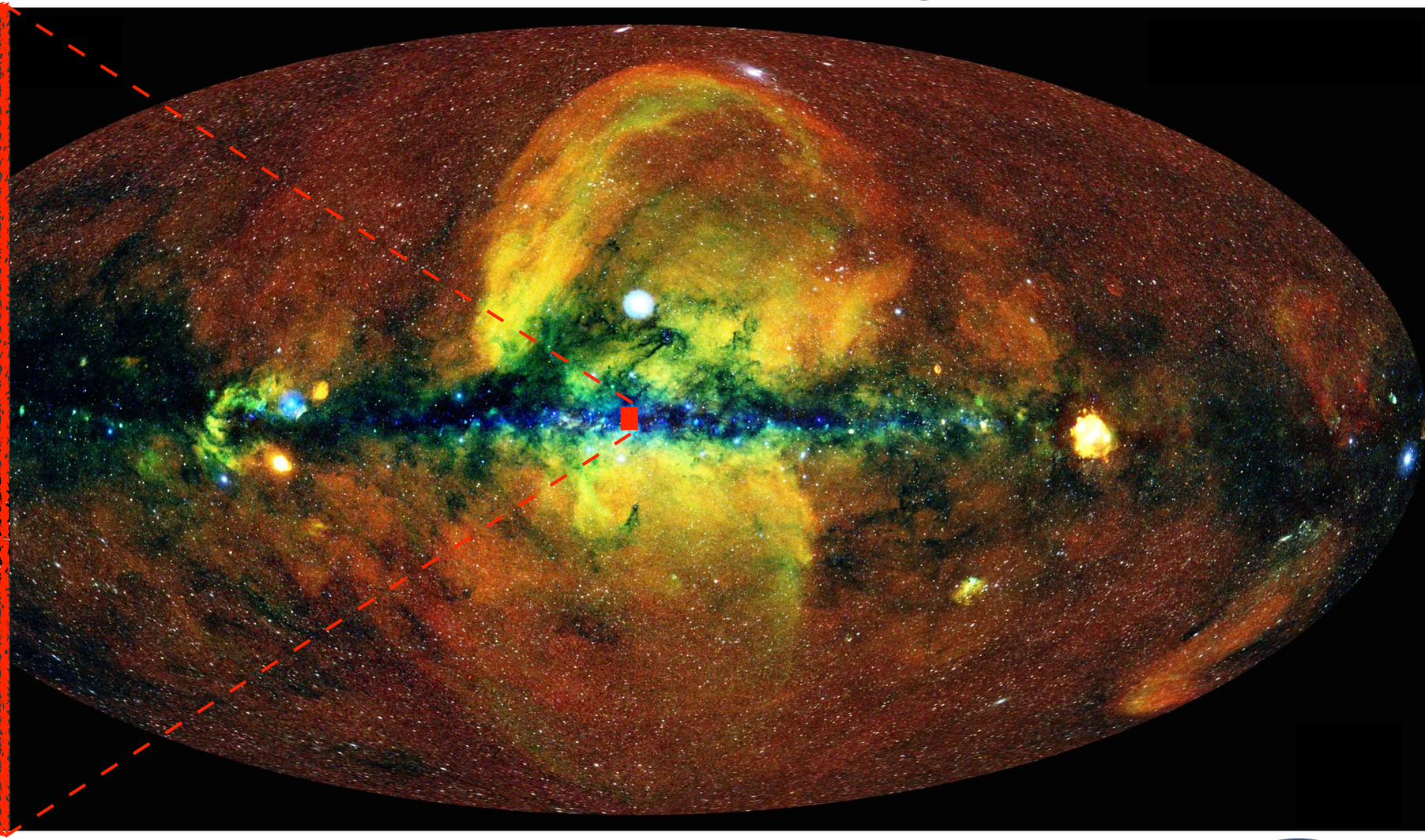
Galactic center and diffuse X-ray emission





European Research Council

Gabriele Ponti (INAF-OA Brera, MPE) and the Hot Milk team

OSSERVATORIO ASTRONOMICO DI BRERA

eROSITA

Why X-rays to study ultra high energy sources?

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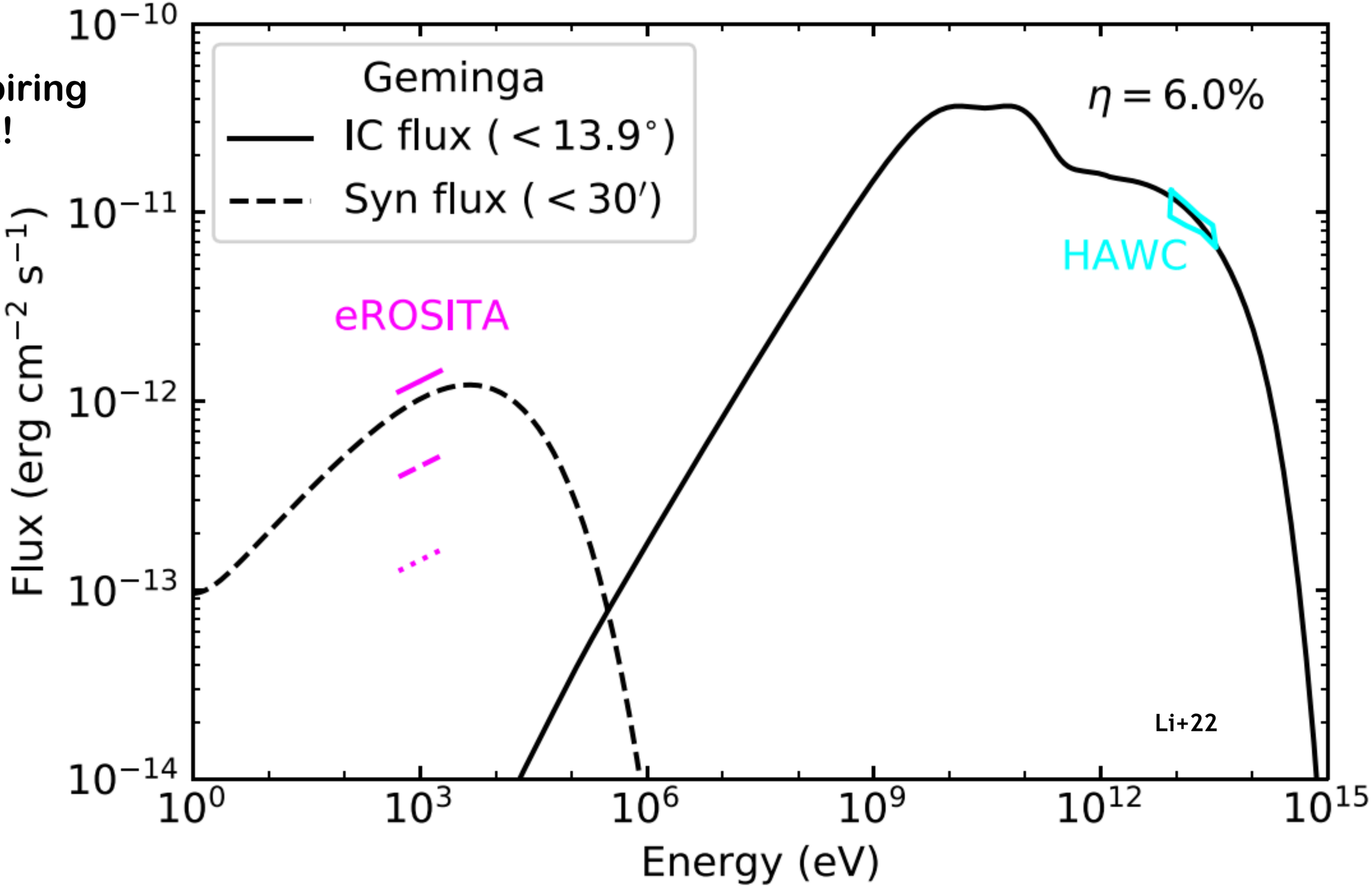
Very inspiring work!



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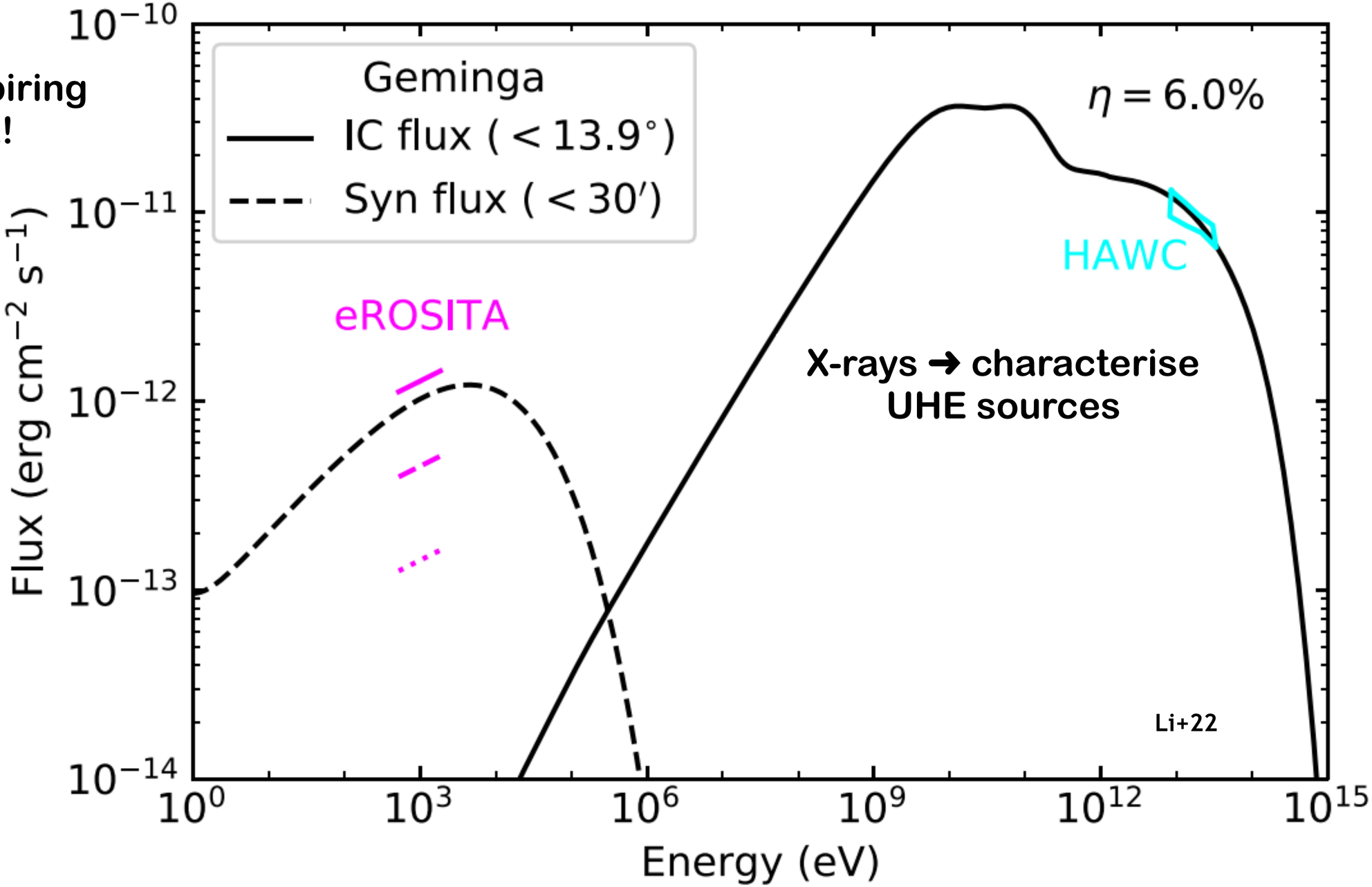

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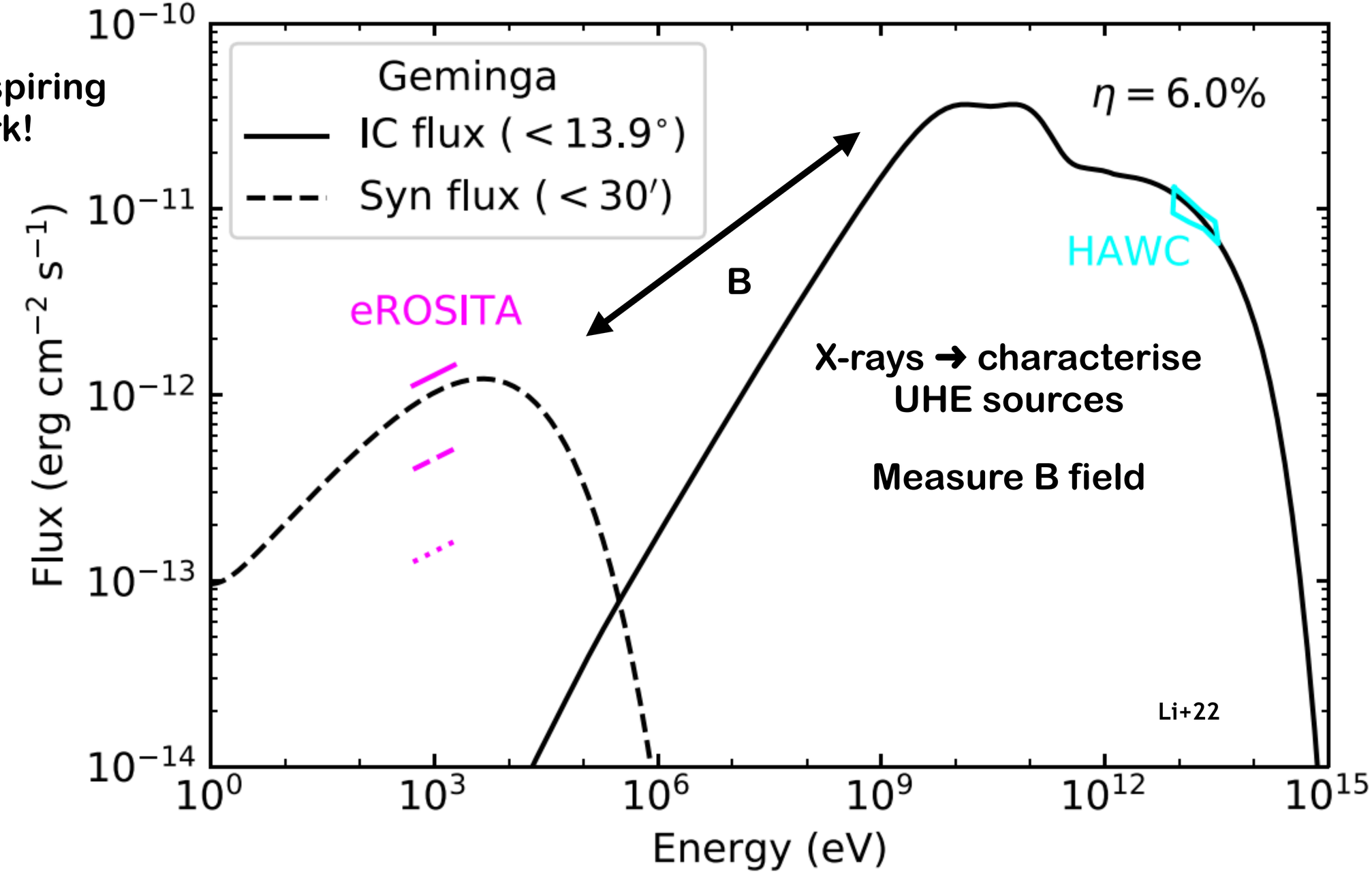

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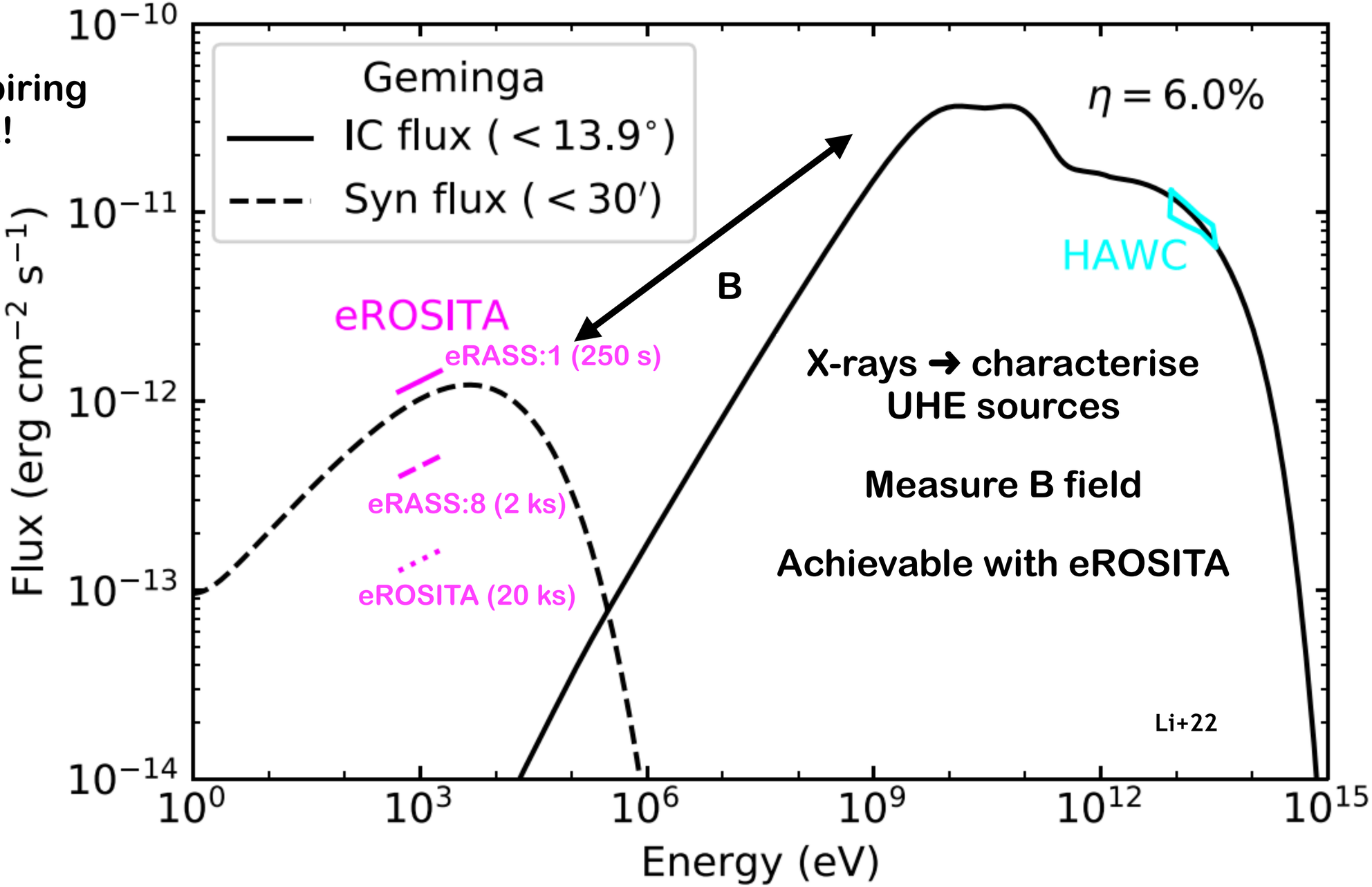

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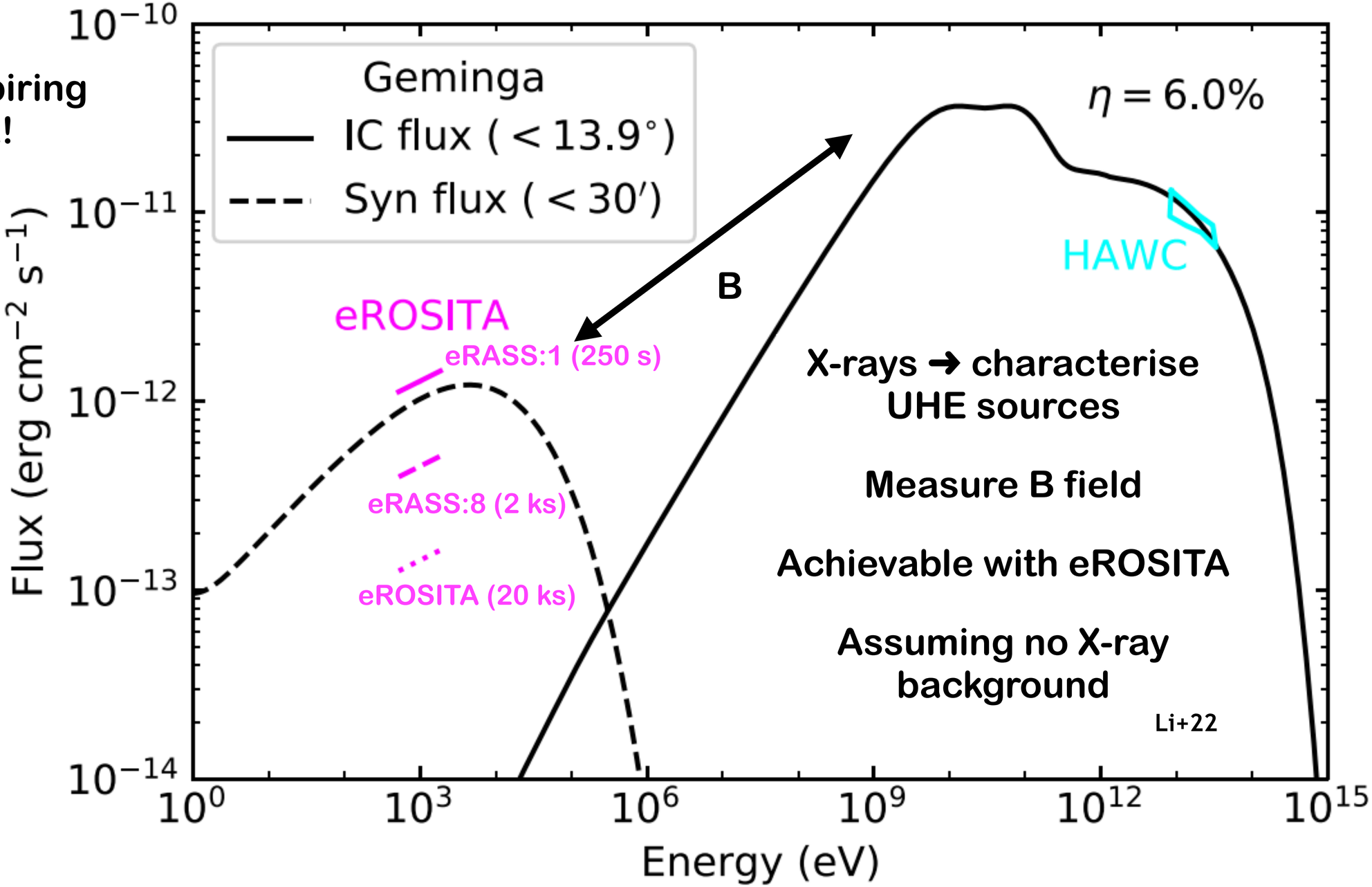

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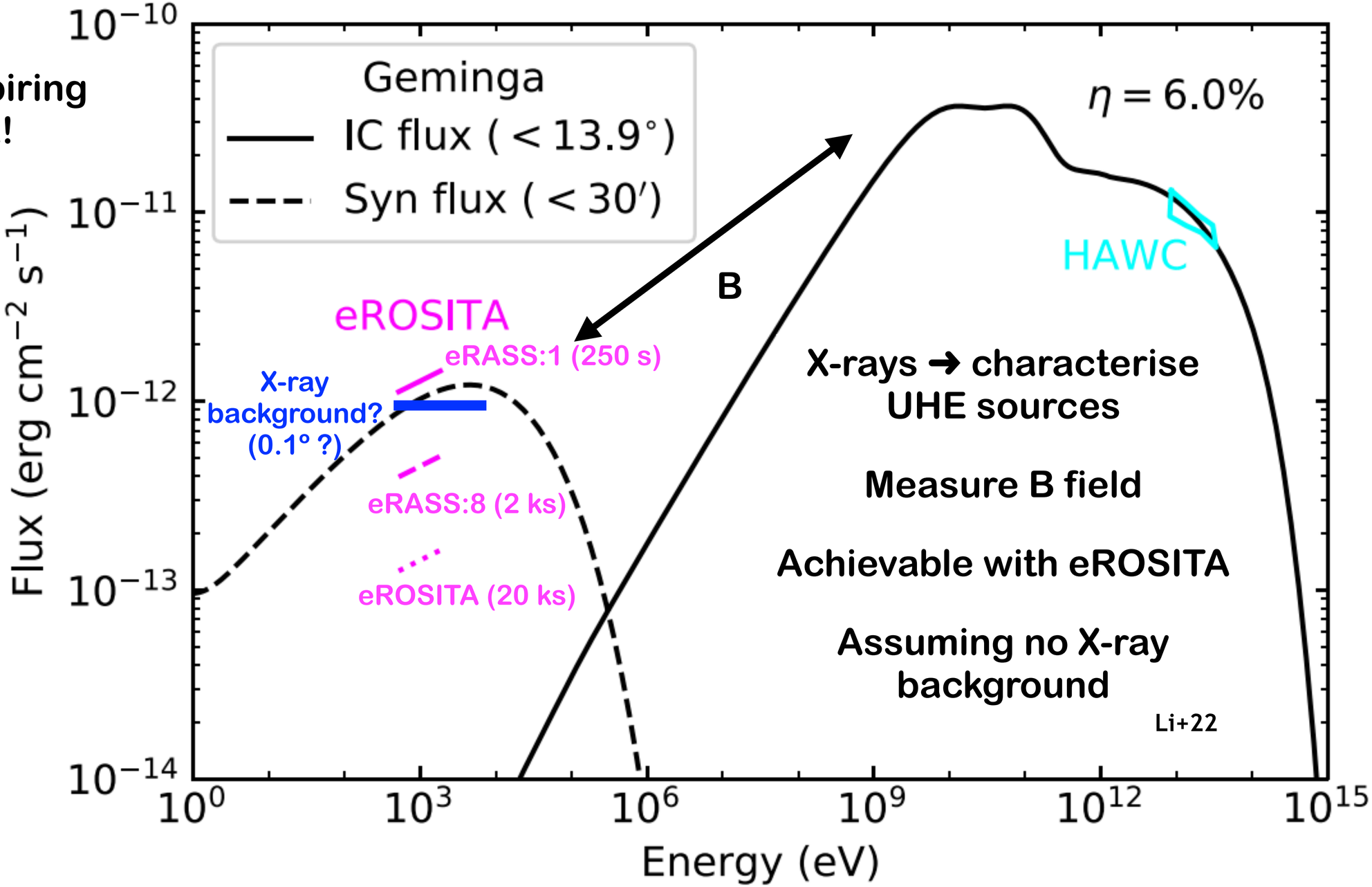
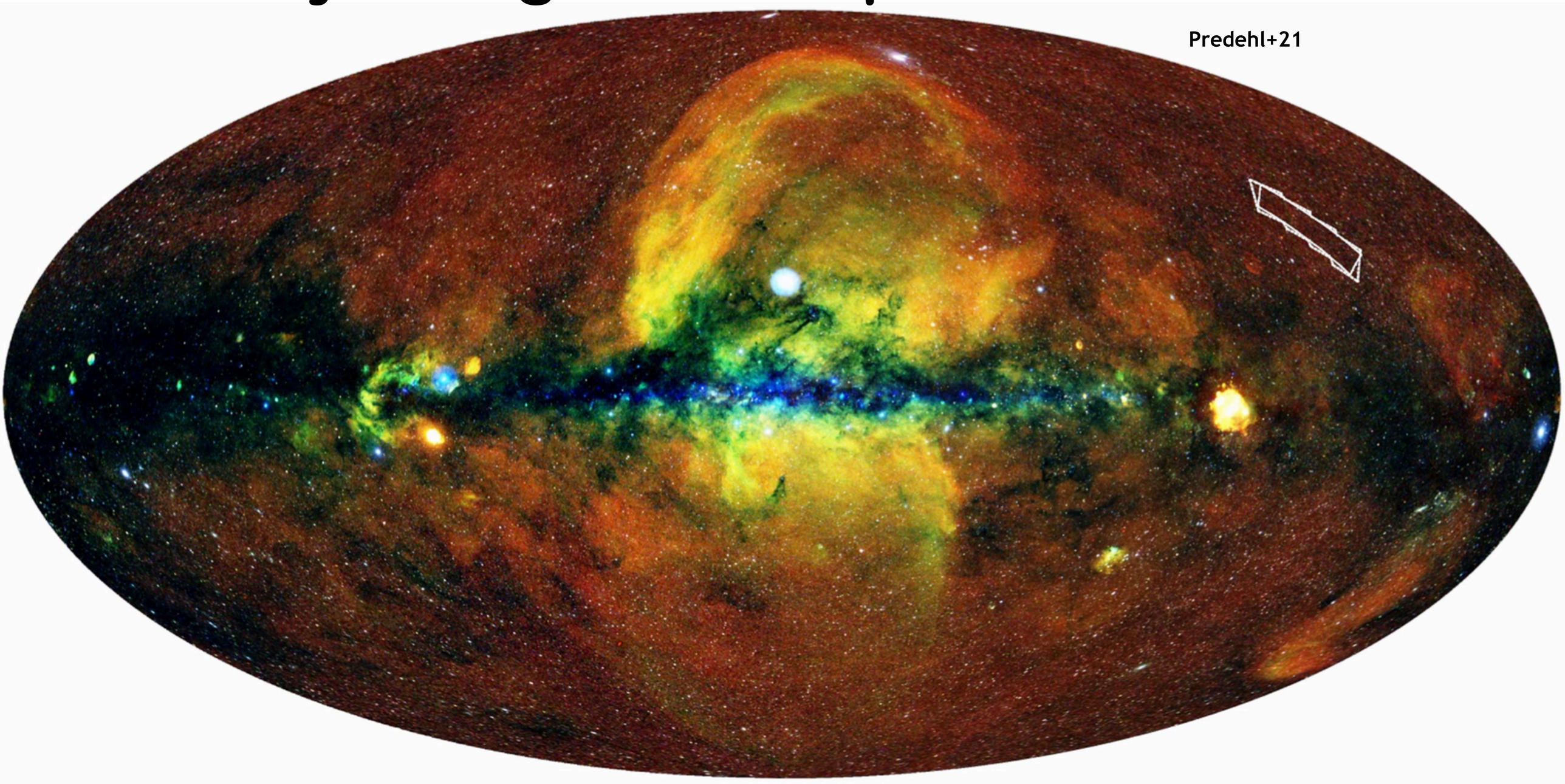


The X-ray background map



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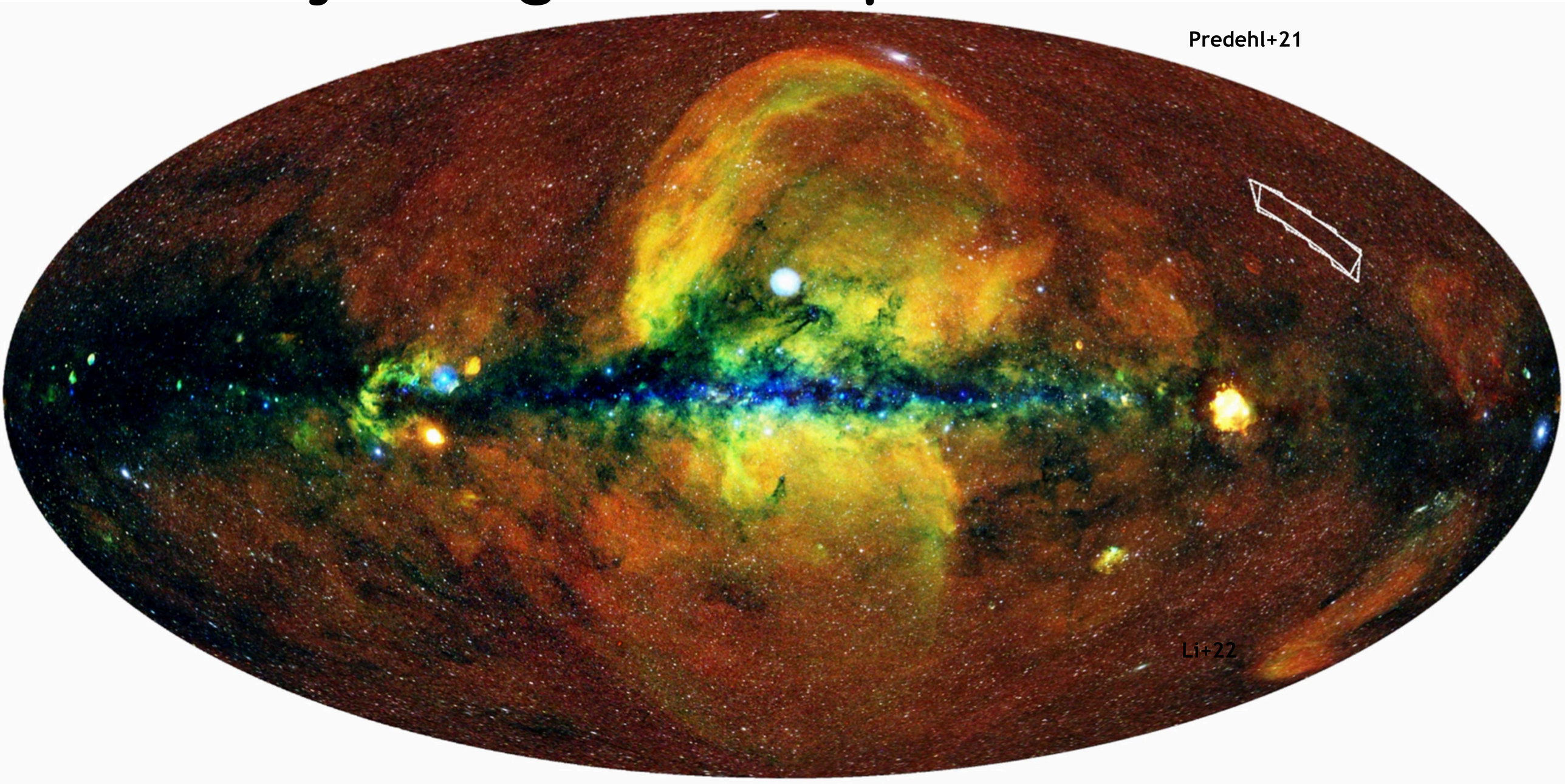

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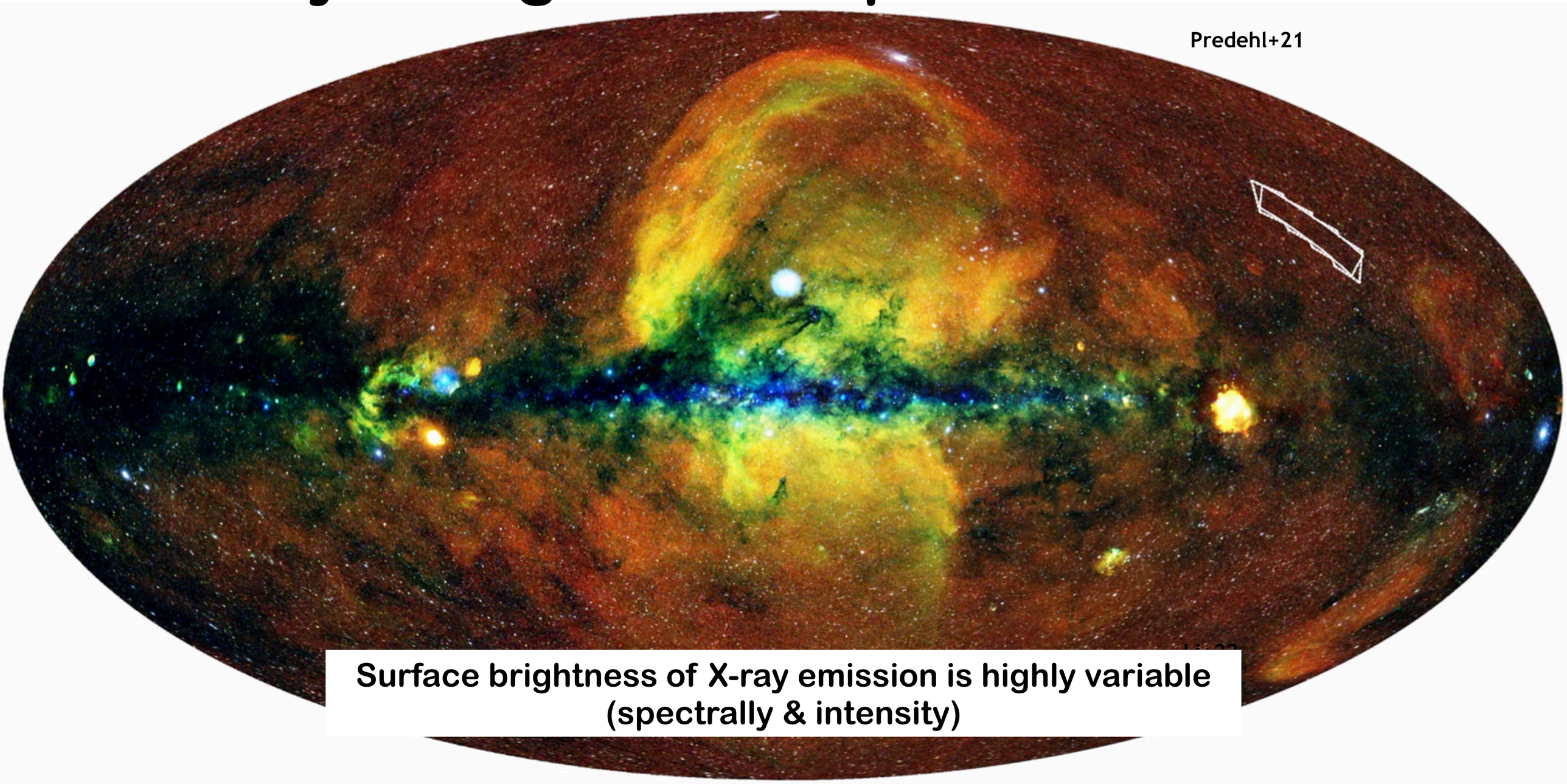
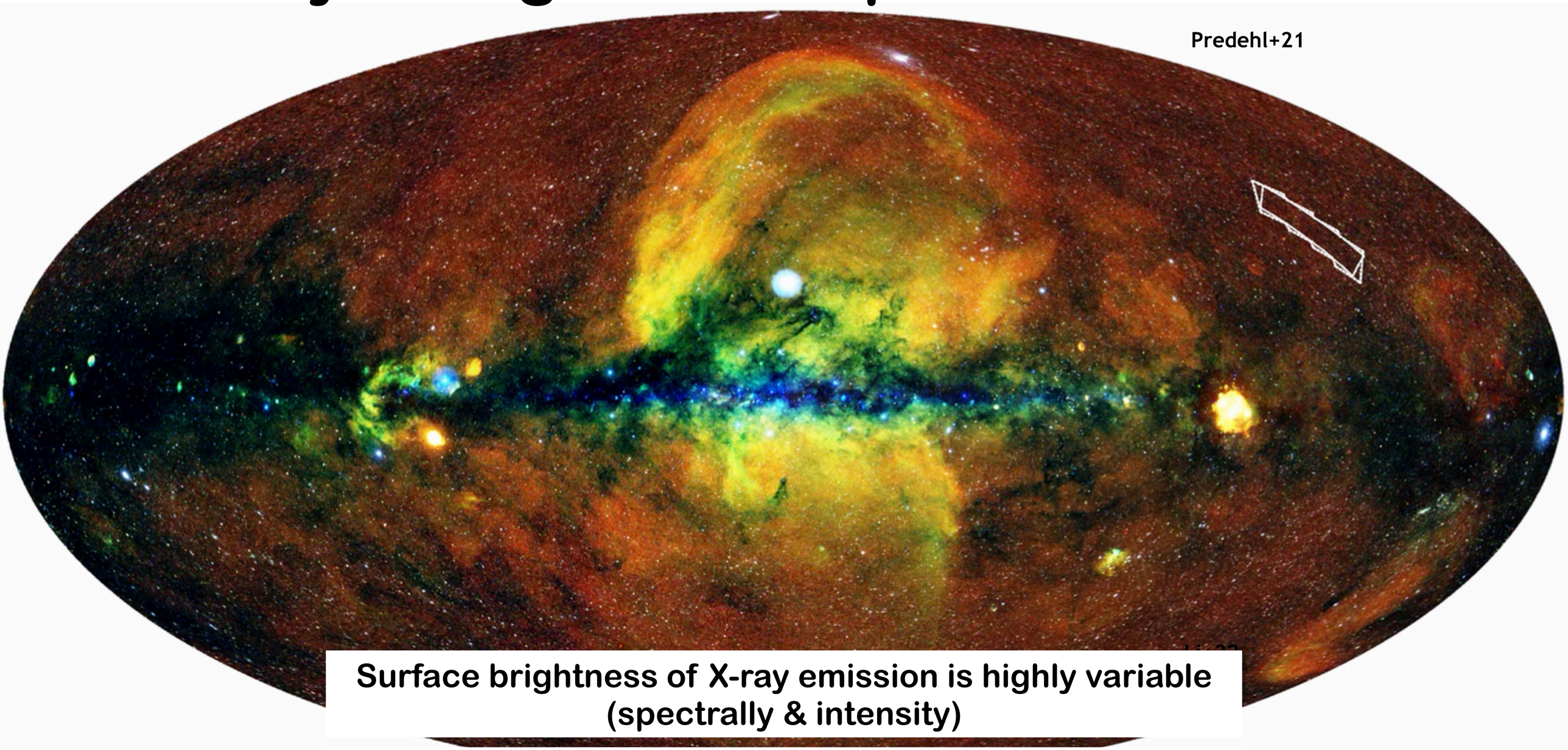


Surface brightness of X-ray emission is highly variable (spectrally & intensity)

The X-ray background map

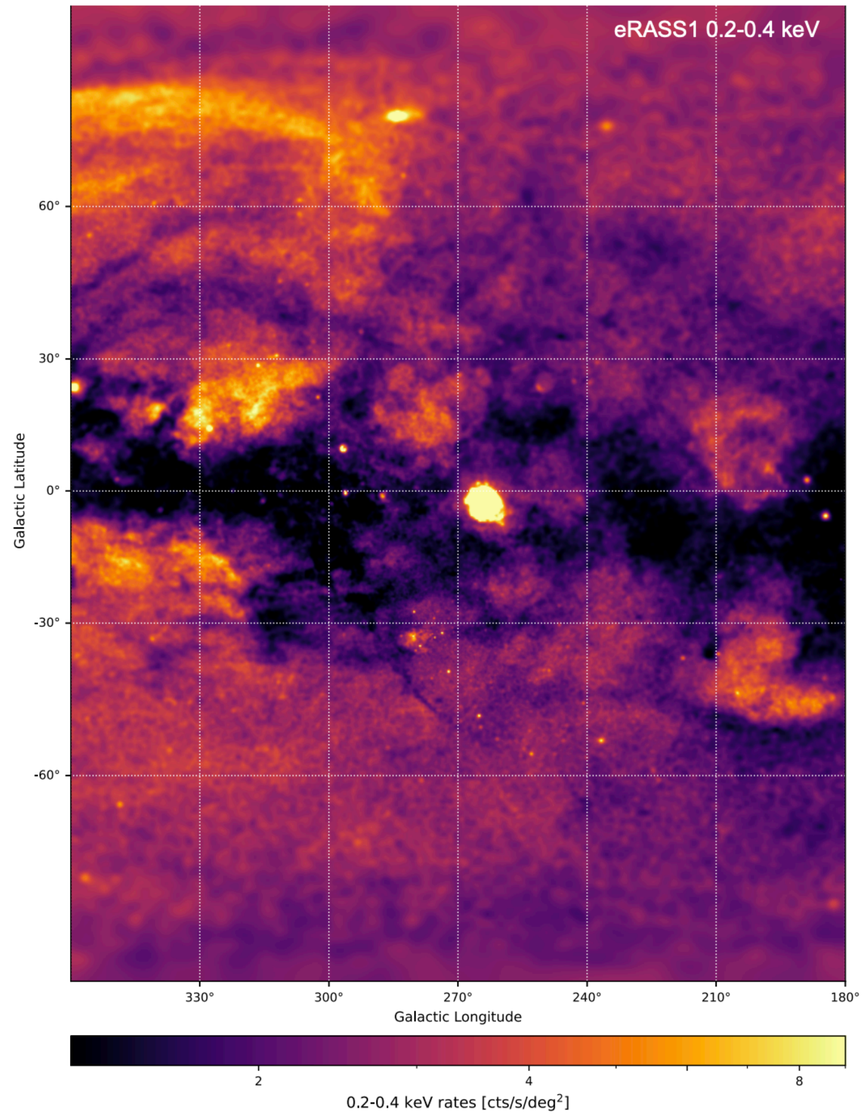


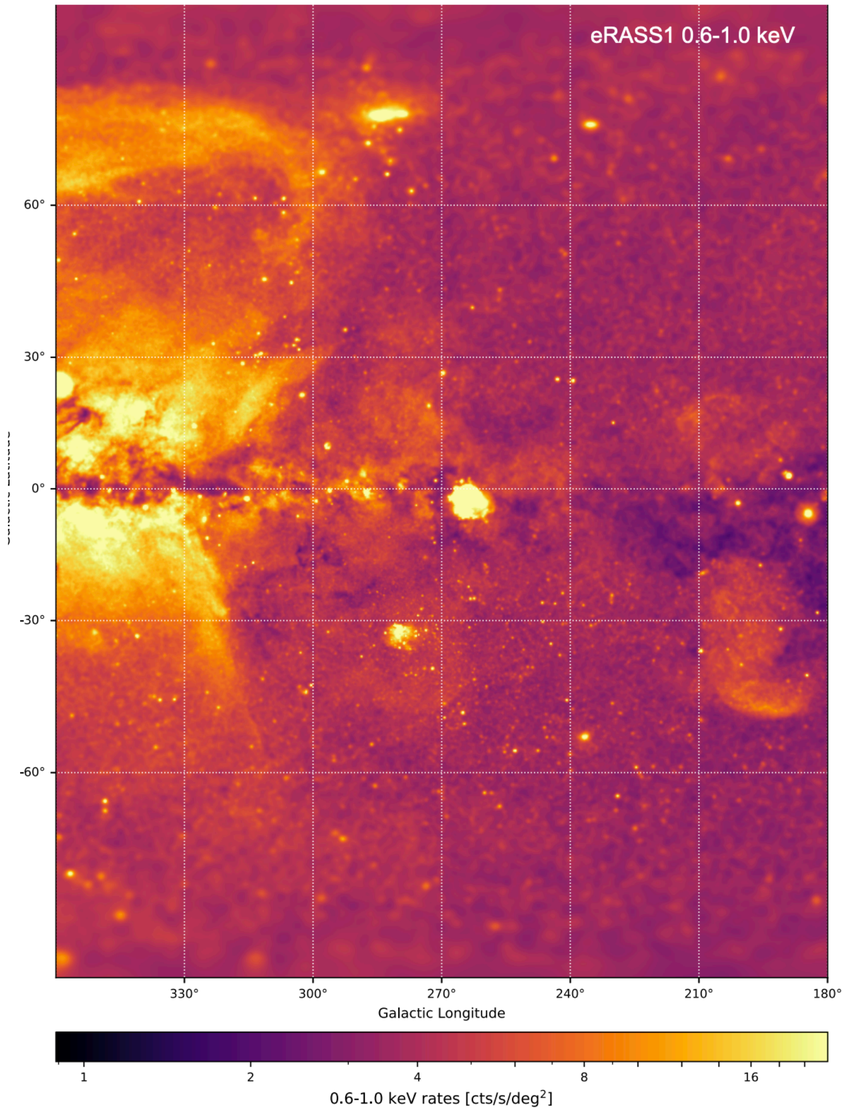
Surface brightness of X-ray emission is highly variable (spectrally & intensity)

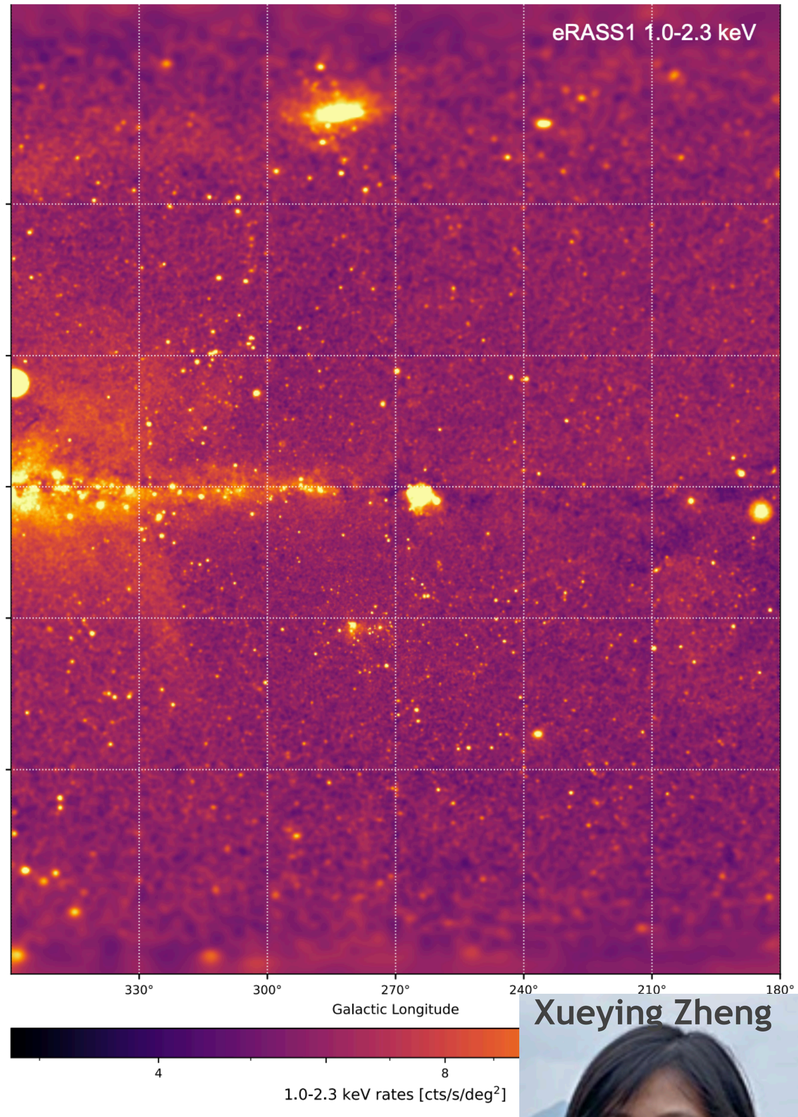
Complexity increasing towards the Galactic disc

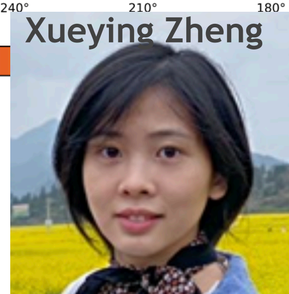
The X-ray background half-sky map

Zheng, GP+24









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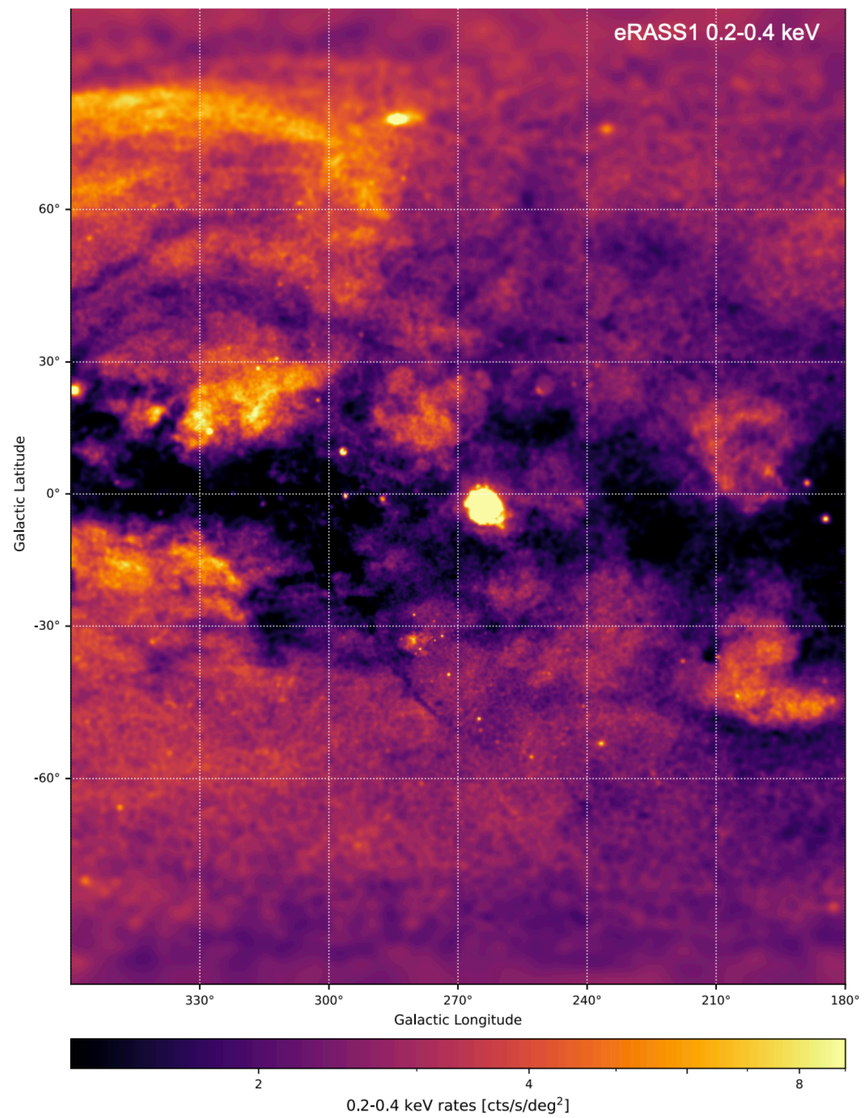
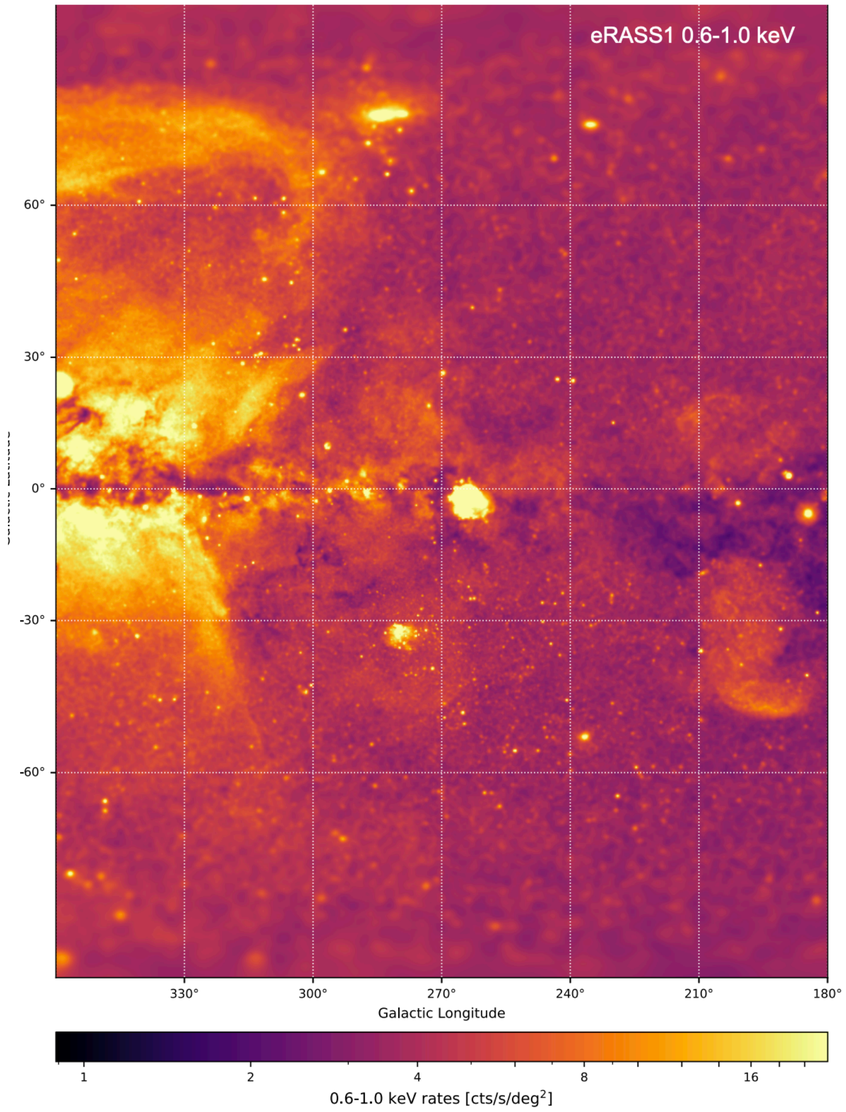
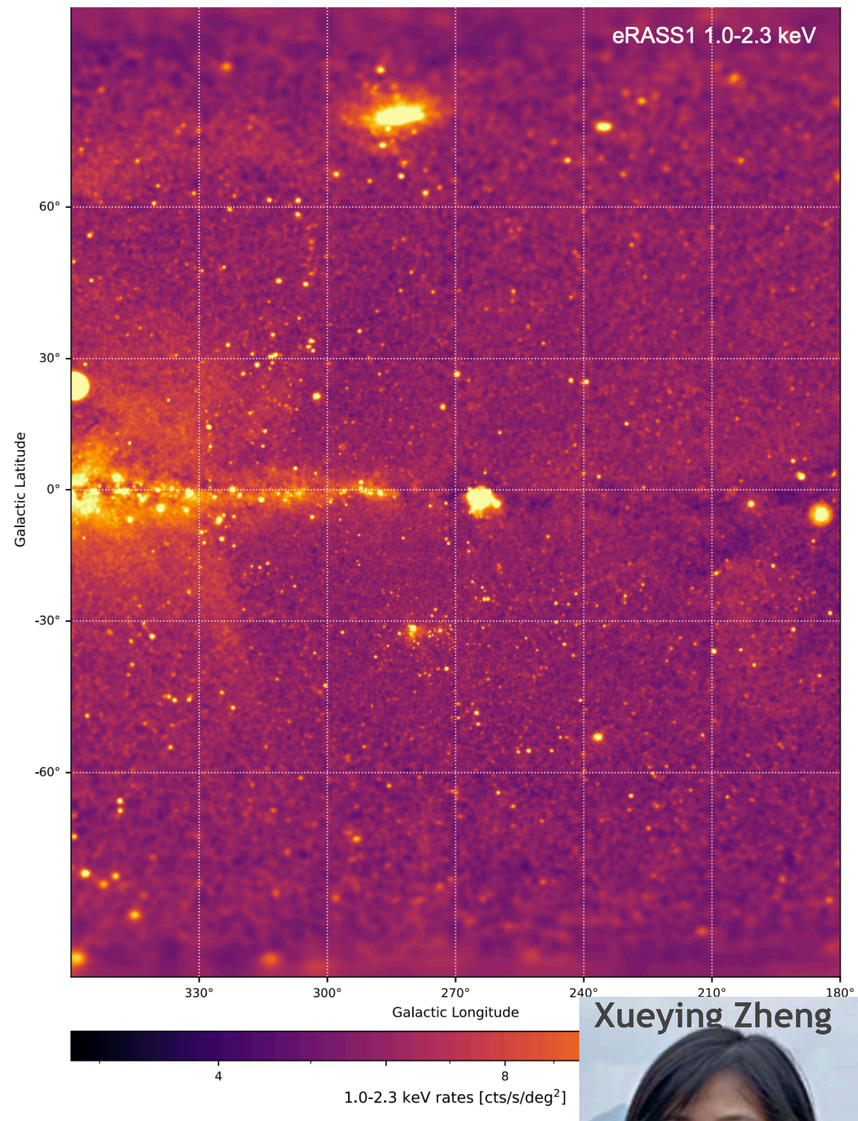
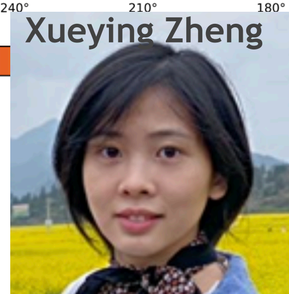






X-ray emission is highly variable (spectrally & intensity)



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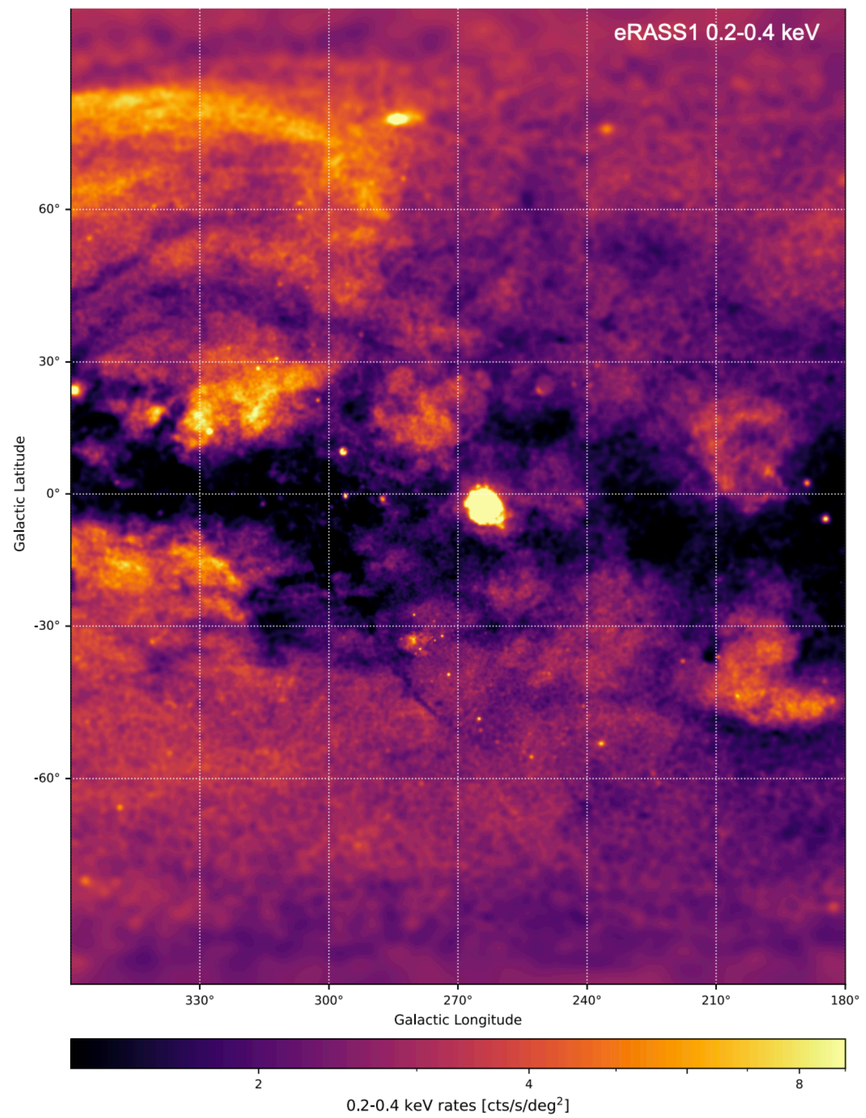

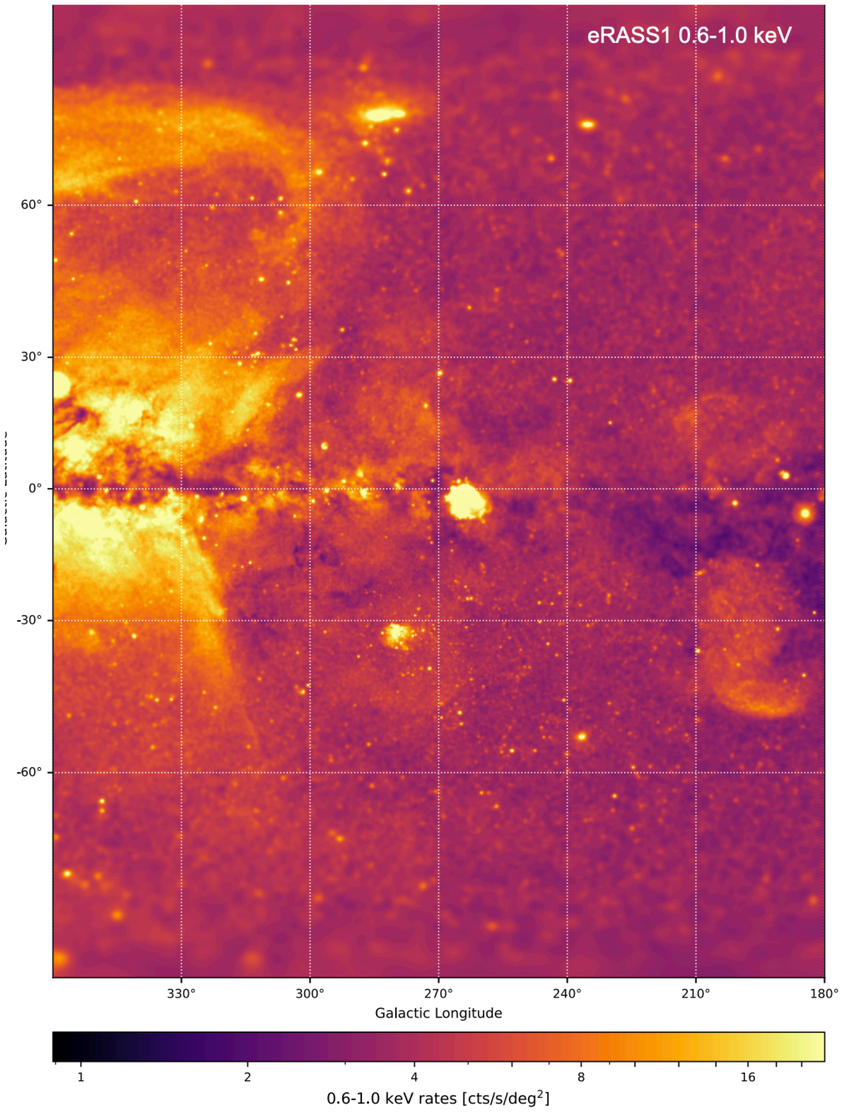

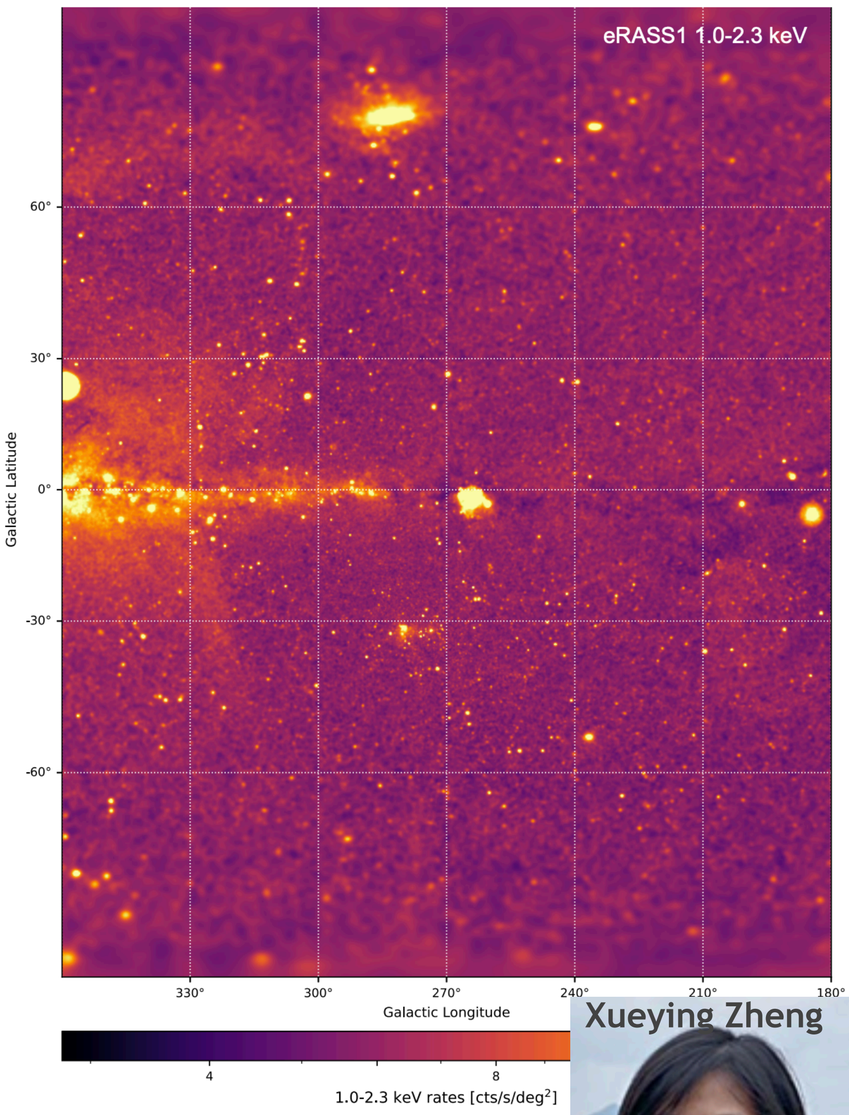

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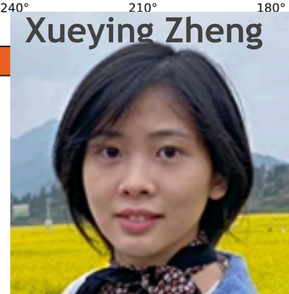
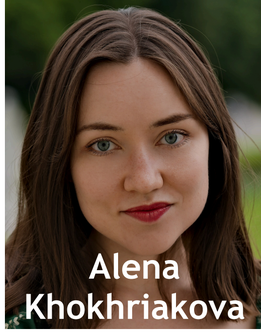
What does this imply?



Pulsars haloes within Monogem Ring

Khokhriakova, Becker, GP+24



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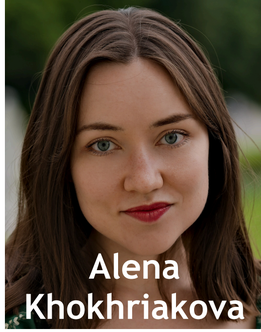

If X-ray surface brightness ≫ diffuse emission (background)

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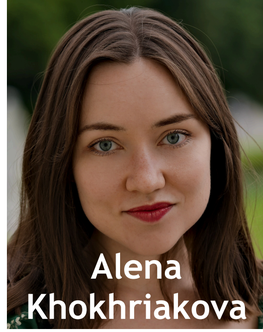

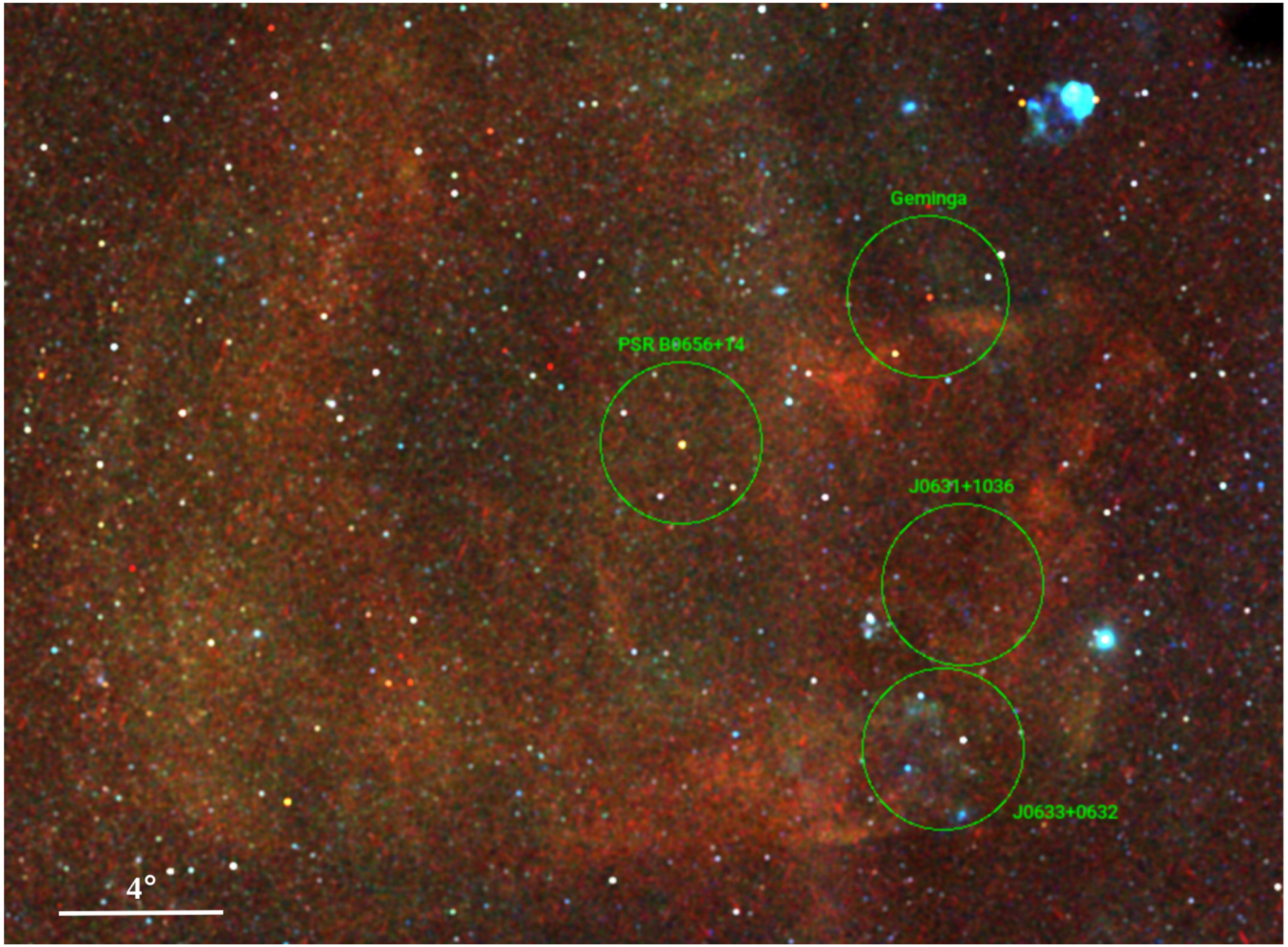

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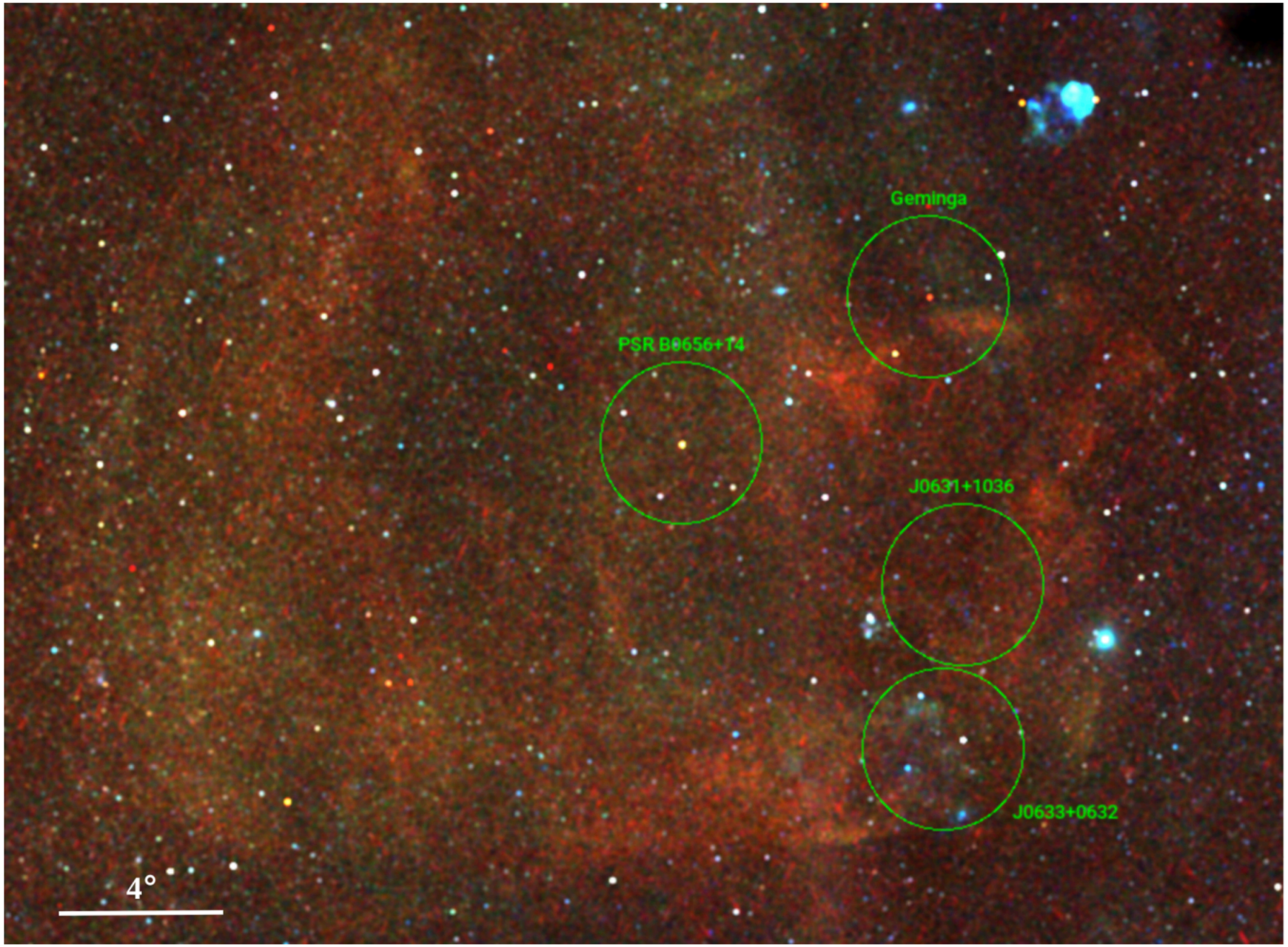

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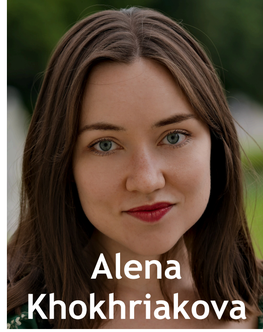

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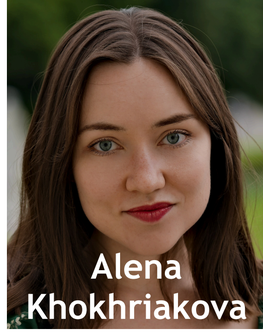

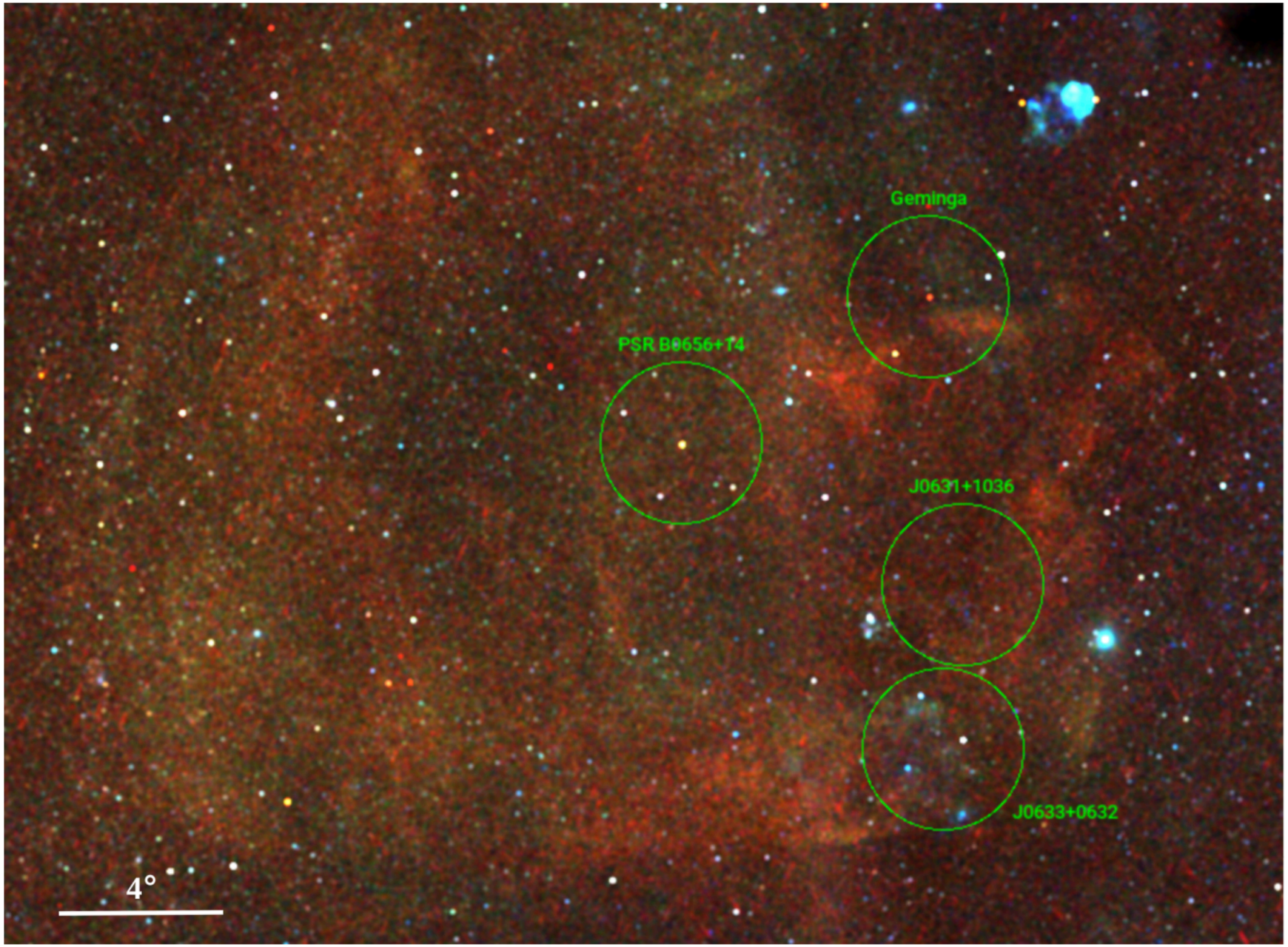

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But see Niu+25!

See Ruoyu's talk

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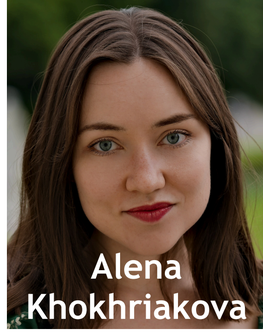

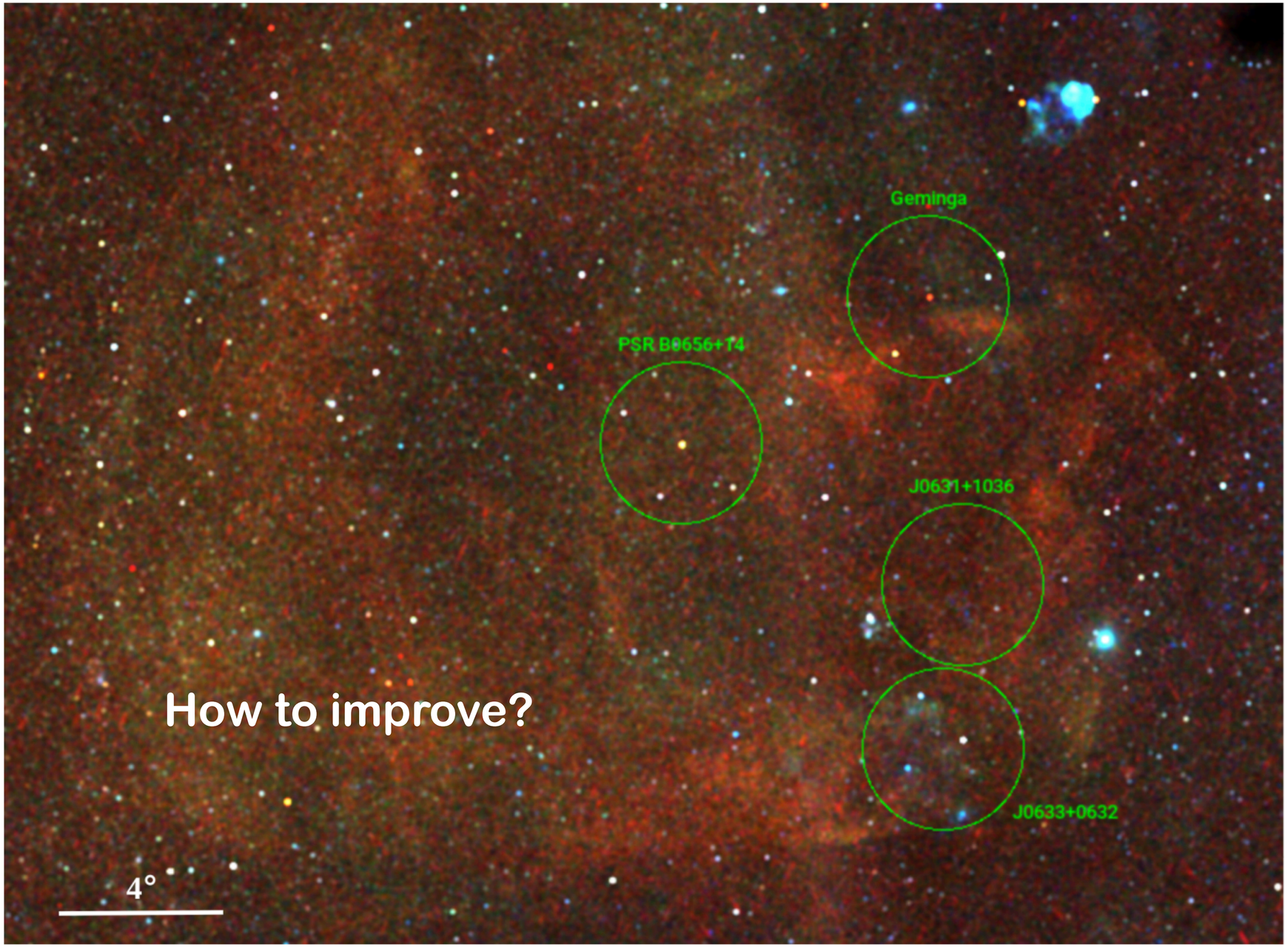

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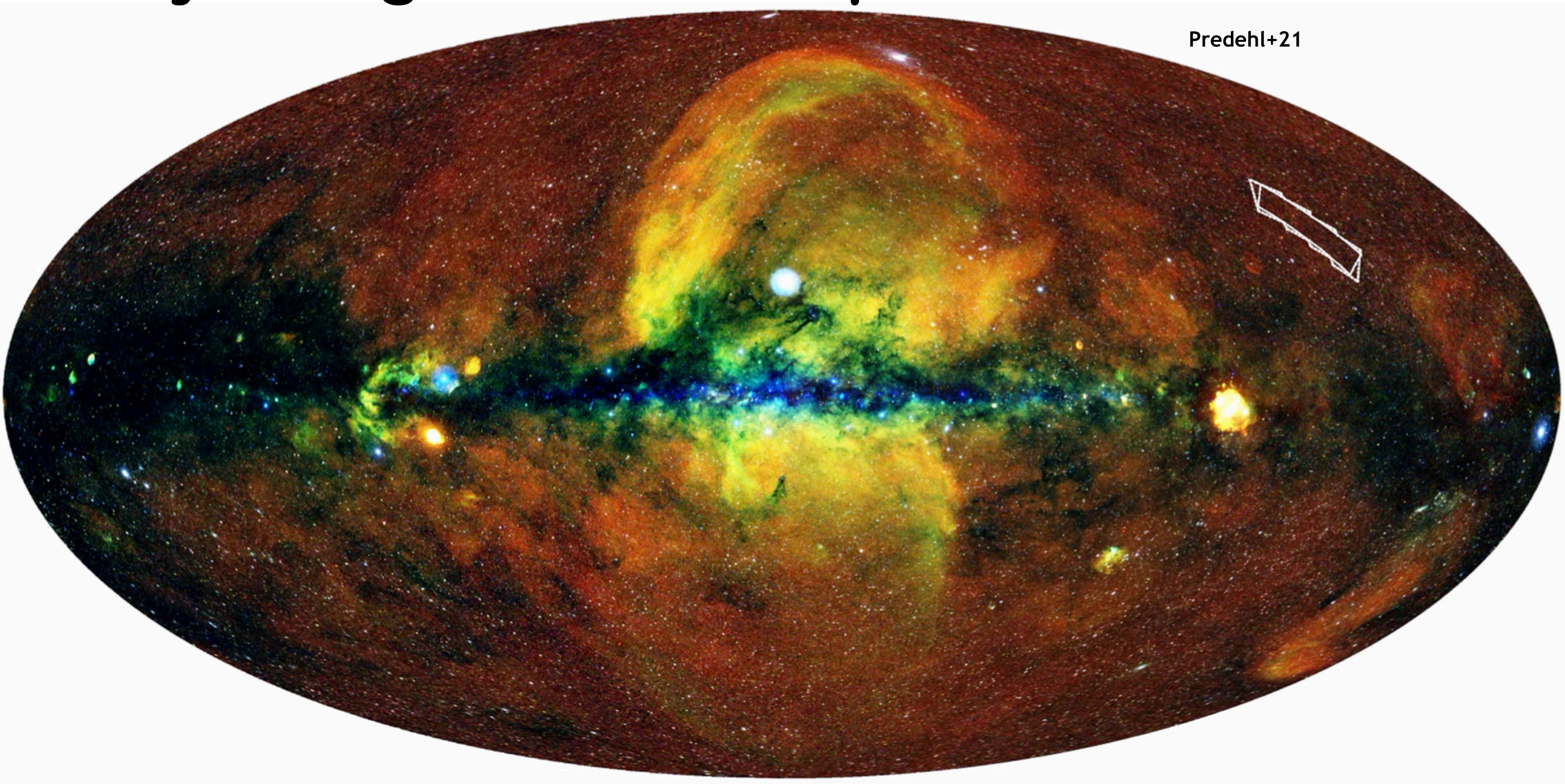

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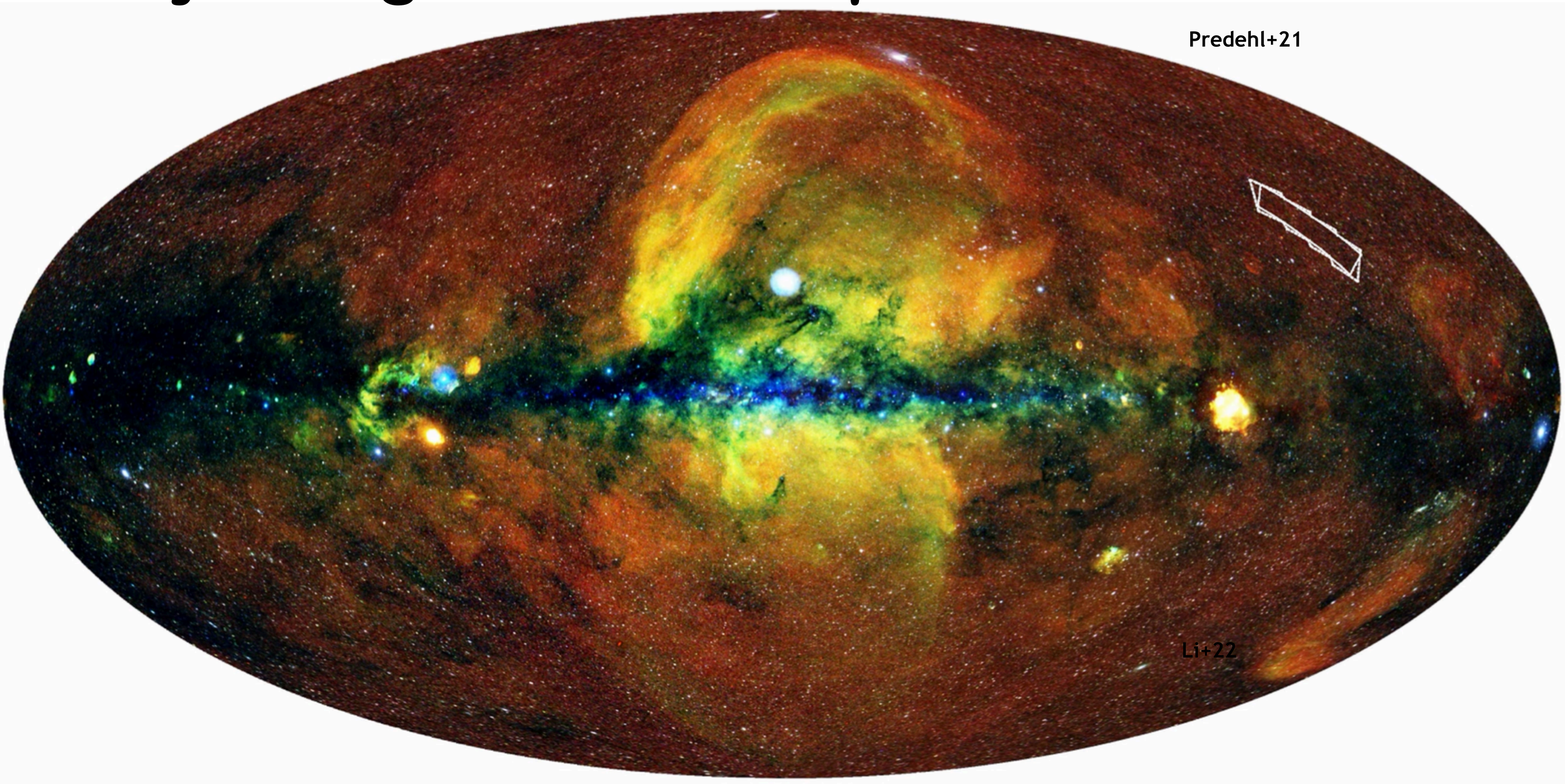

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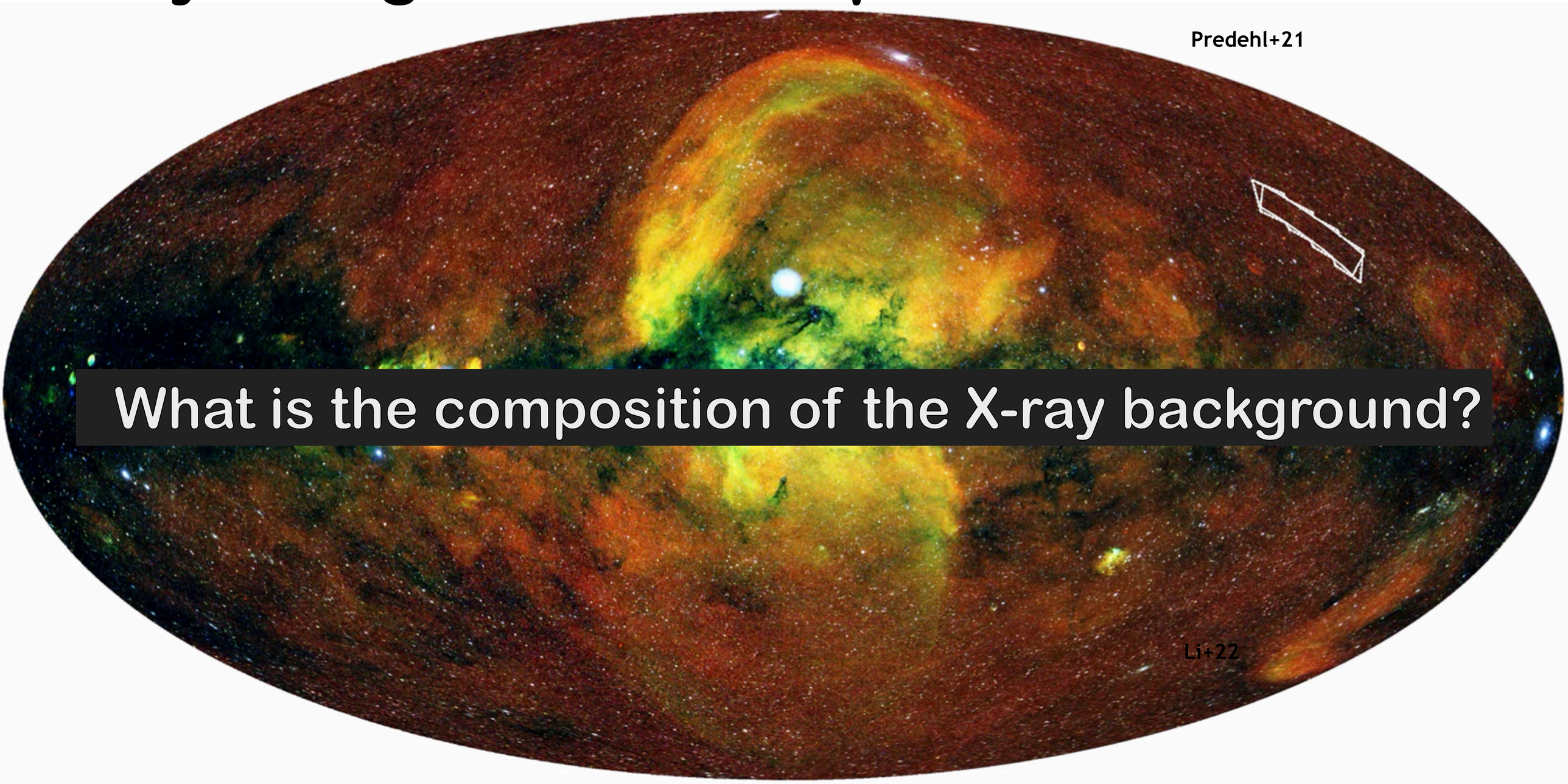

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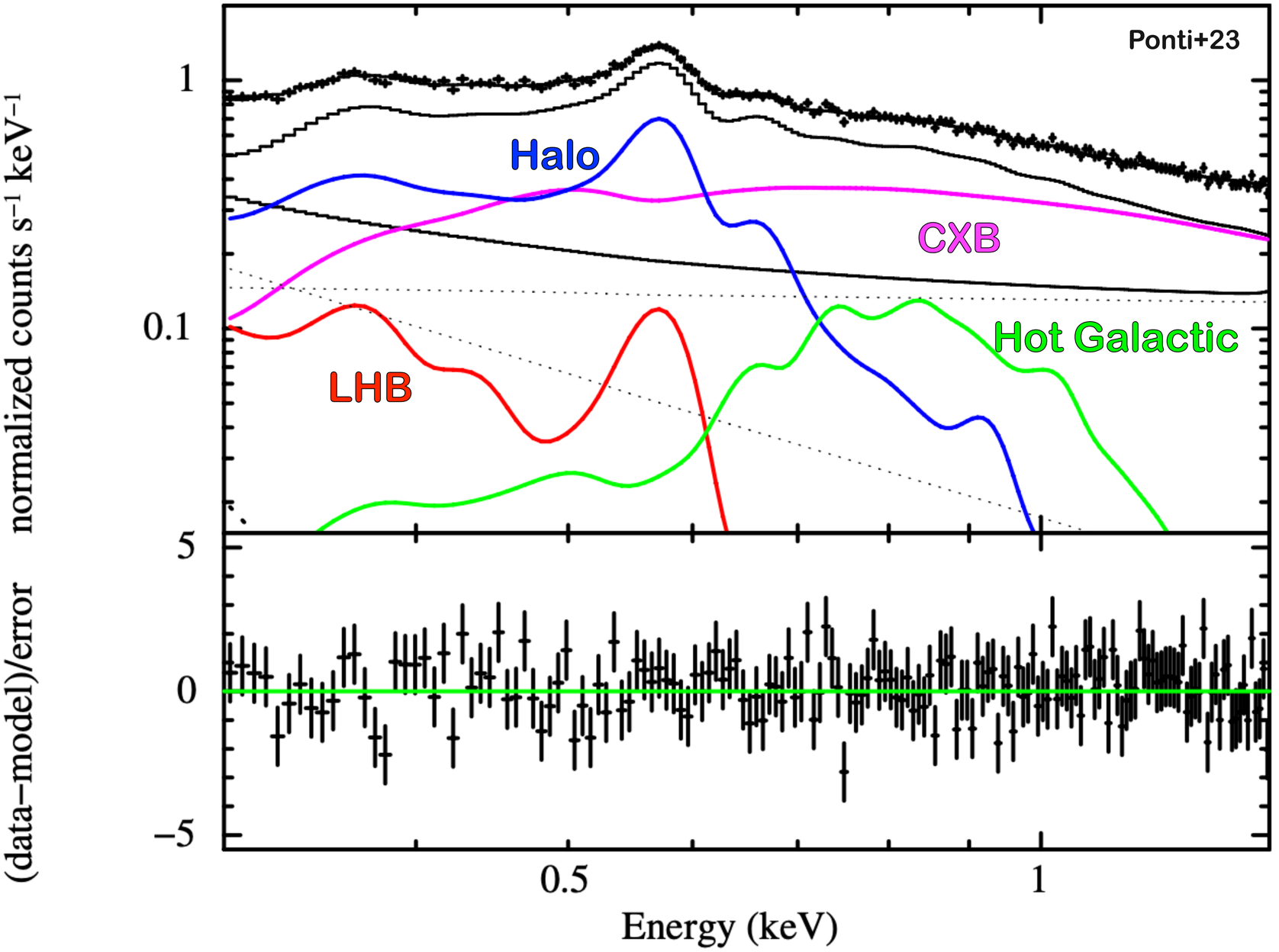

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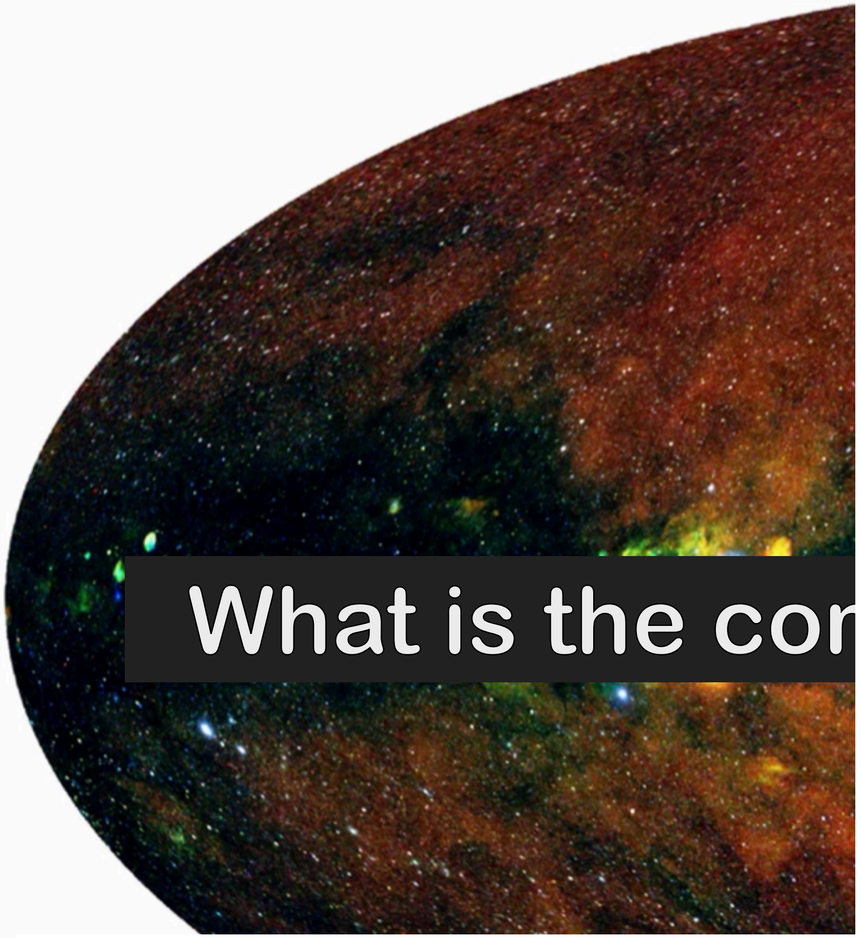
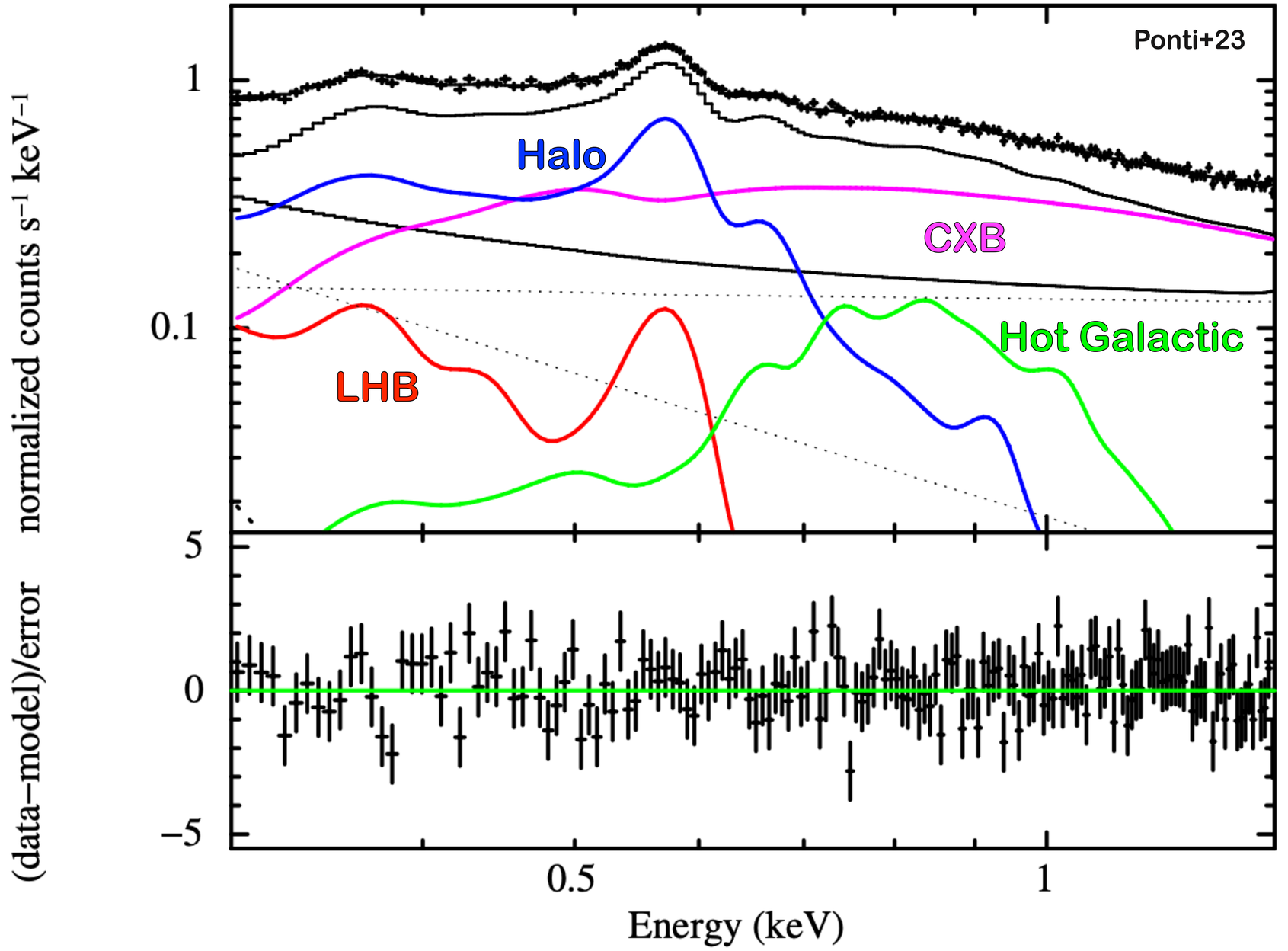


LHB: Local hot bubble

Halo: Circum Galactic medium

CXB: Cosmic X-ray background

Hot Galactic → Required!



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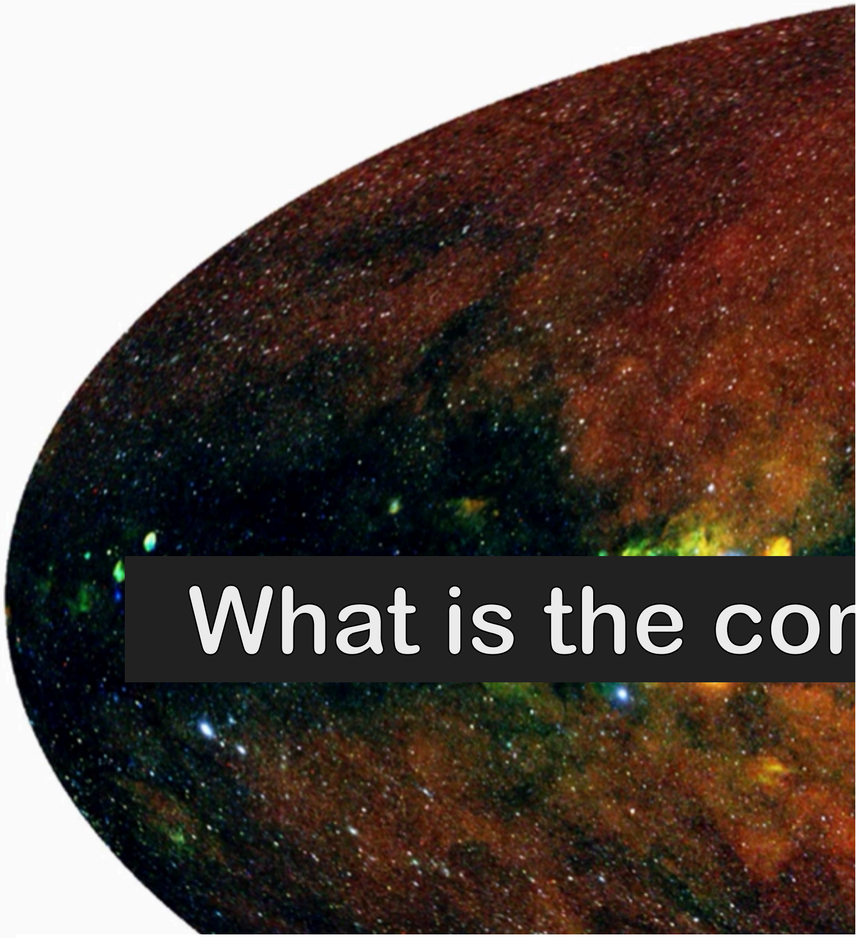

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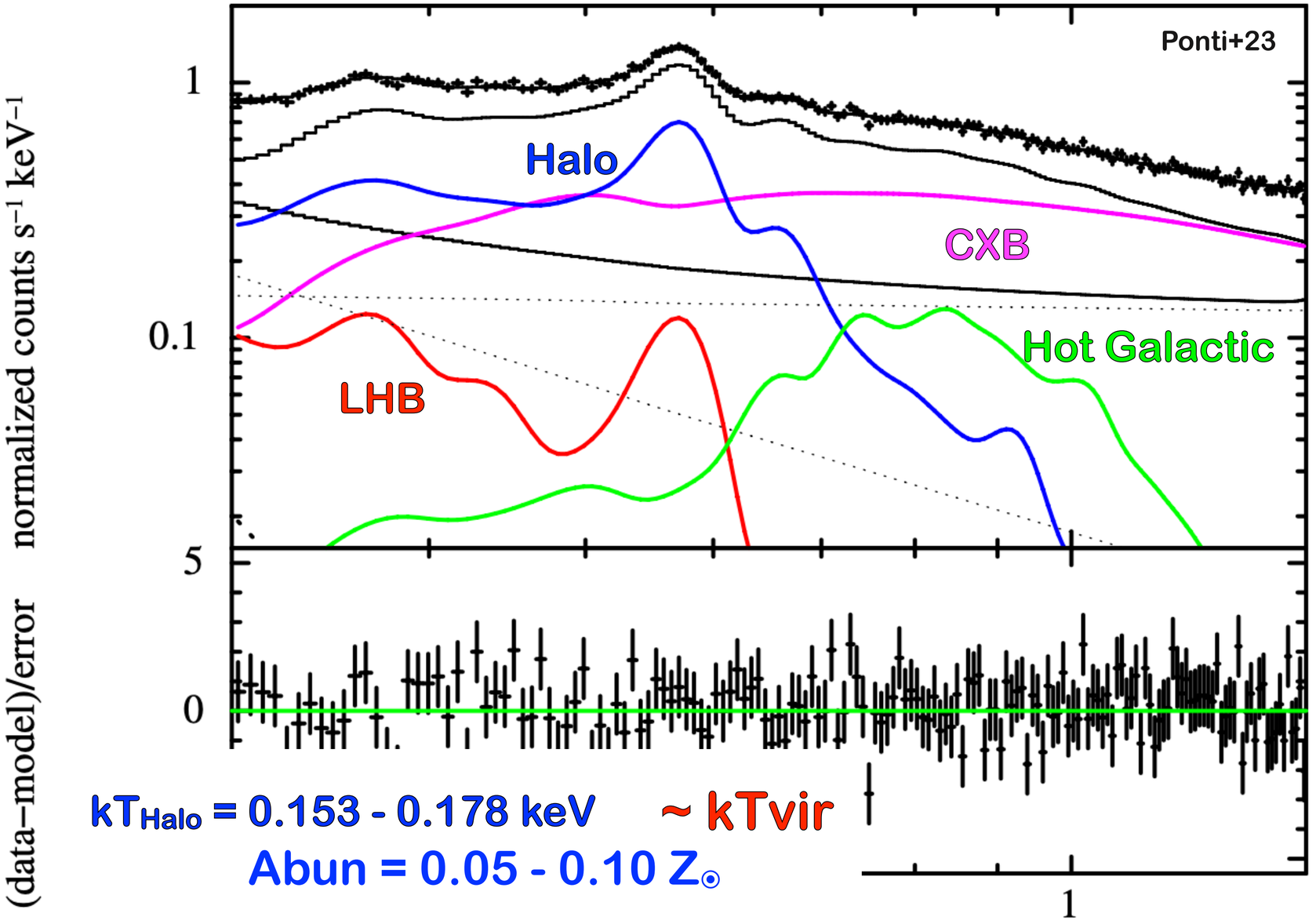


kT_{Halo} = 0.153 - 0.178 keV ~ kTvir

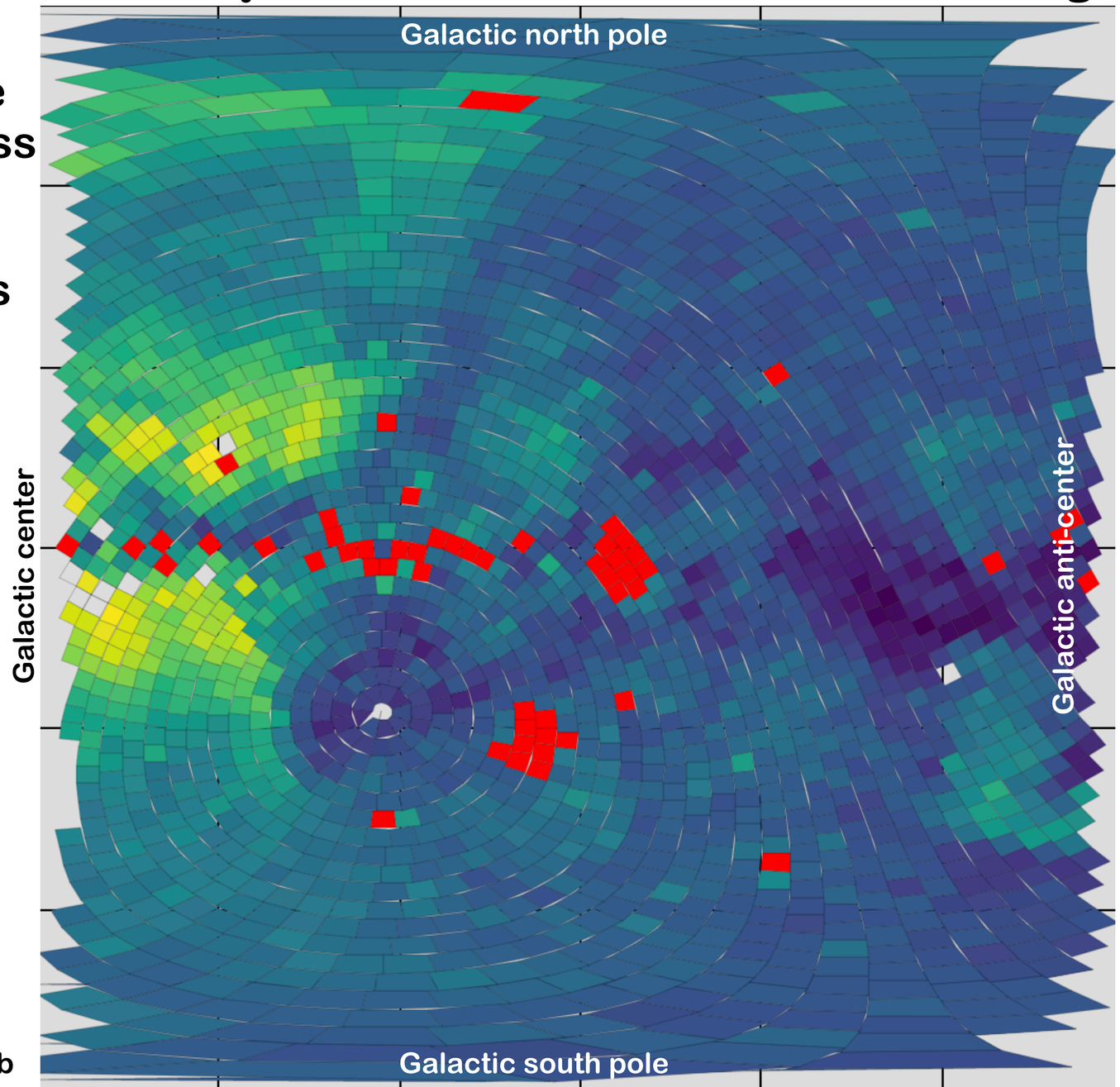
Abun = 0.05 - 0.10 $Z_\odot$

kT_{hotG} = 0.4 - 0.7 keV

The composition of the X-ray background

Surface brightness

Sky Tiles 3×3°



Ponti+sub

The composition of the X-ray background

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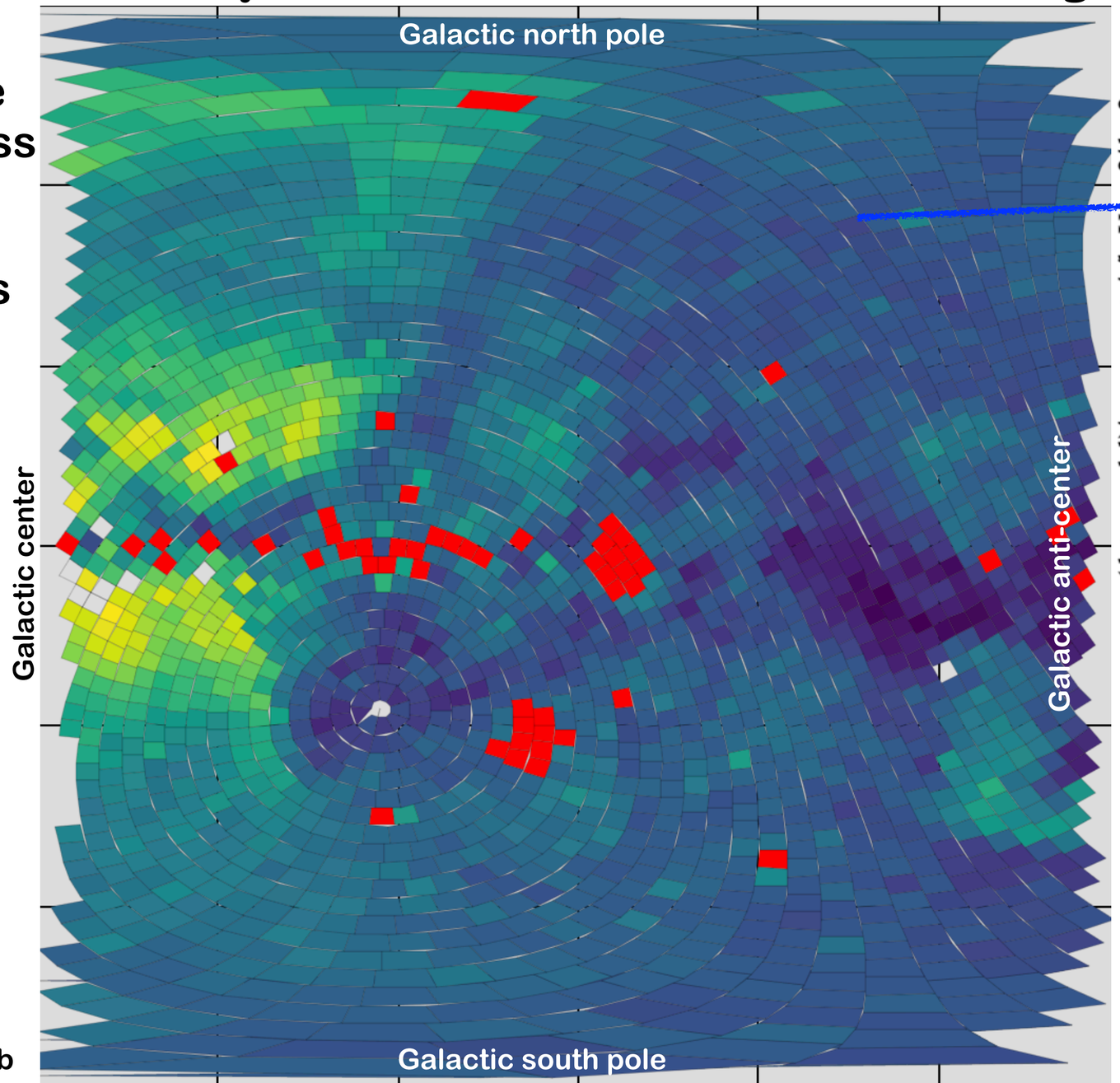

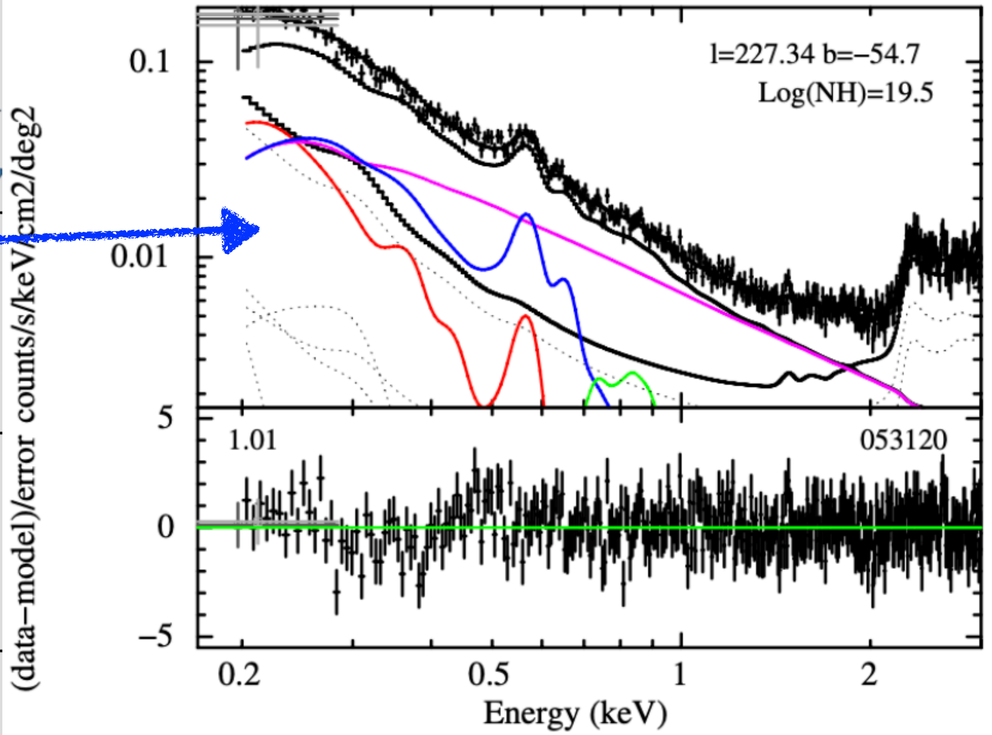

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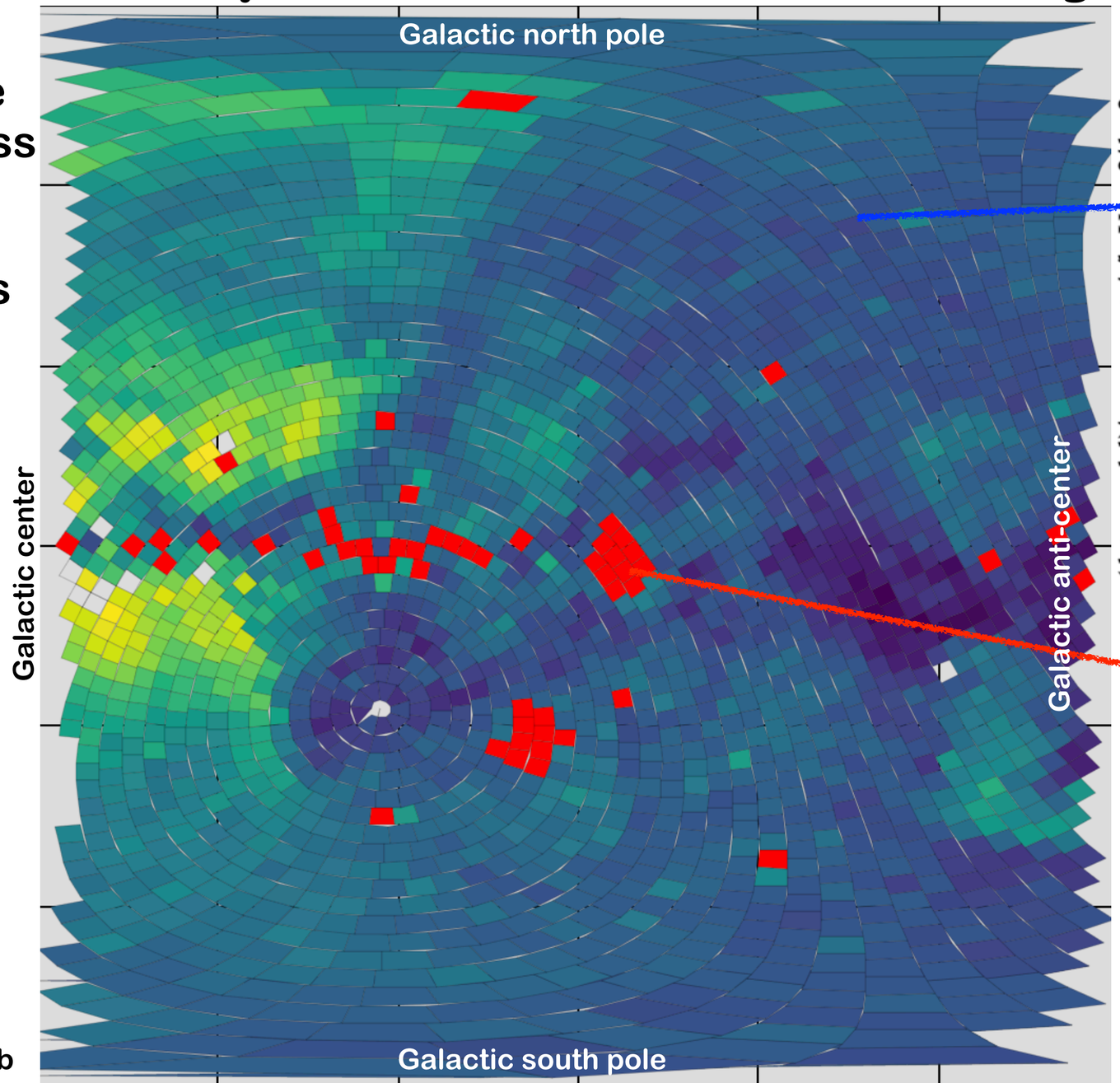

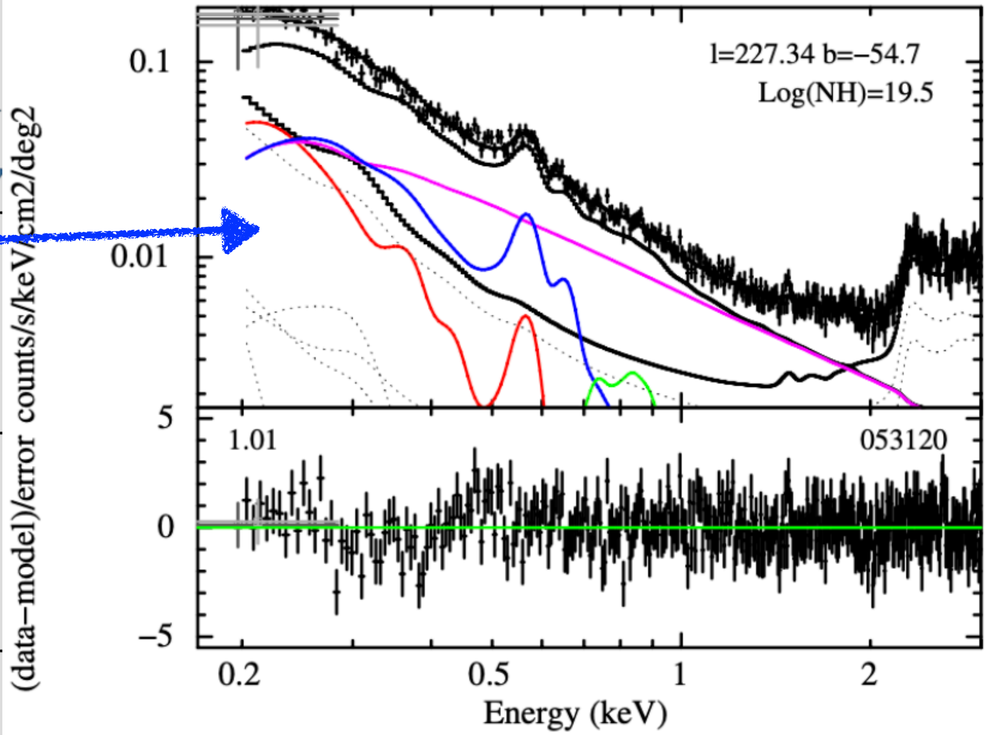

$\chi^2_{red} > 1.5$

Good fit over most of the sky even with oversimplified model

Ponti+sub

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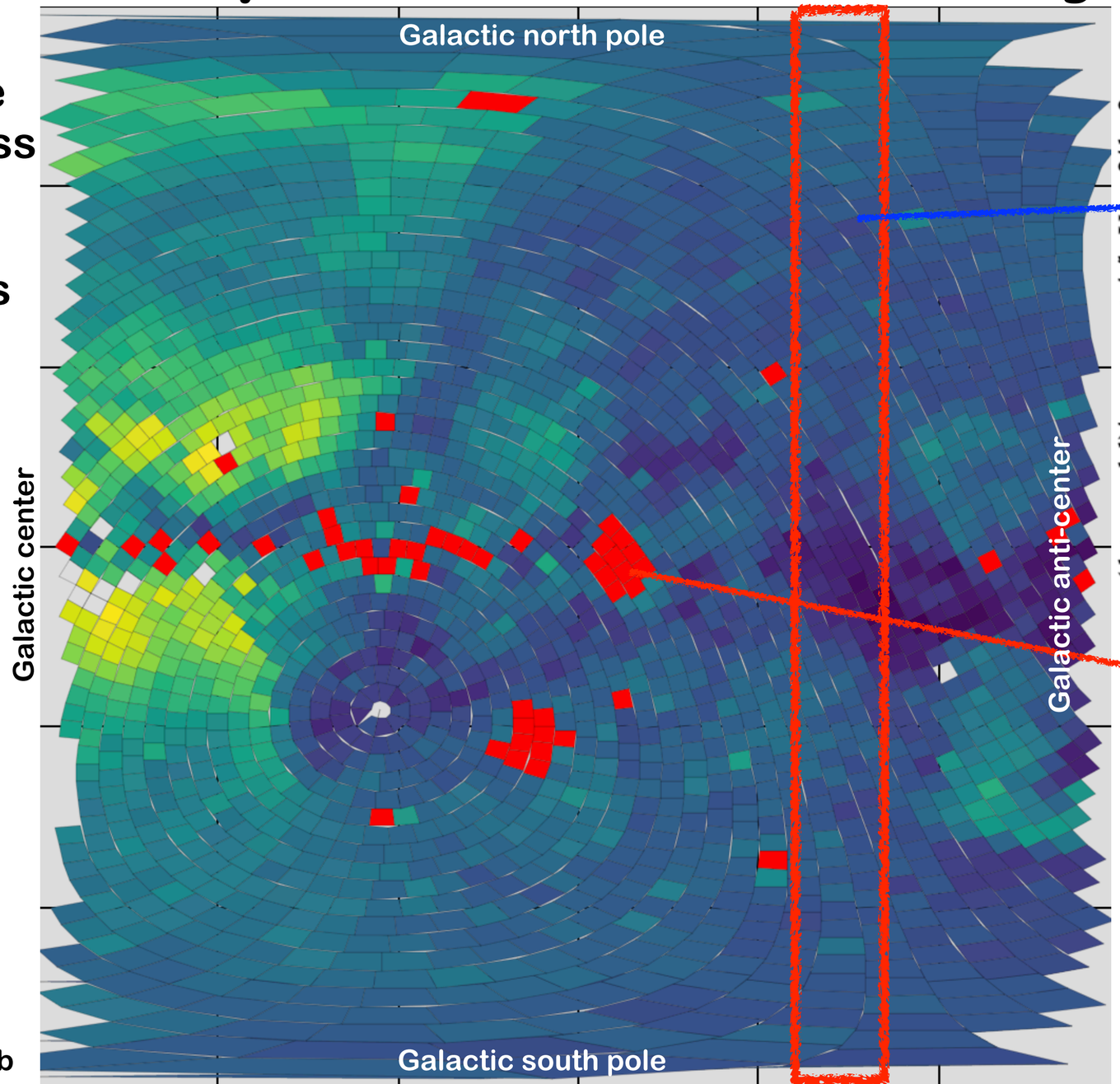

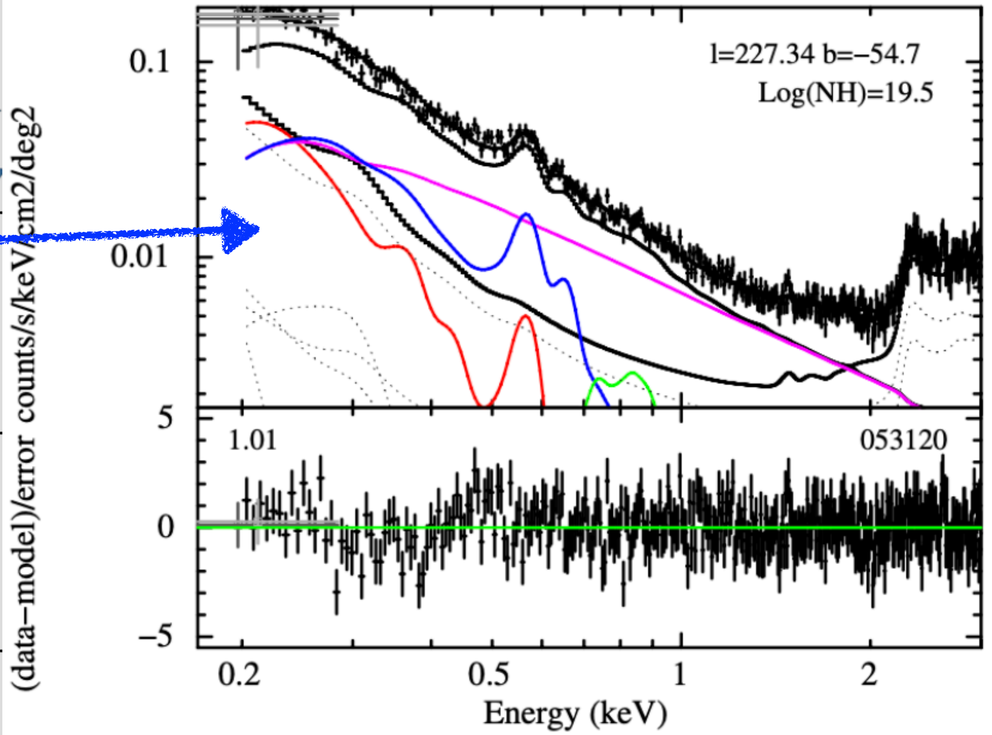

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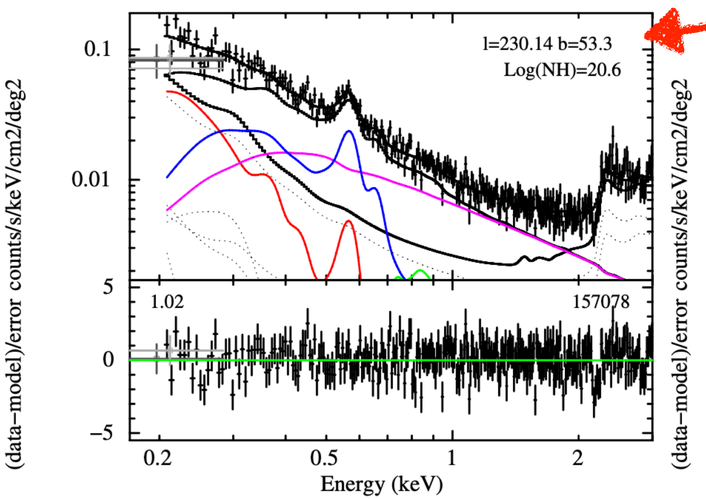
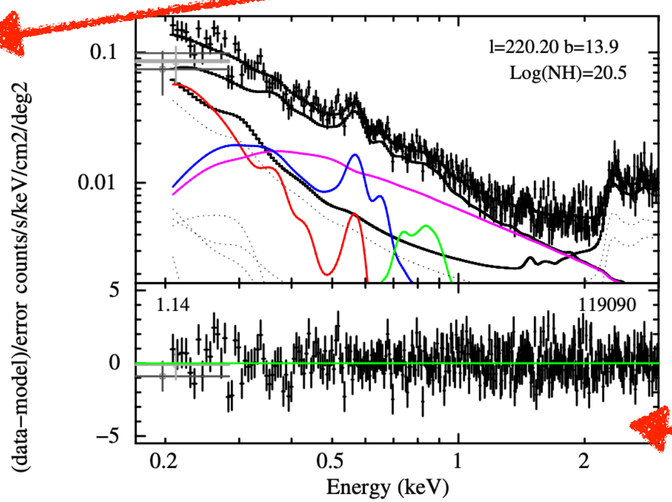
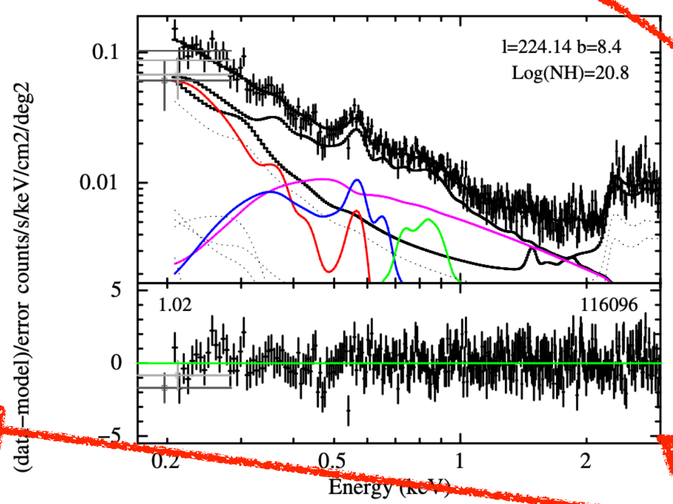
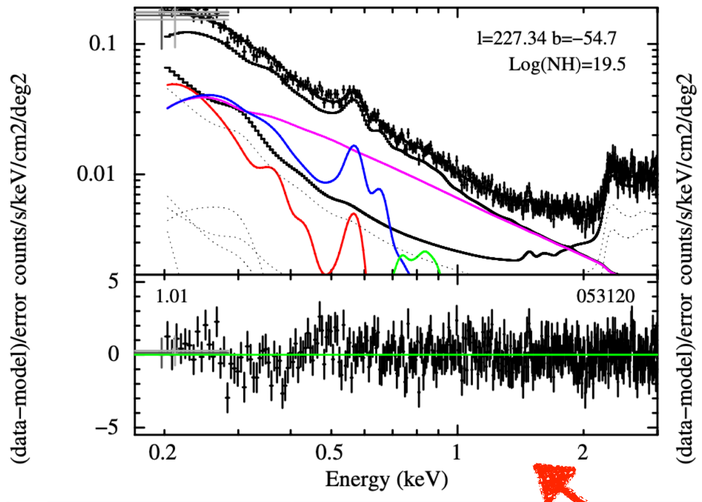
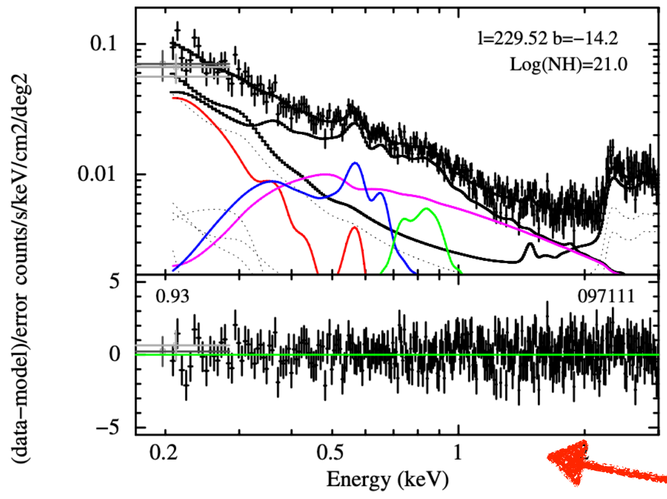
Spectral variations over the half-sky

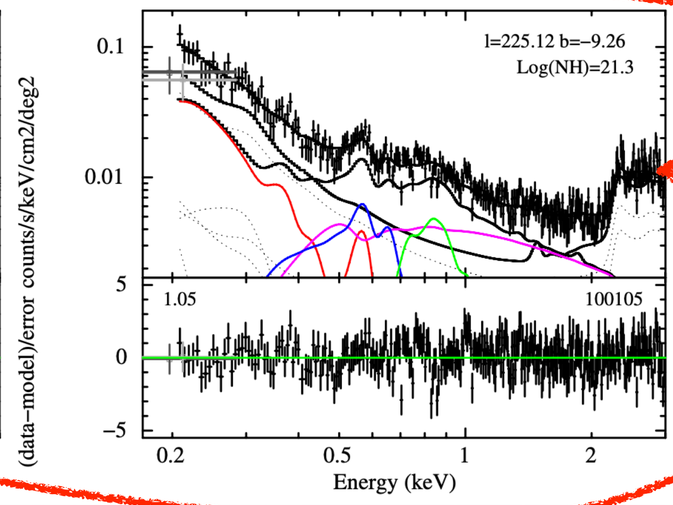


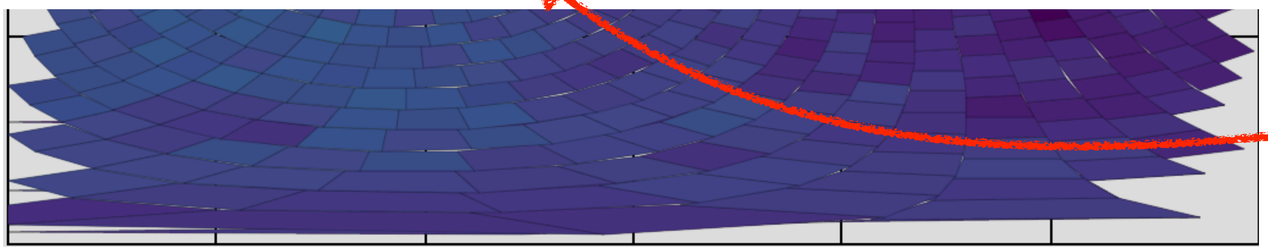


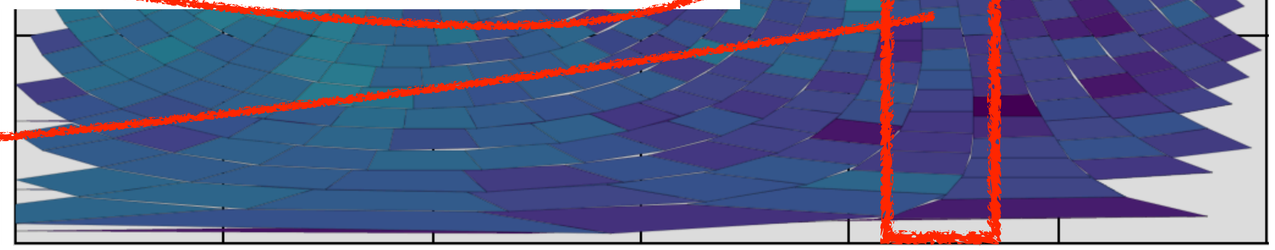








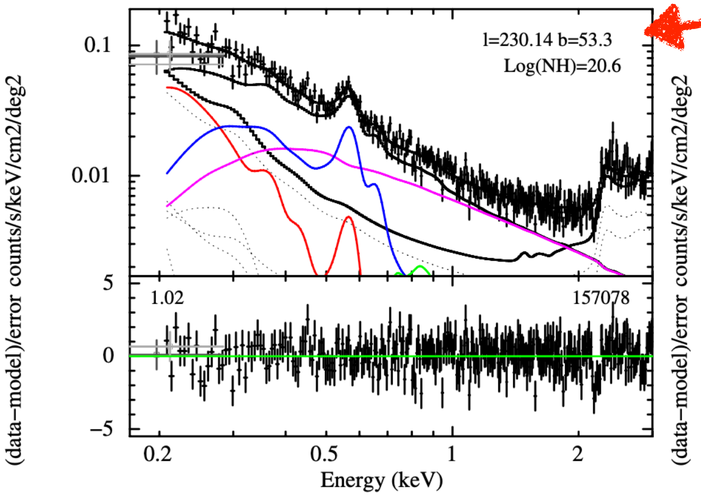


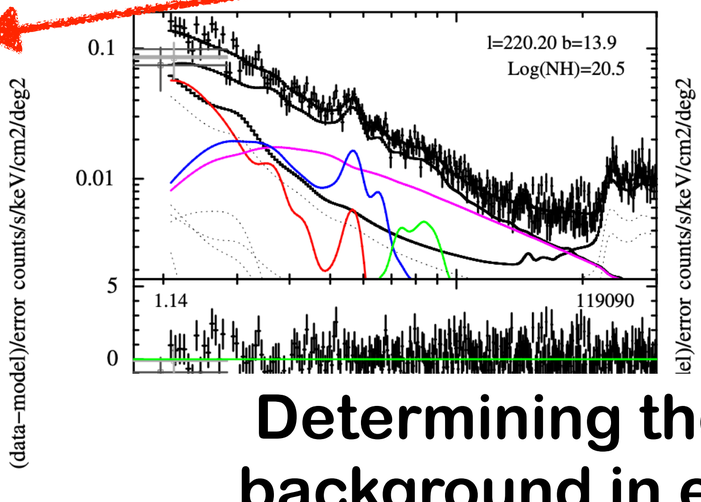


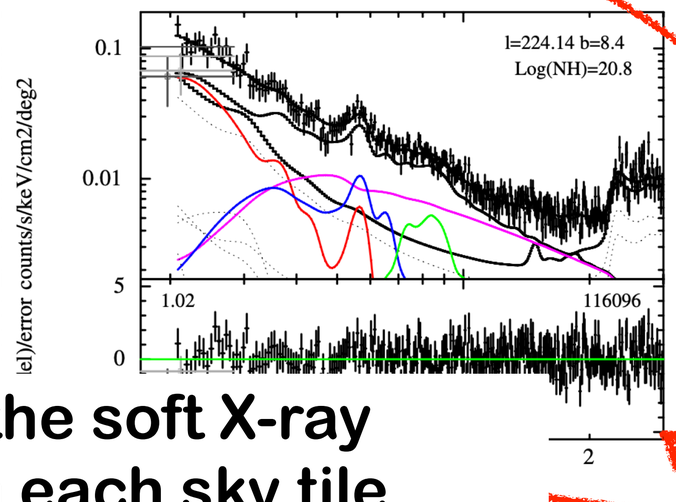
Ponti+sub

Ponti+sub

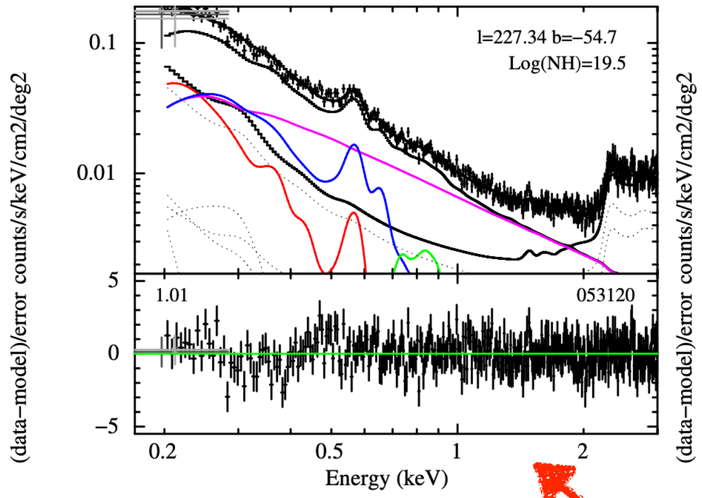
Spectral variations over the half-sky

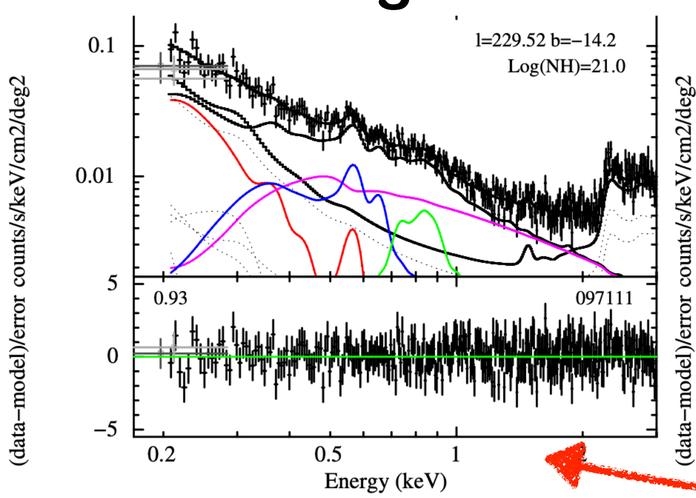


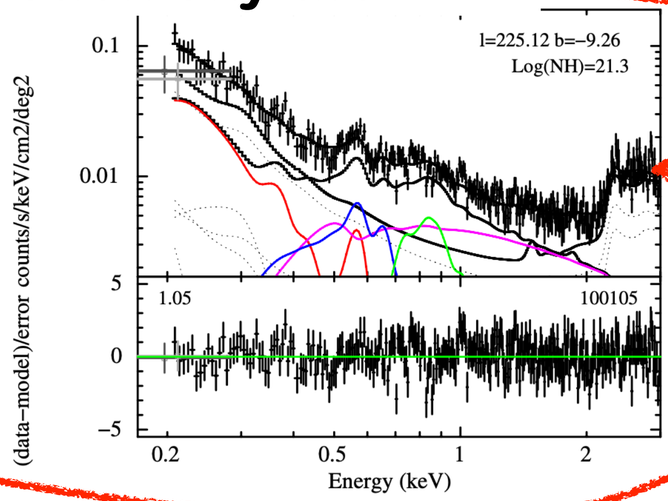


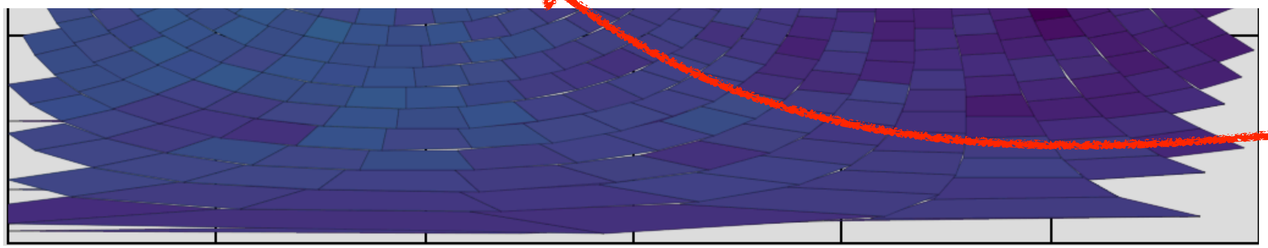


Determining the soft X-ray background in each sky tile

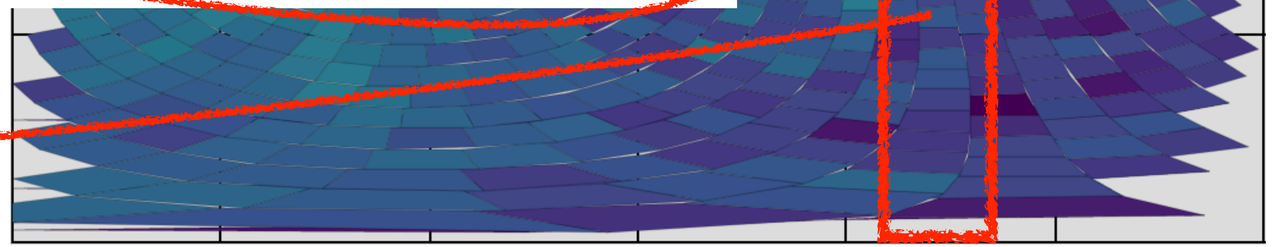






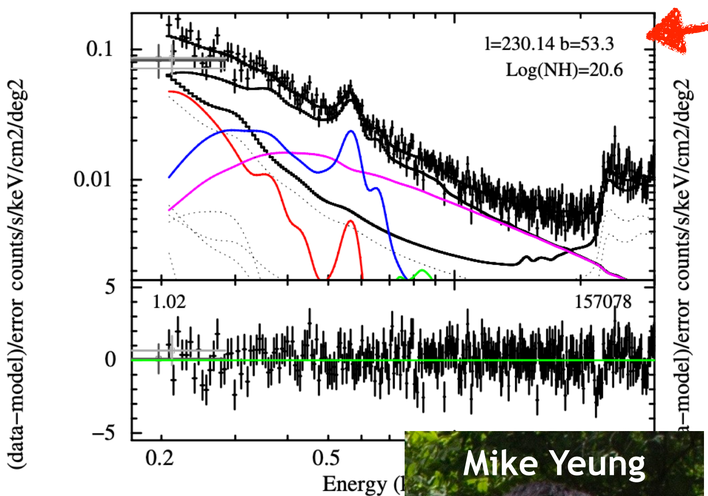


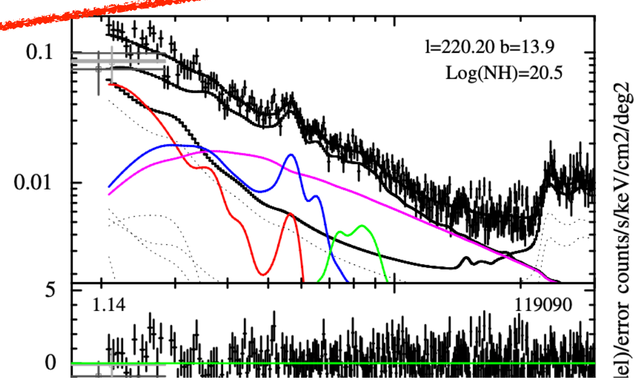
Ponti+sub

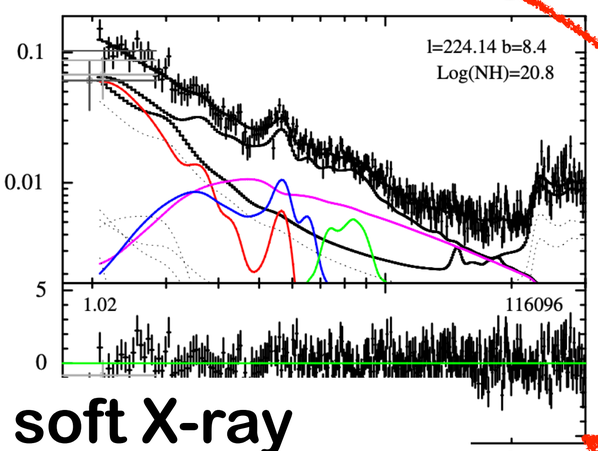


Ponti+sub

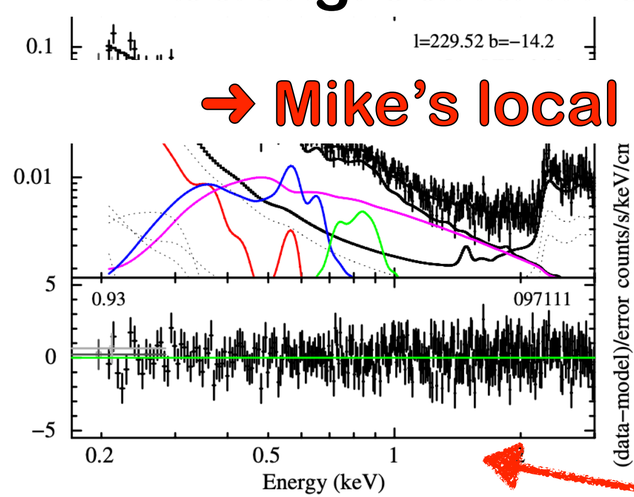
Spectral variations over the half-sky

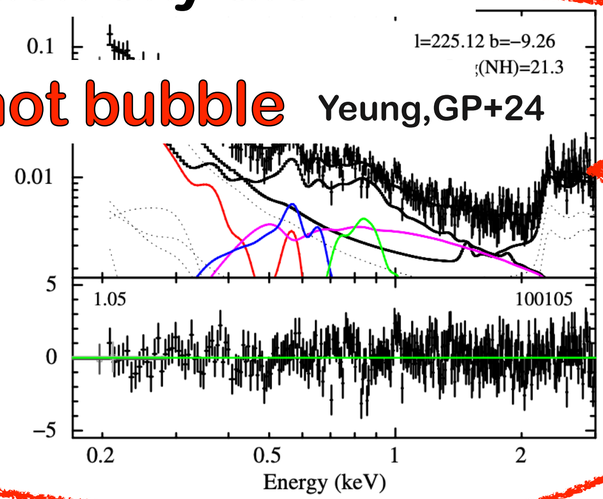




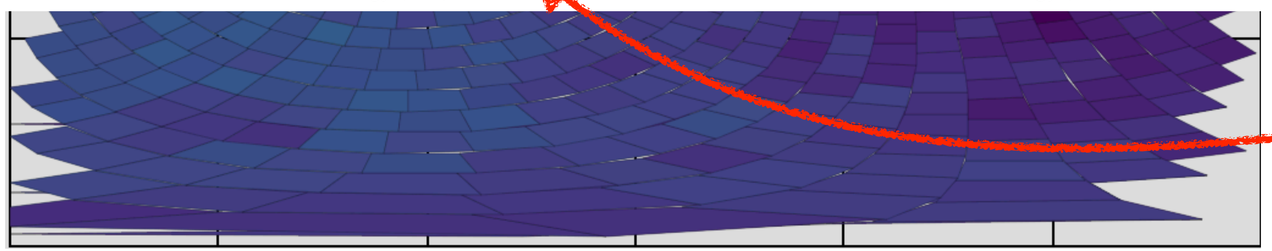


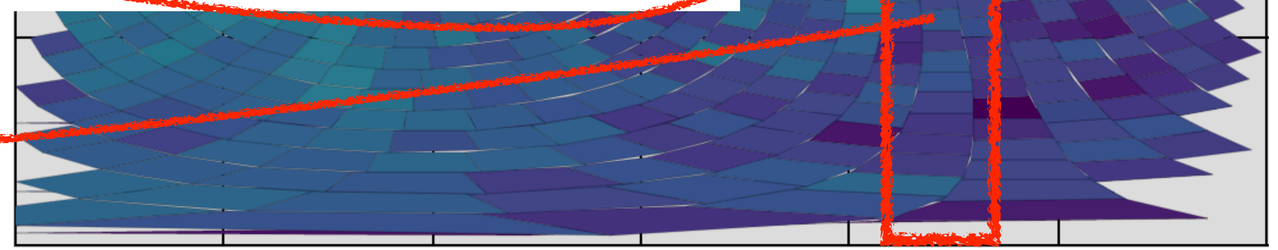
Determining the soft X-ray background in each sky tile



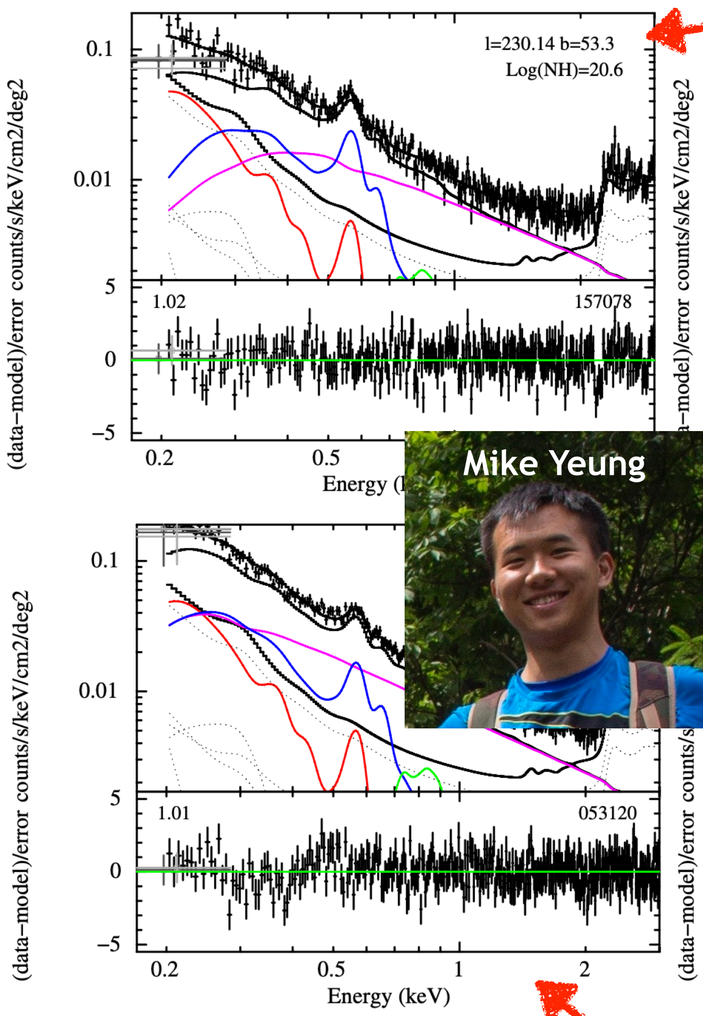


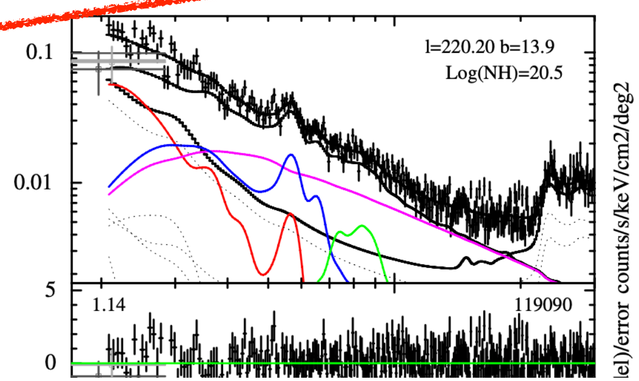
➜ Mike's local hot bubble Yeung,GP+24

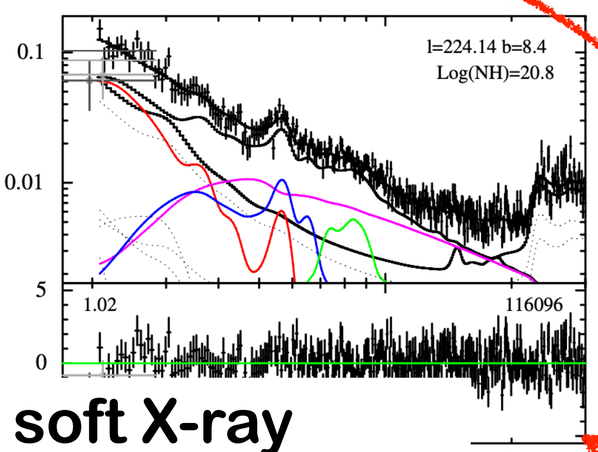


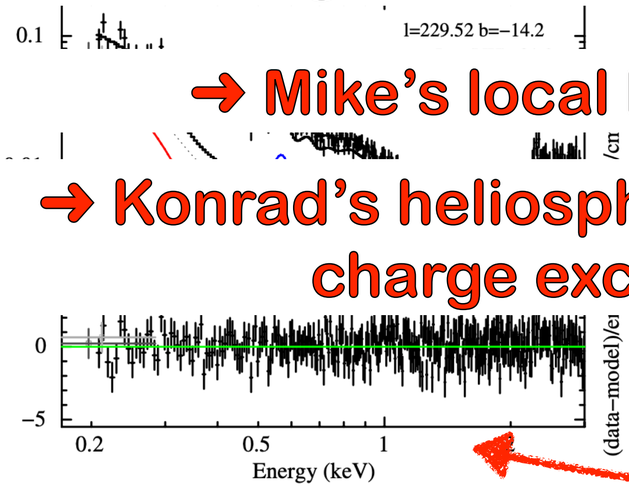


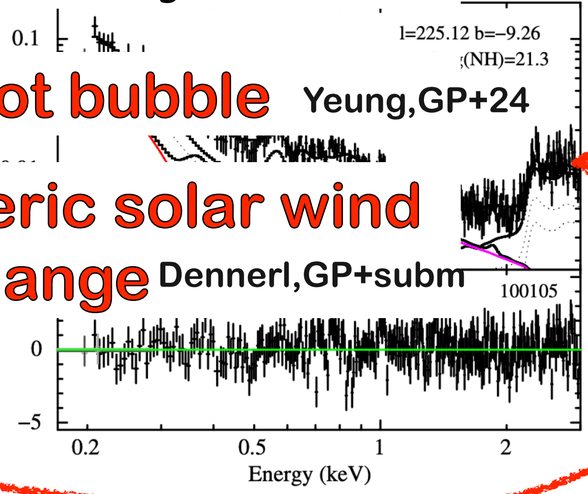
Spectral variations over the half-sky







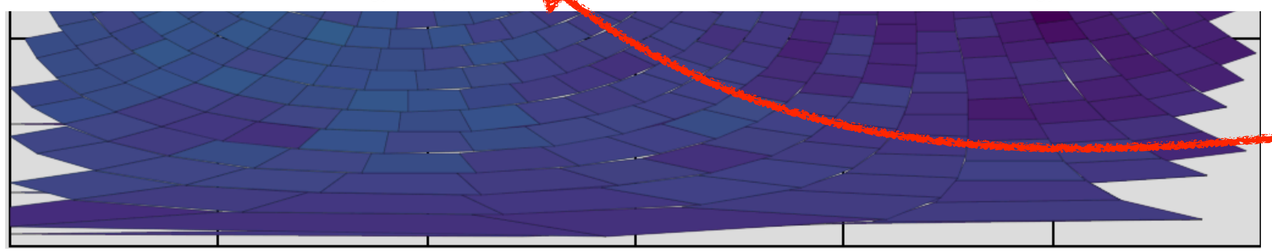




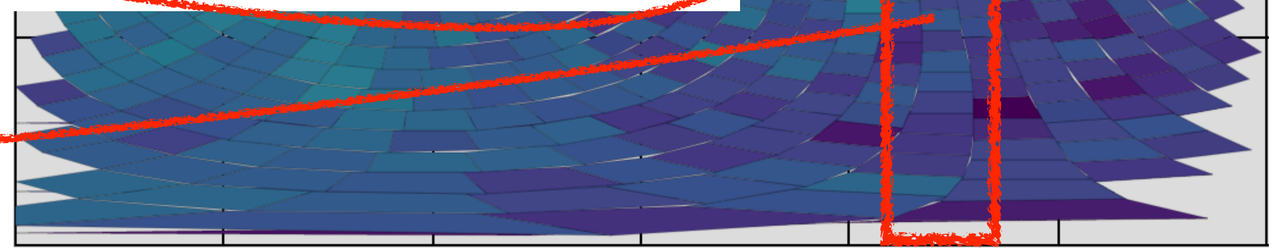
Determining the soft X-ray background in each sky tile

➔ **Mike's local hot bubble** Yeung,GP+24

➔ **Konrad's heliospheric solar wind charge exchange** Dennerl,GP+subm

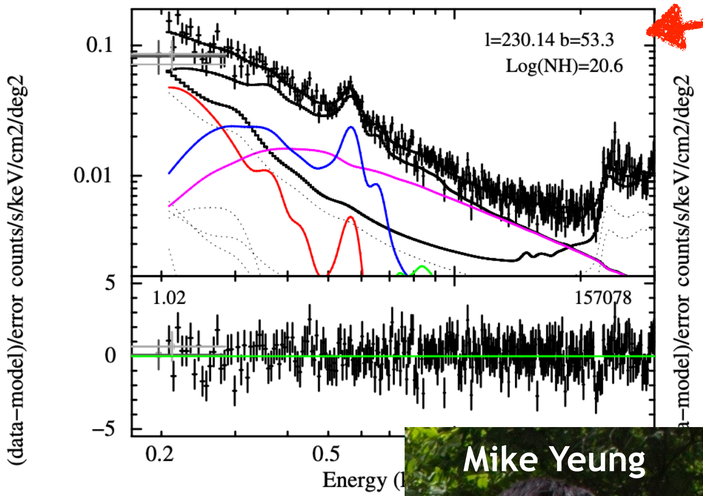


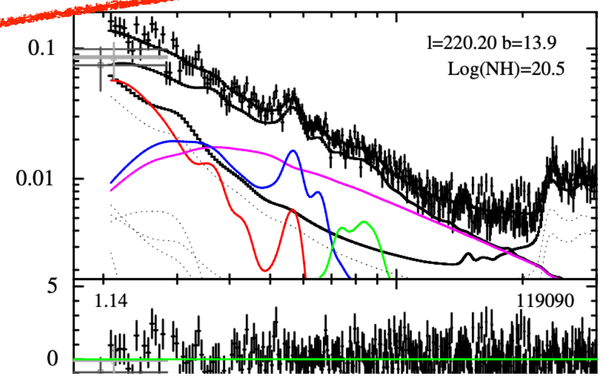
Ponti+sub

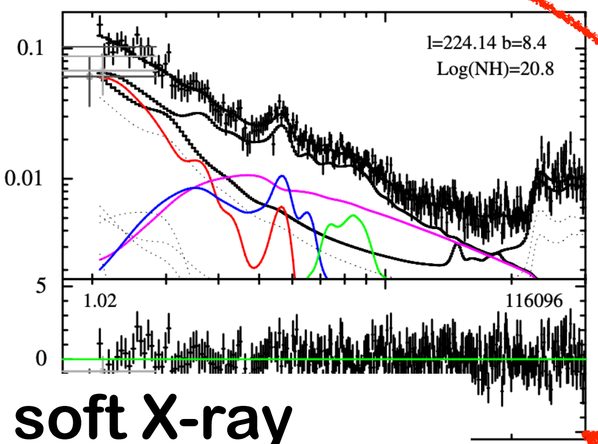


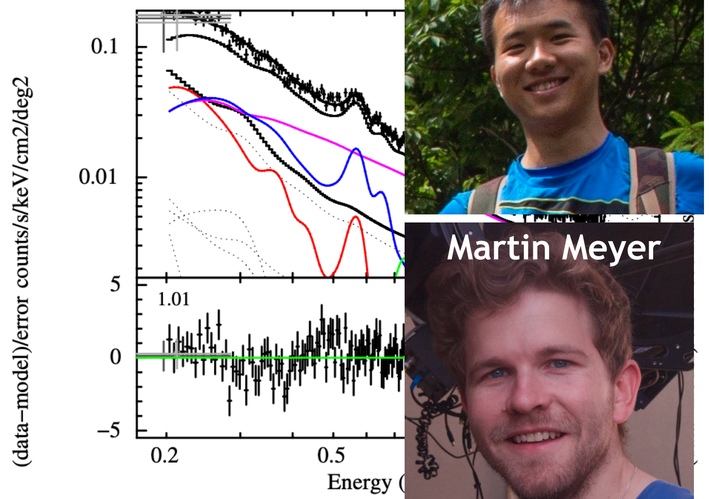
Ponti+sub

Spectral variations over the half-sky

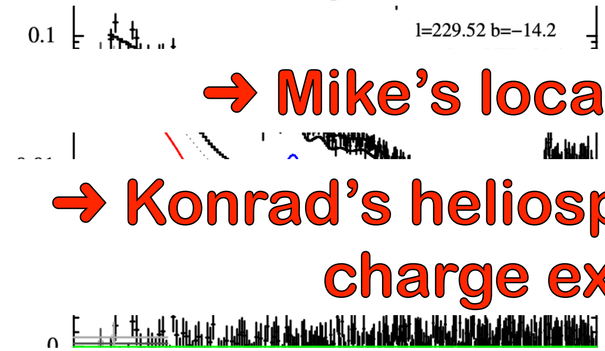


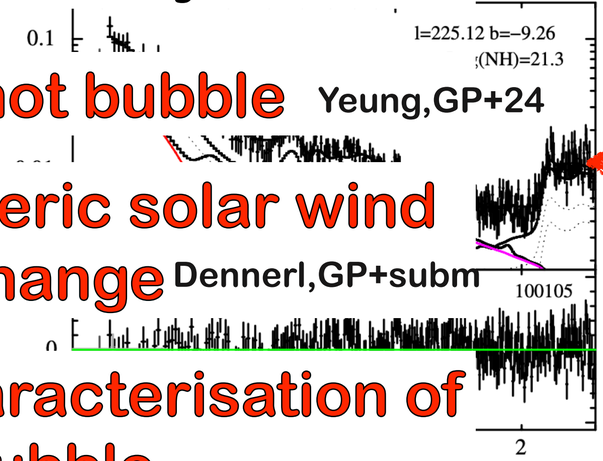






Determining the soft X-ray background in each sky tile

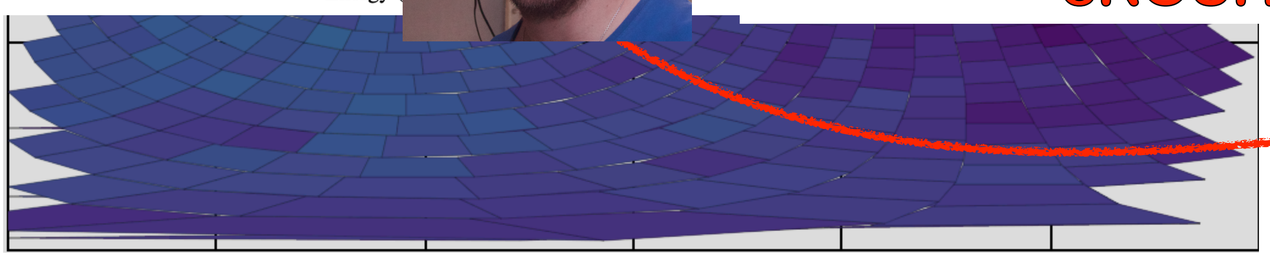




➜ Mike's local hot bubble Yeung,GP+24

➜ Konrad's heliospheric solar wind charge exchange Dennerl,GP+subm

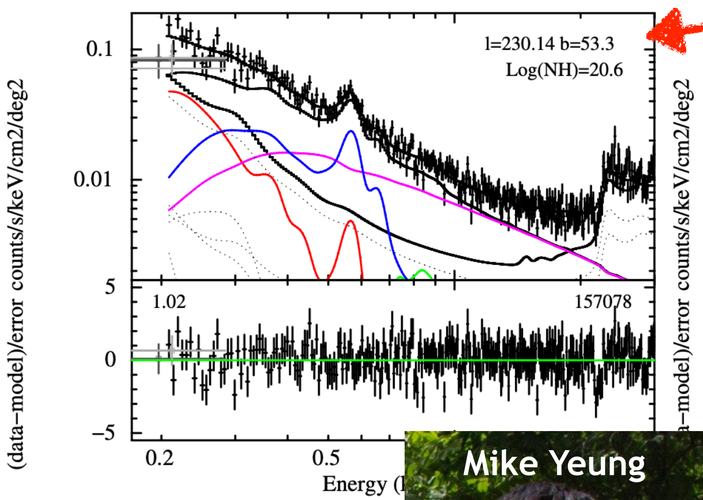
➜ Mike & Martin's characterisation of eROSITA bubble

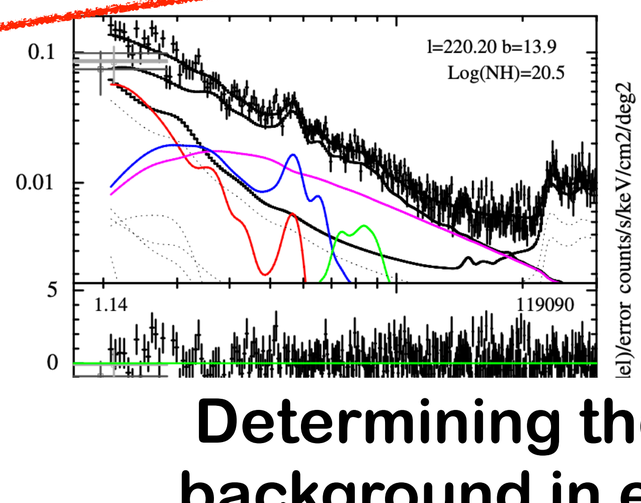


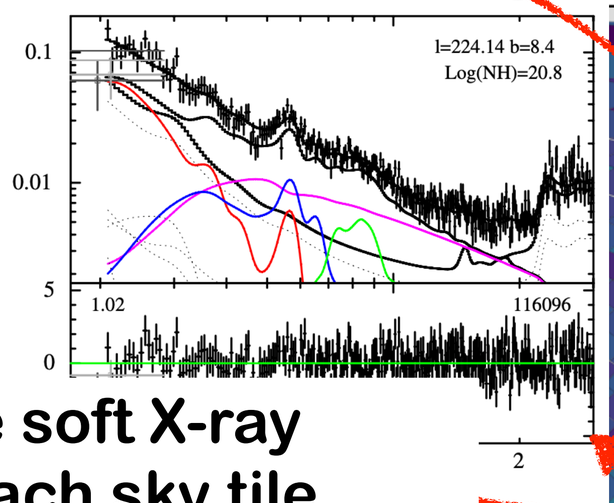
Ponti+sub

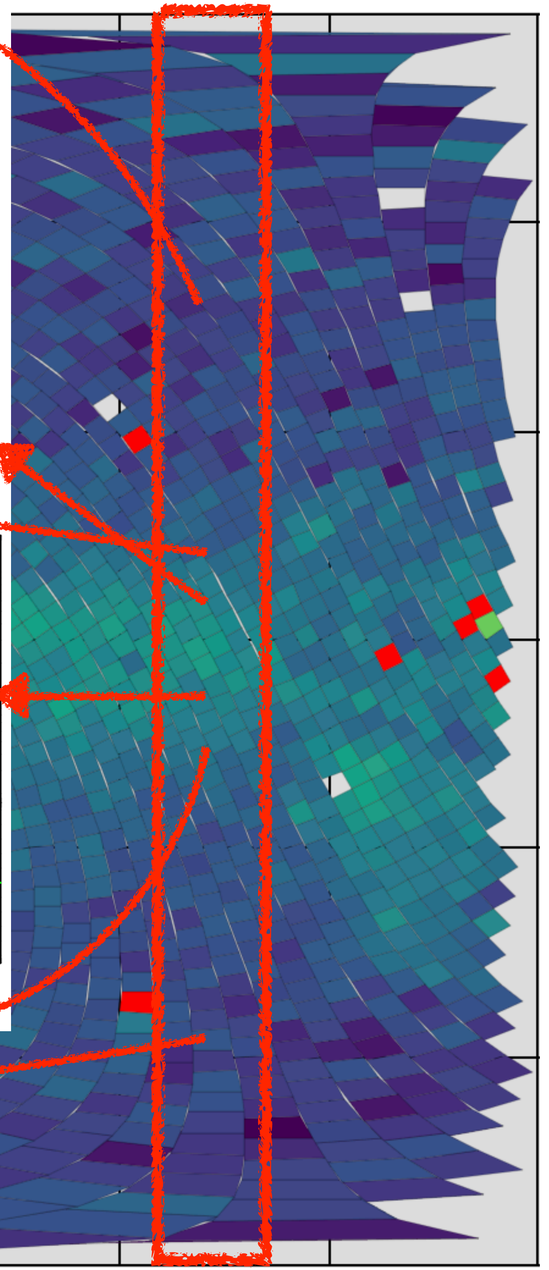
Ponti+sub

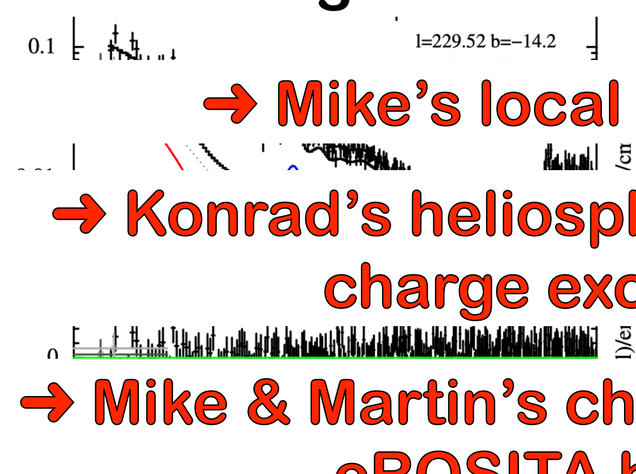
Spectral variations over the half-sky

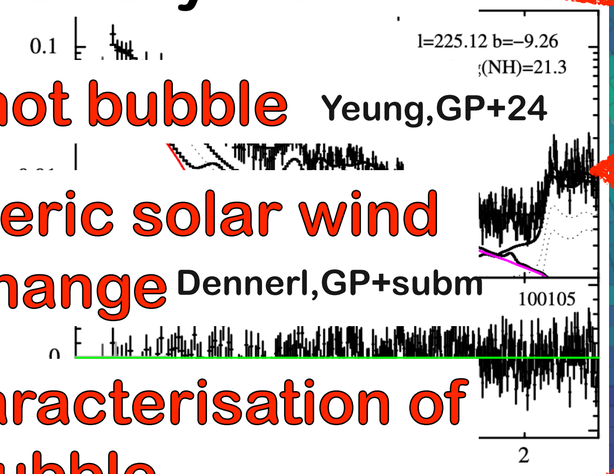












Determining the soft X-ray background in each sky tile

➜ **Mike's local hot bubble** Yeung,GP+24

➜ **Konrad's heliospheric solar wind charge exchange** Dennerl,GP+subm

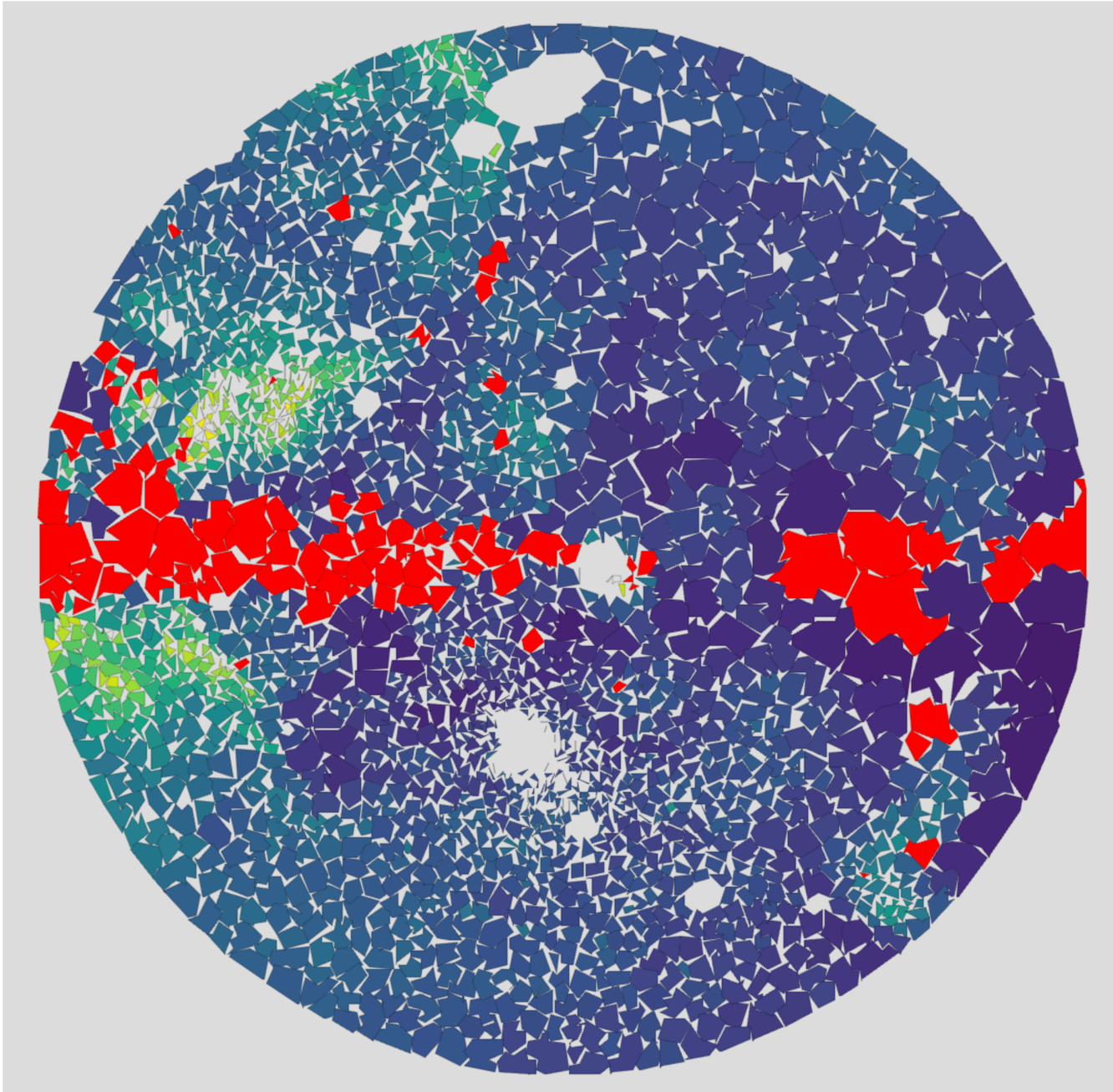
➜ **Mike & Martin's characterisation of eROSITA bubble**

Measuring CGM physical properties from spectra

Ponti+sub

Ponti+sub

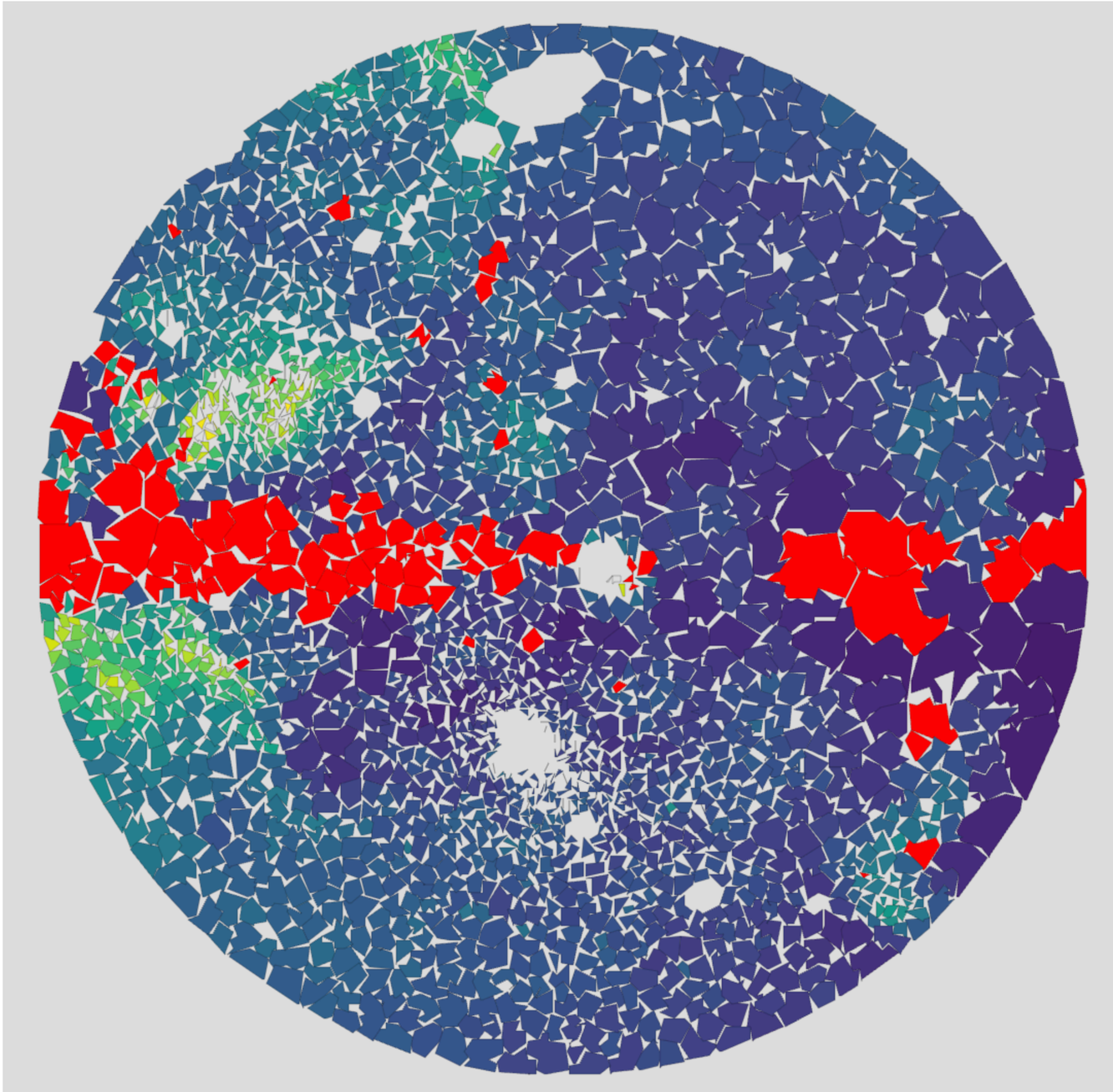
Spectral variations over the half-sky



Spectral variations over the half-sky

eROSITA spectra and best fit model for each region in the western Galactic hemisphere

https://erosita.mpe.mpg.de/dr1/AllSkySurveyData_dr1/DiffuseBkg/



Spectral variations over the half-sky

eROSITA spectra and best fit model for each region in the western Galactic hemisphere

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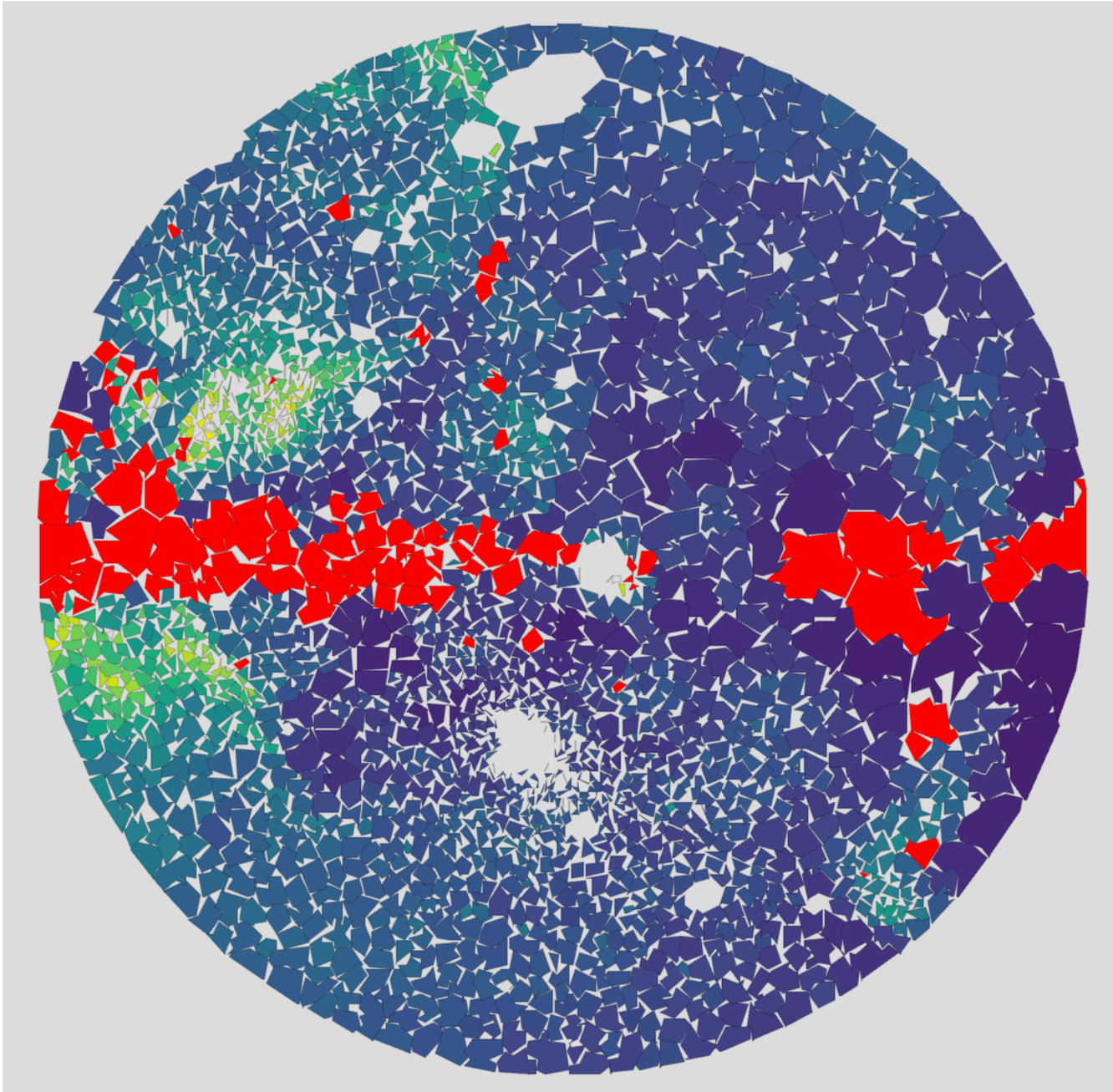
What about the Galactic center?



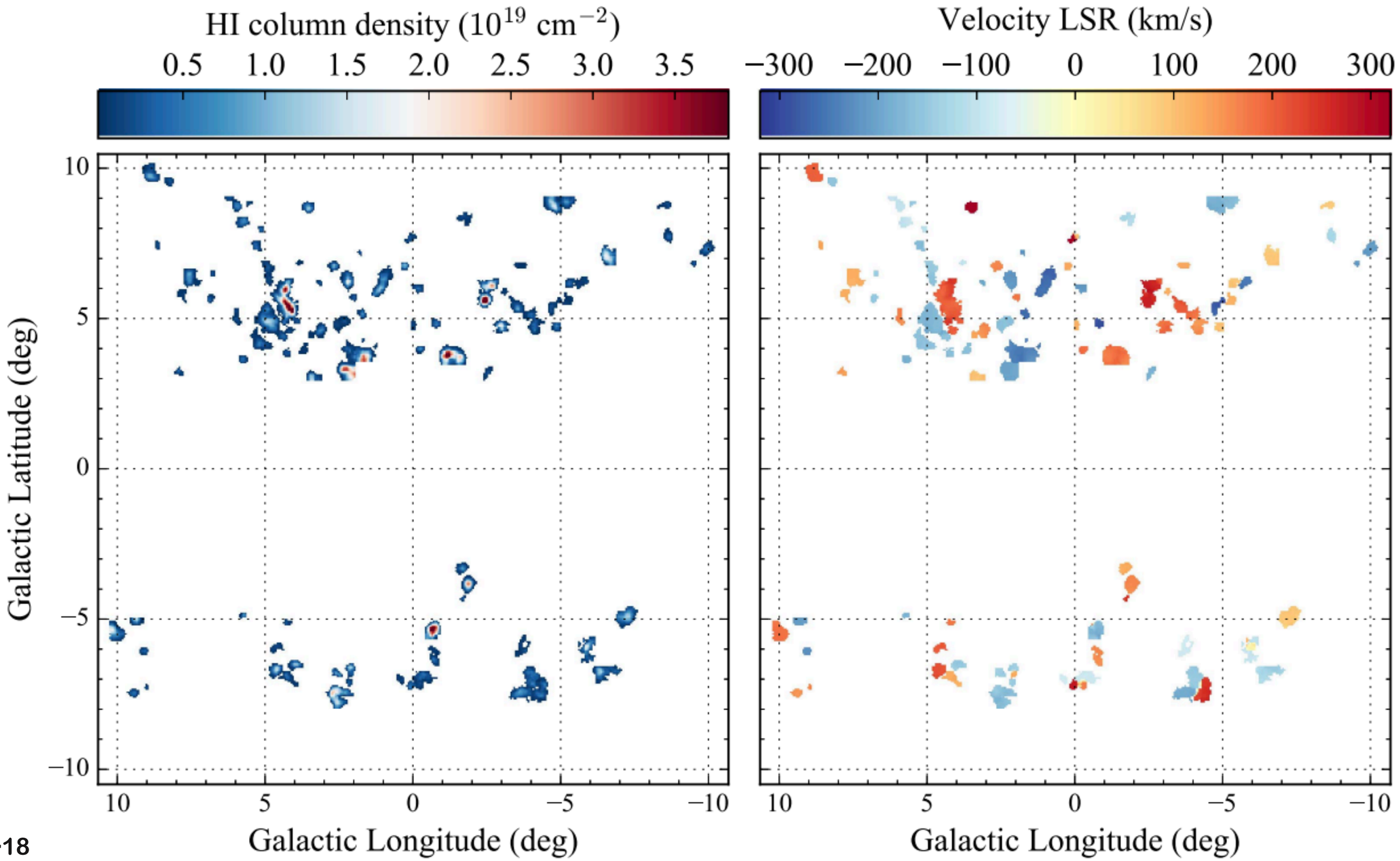
Do we need an outflow from Galactic center?

Do we need an outflow from Galactic center?

Polarised synchrotron intensity: WMAP 22.8 GHz
X-rays: eROSITA 0.6-1 keV
Magnetic field direction

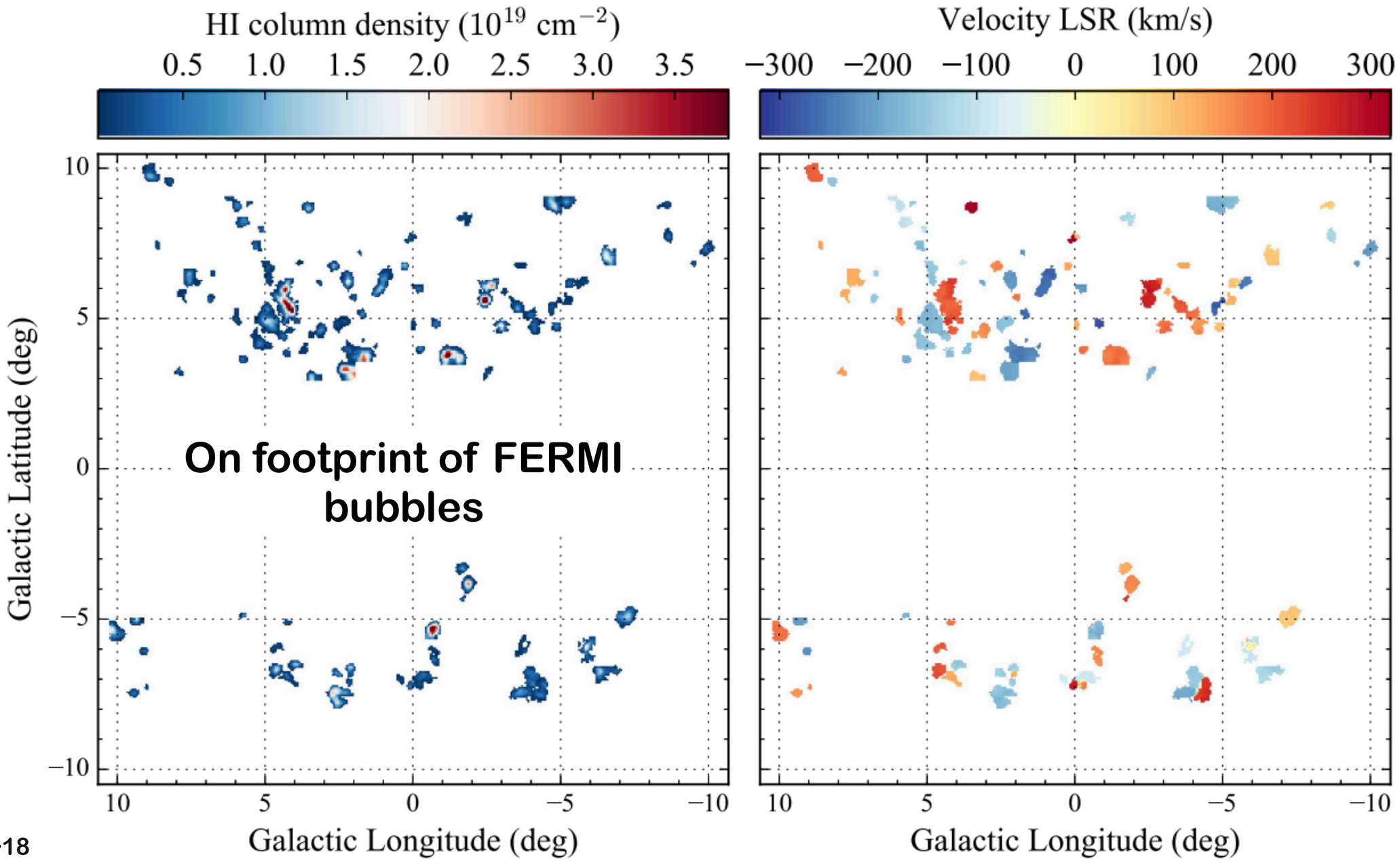
Zhang,GP+24

The cold outflowing and accelerating clouds



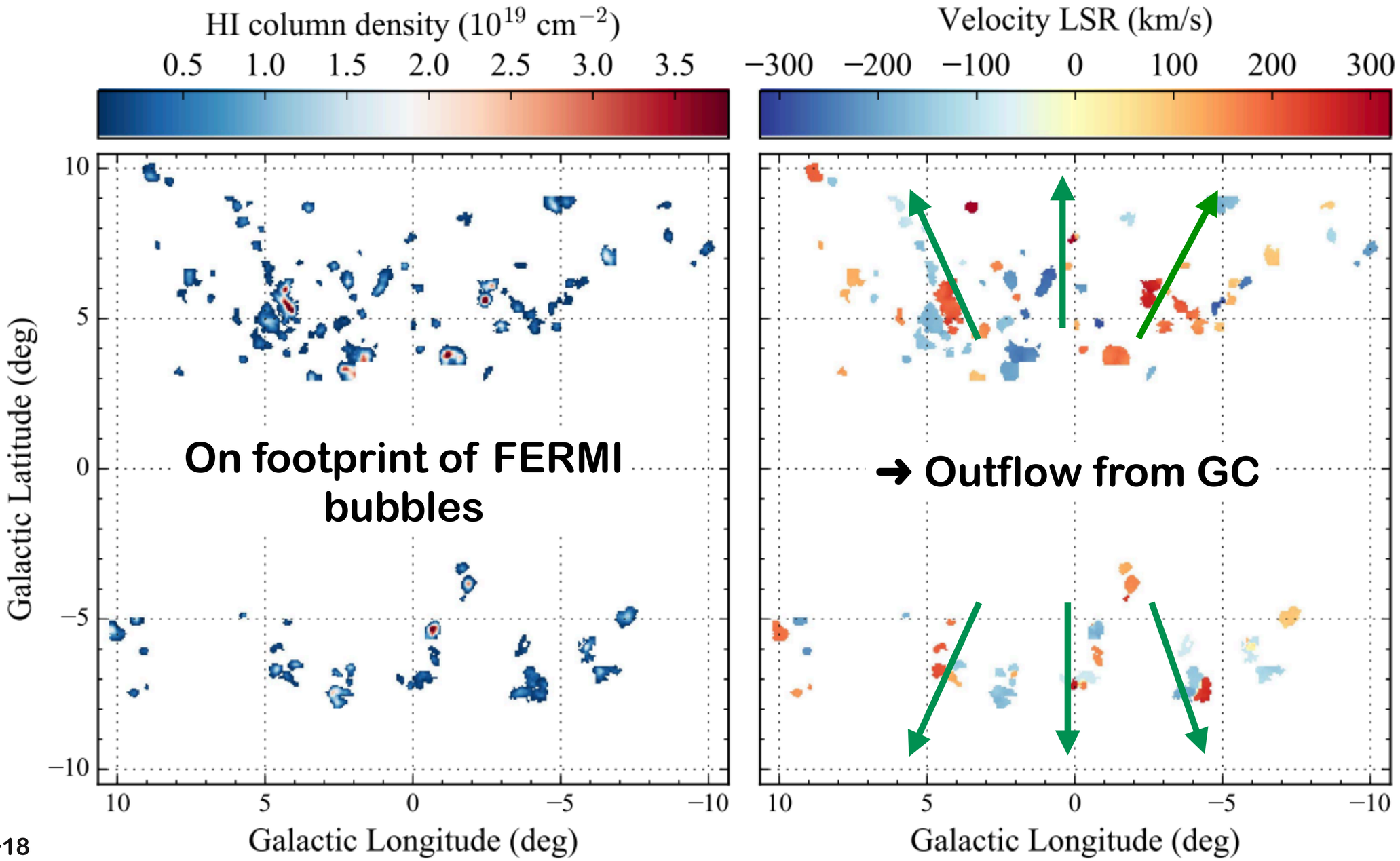
Di Teodoro+18

The cold outflowing and accelerating clouds



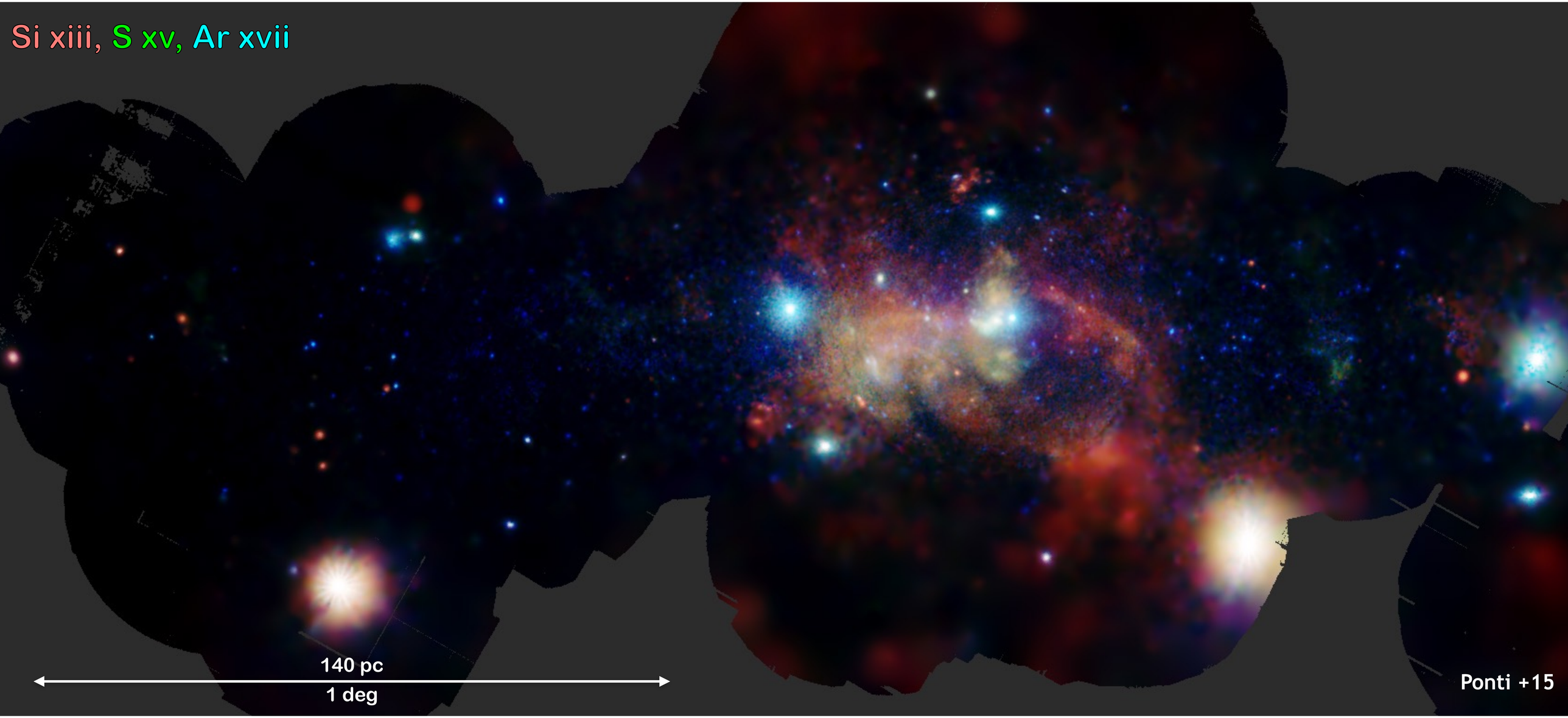
Di Teodoro+18

The cold outflowing and accelerating clouds



Di Teodoro+18

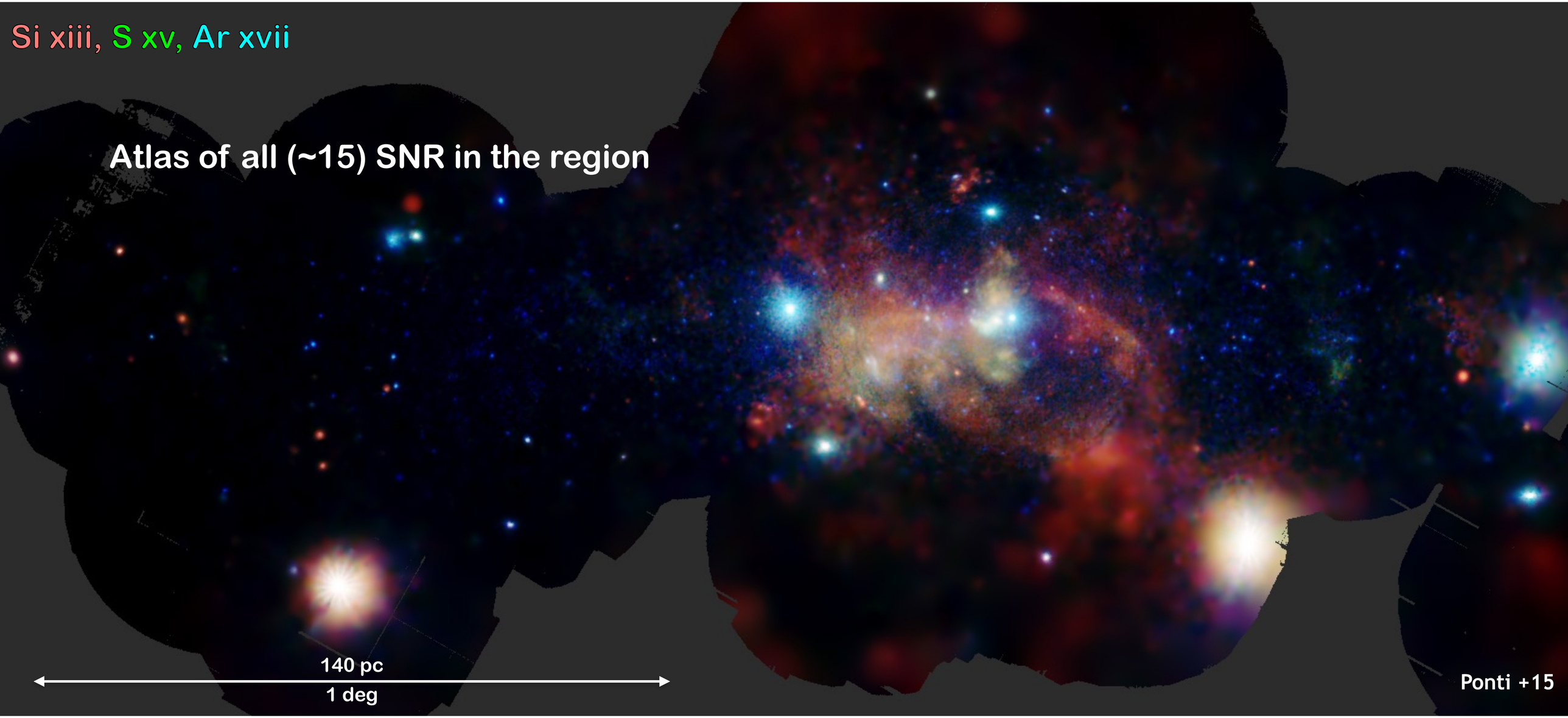
Hot plasma to trace past activity



Ponti +15

Ponti +15

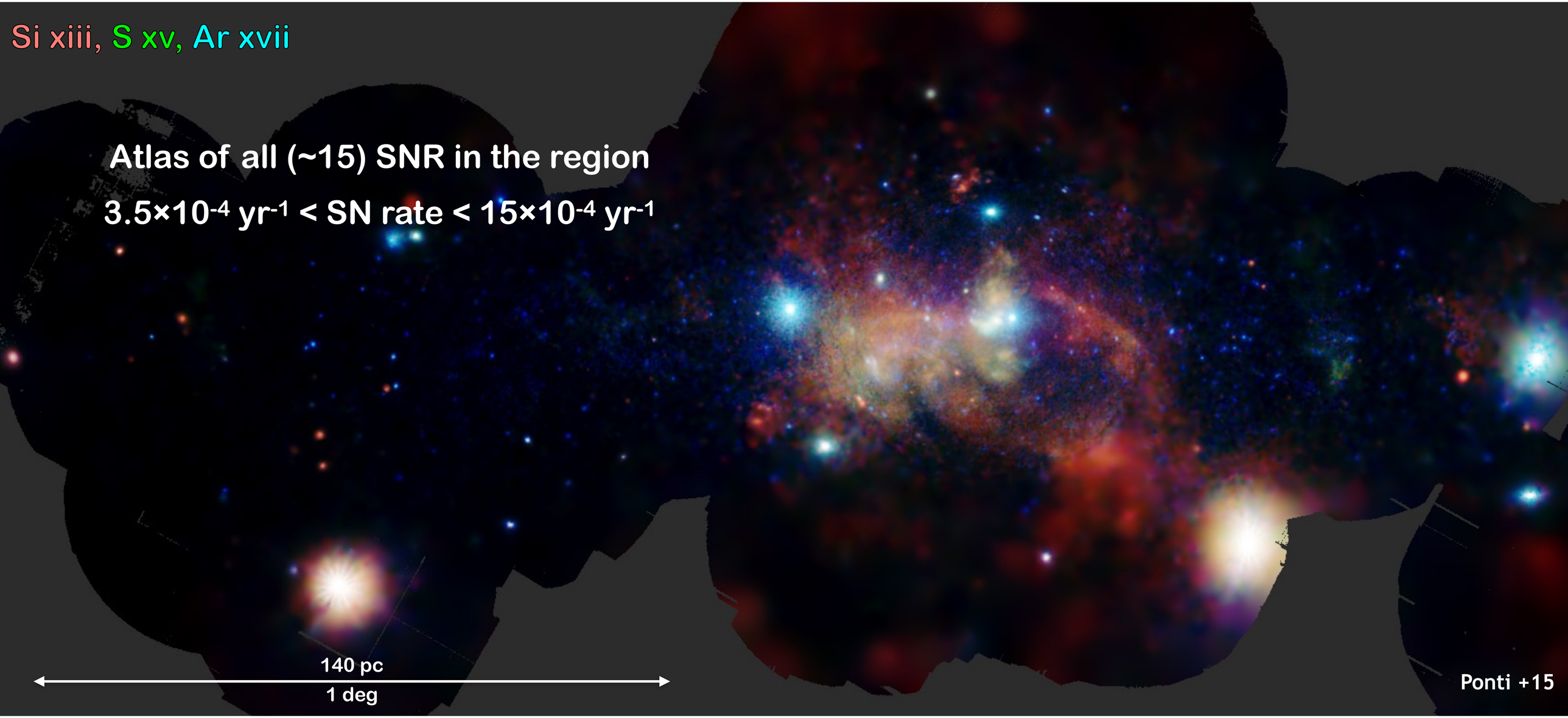
Hot plasma to trace past activity



Ponti +15

Ponti +15

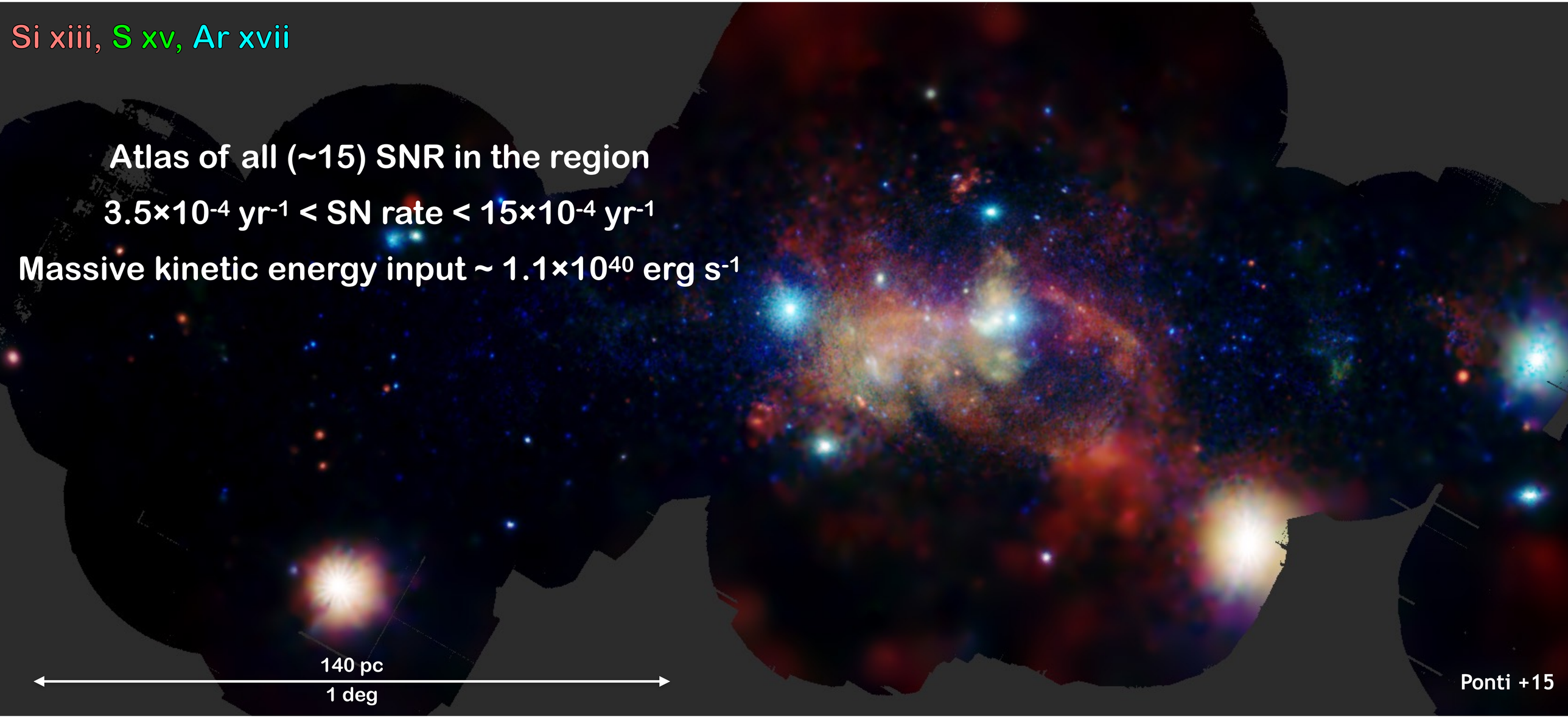
Hot plasma to trace past activity



Ponti +15

Ponti +15

Hot plasma to trace past activity



Ponti +15

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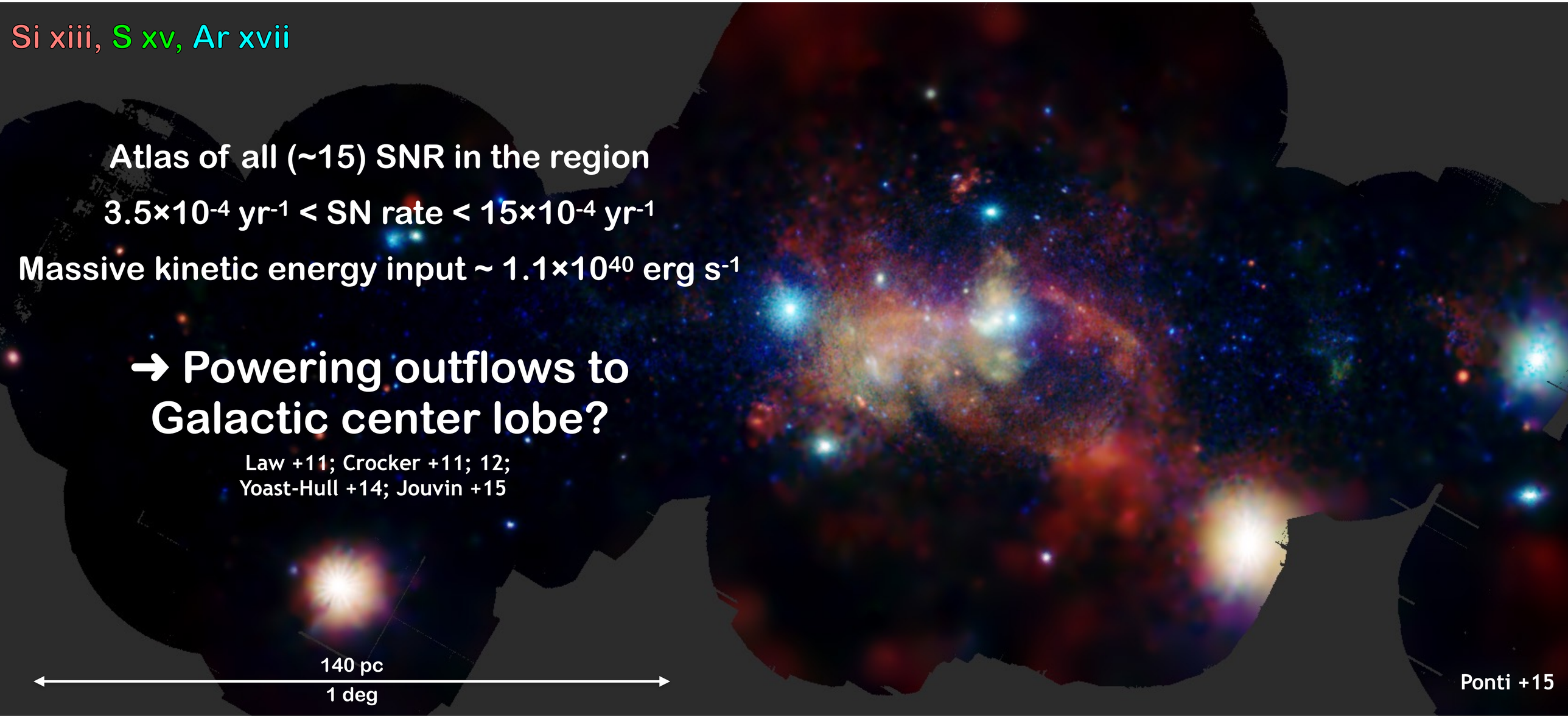
Hot plasma to trace past activity



Ponti +15

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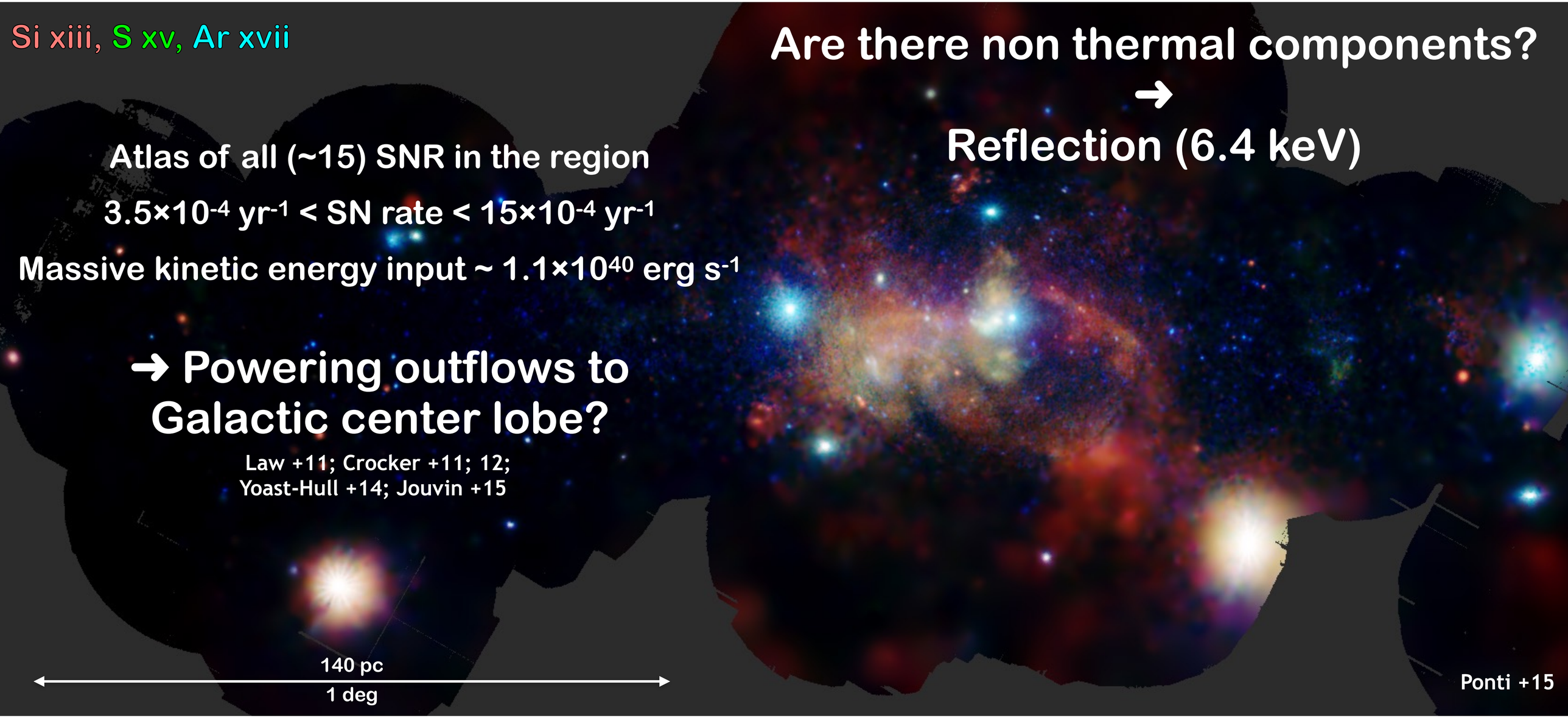
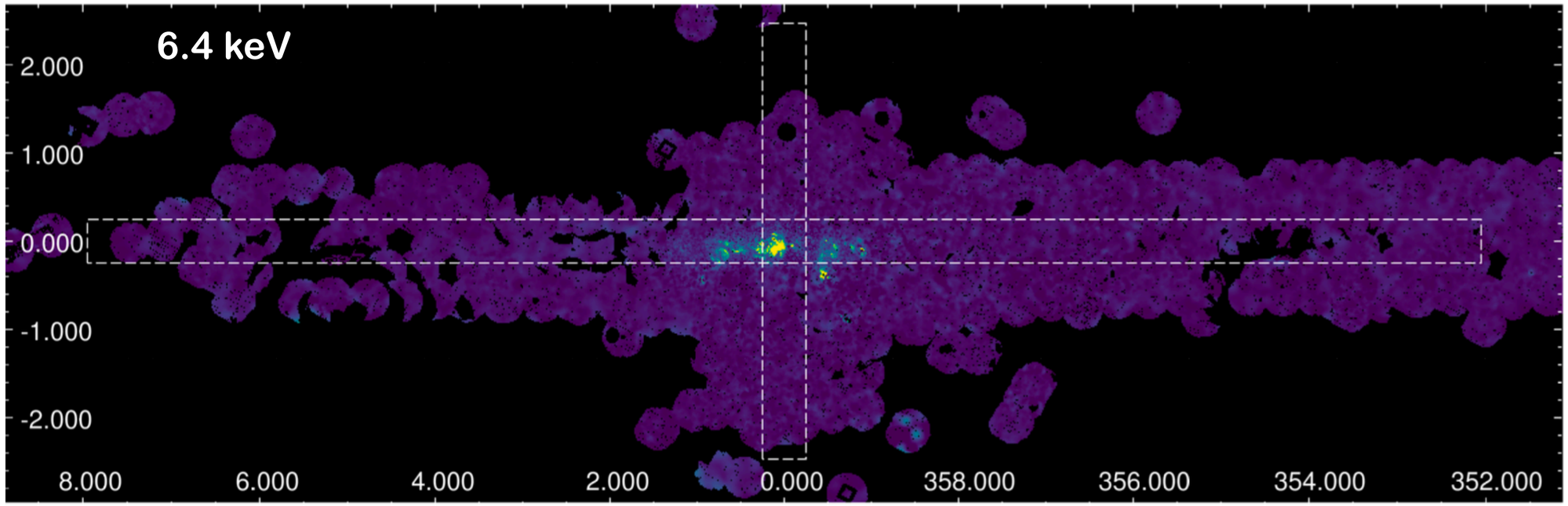
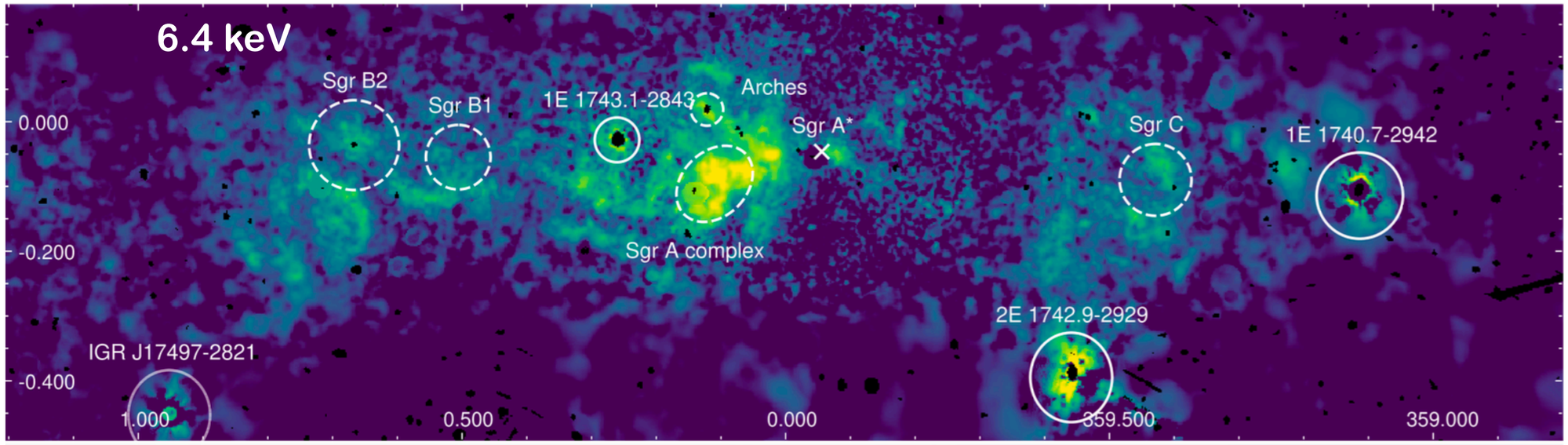


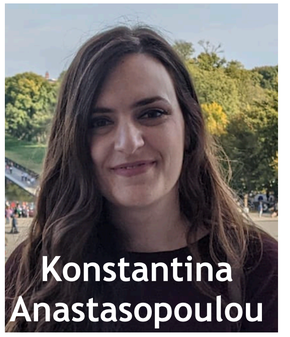
Ponti +15

Ponti +15

How is the non thermal emission distributed?

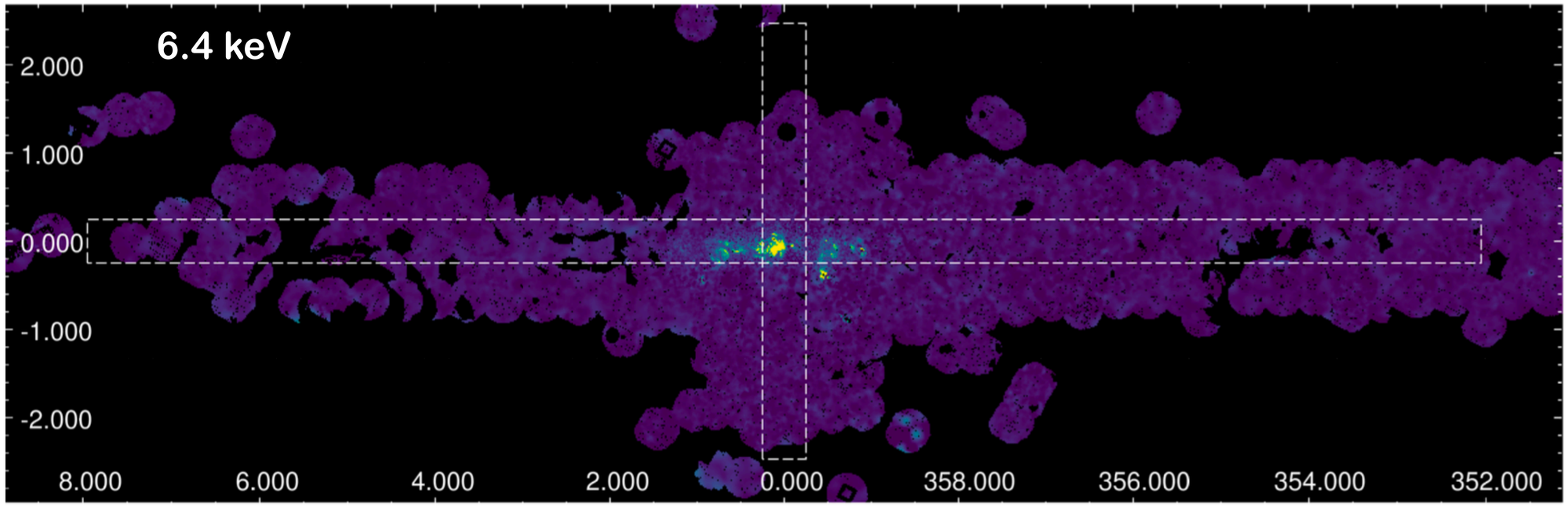


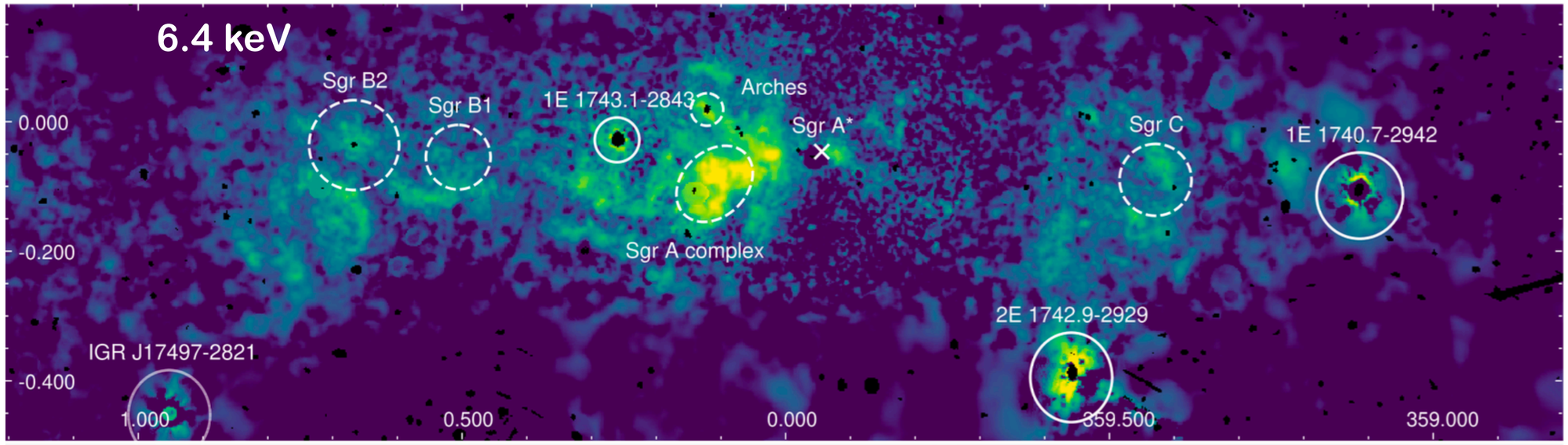


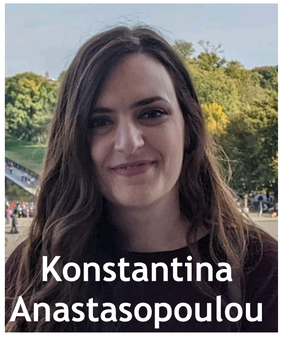


Anastasopoulou+sub.

How is the non thermal emission distributed?



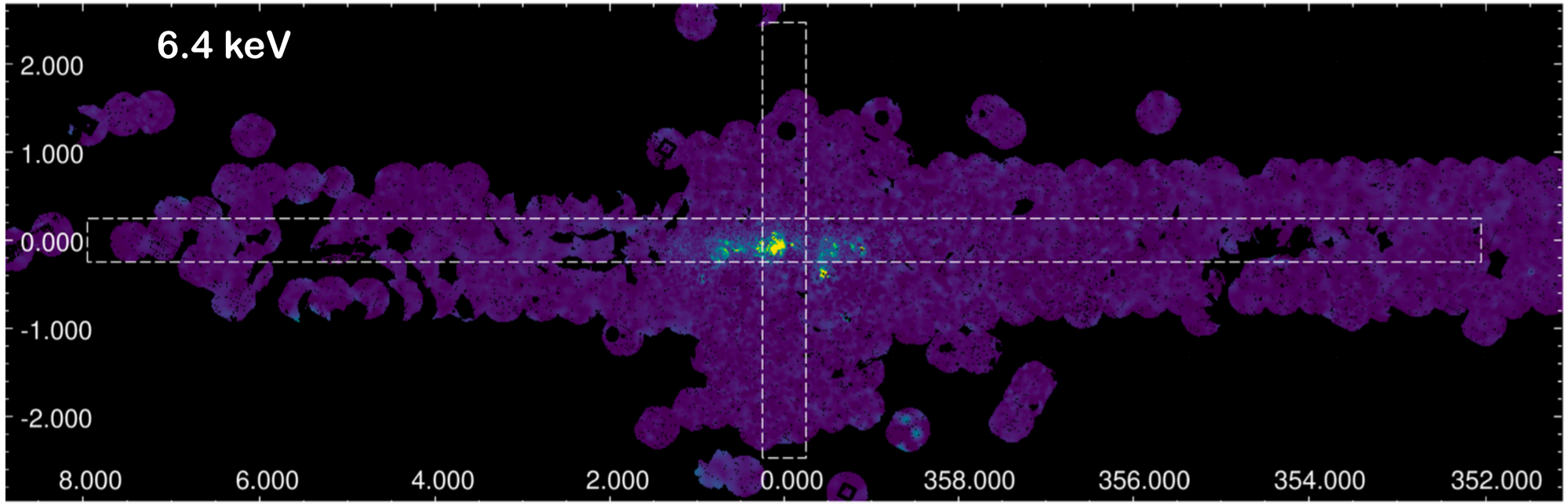


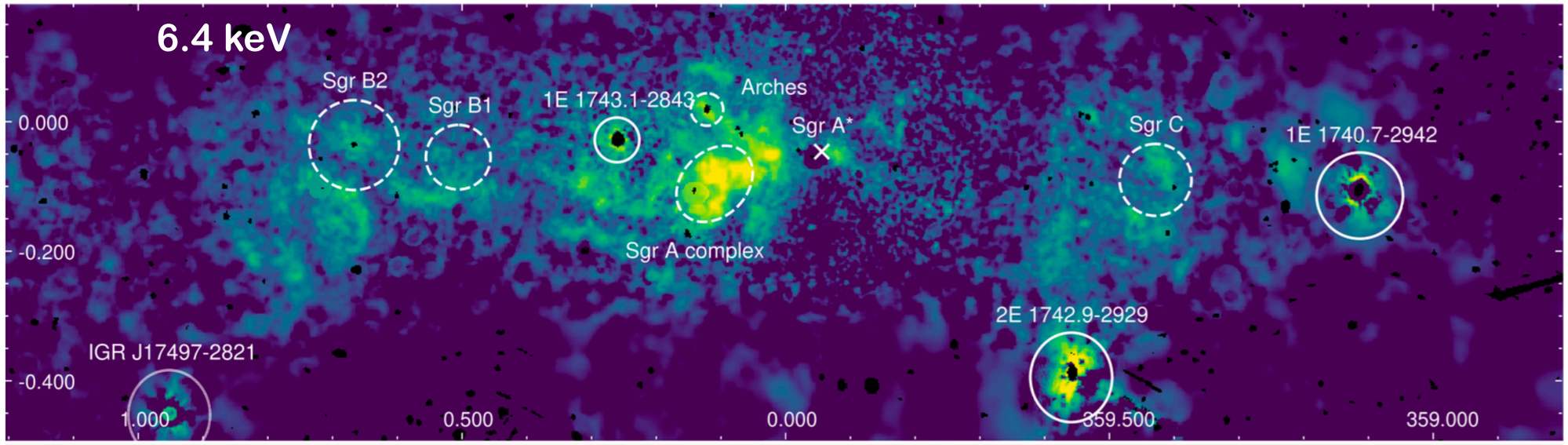


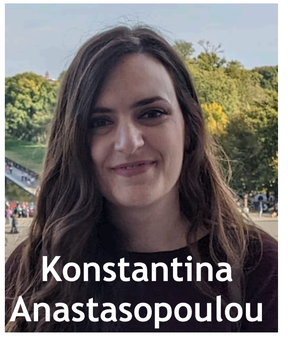
Non-thermal component (reflection 6.4 keV) ➜ central molecular zone

Anastasopoulou+sub.

How is the non thermal emission distributed?







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Consistent with past flare of Sgr A*

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Are CR observed at ~10^2 kpc from discs?

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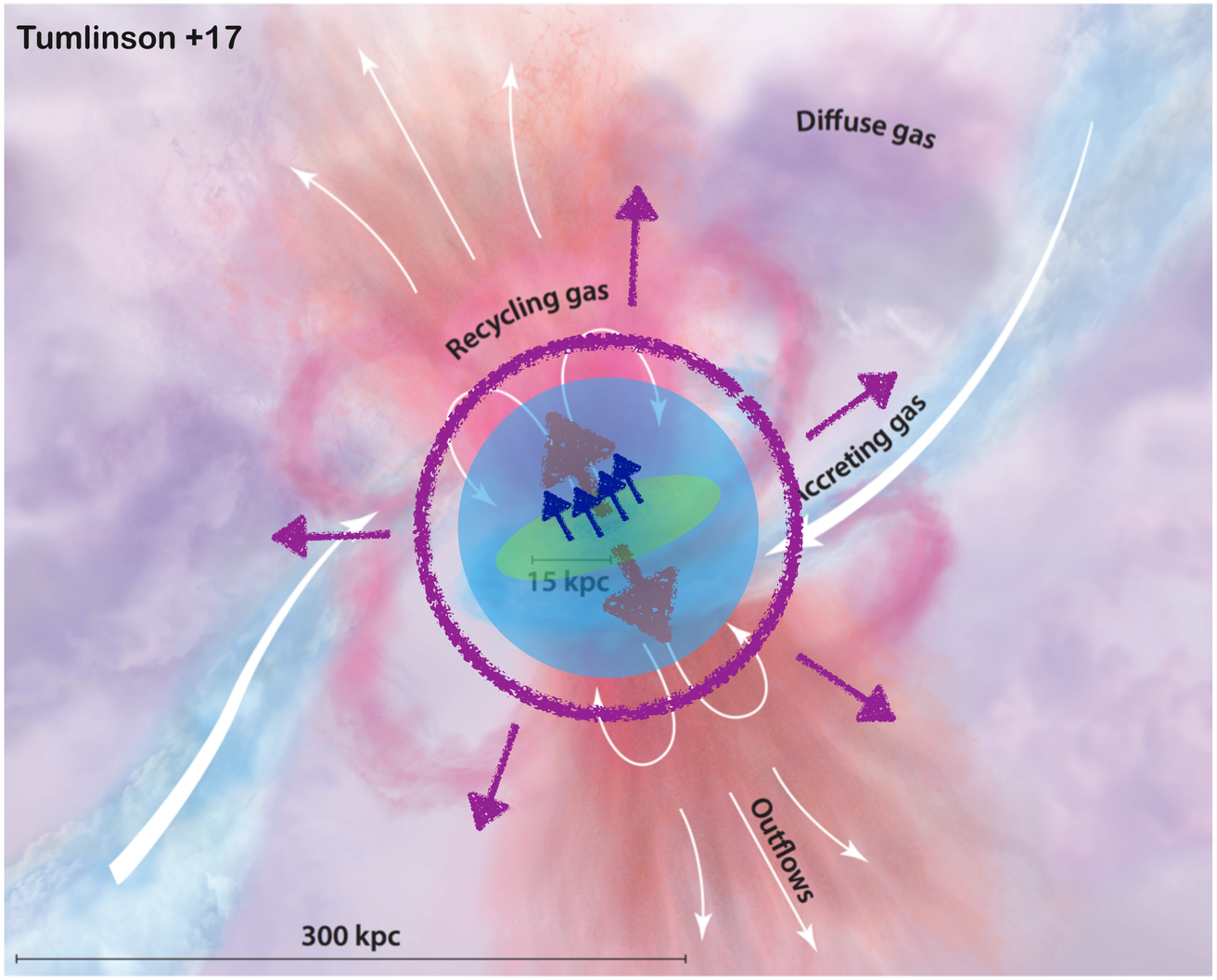
Polarised synchrotron intensity: WMAP 22.8 GHz
X-rays: eROSITA 0.6-1 keV
Magnetic field direction

Zhang,GP+24

Do outflows help transport CR to the halo of Milky Way-like galaxies?

eROSITA stack of ~10^4 MW-like galaxies

Yi Zhang



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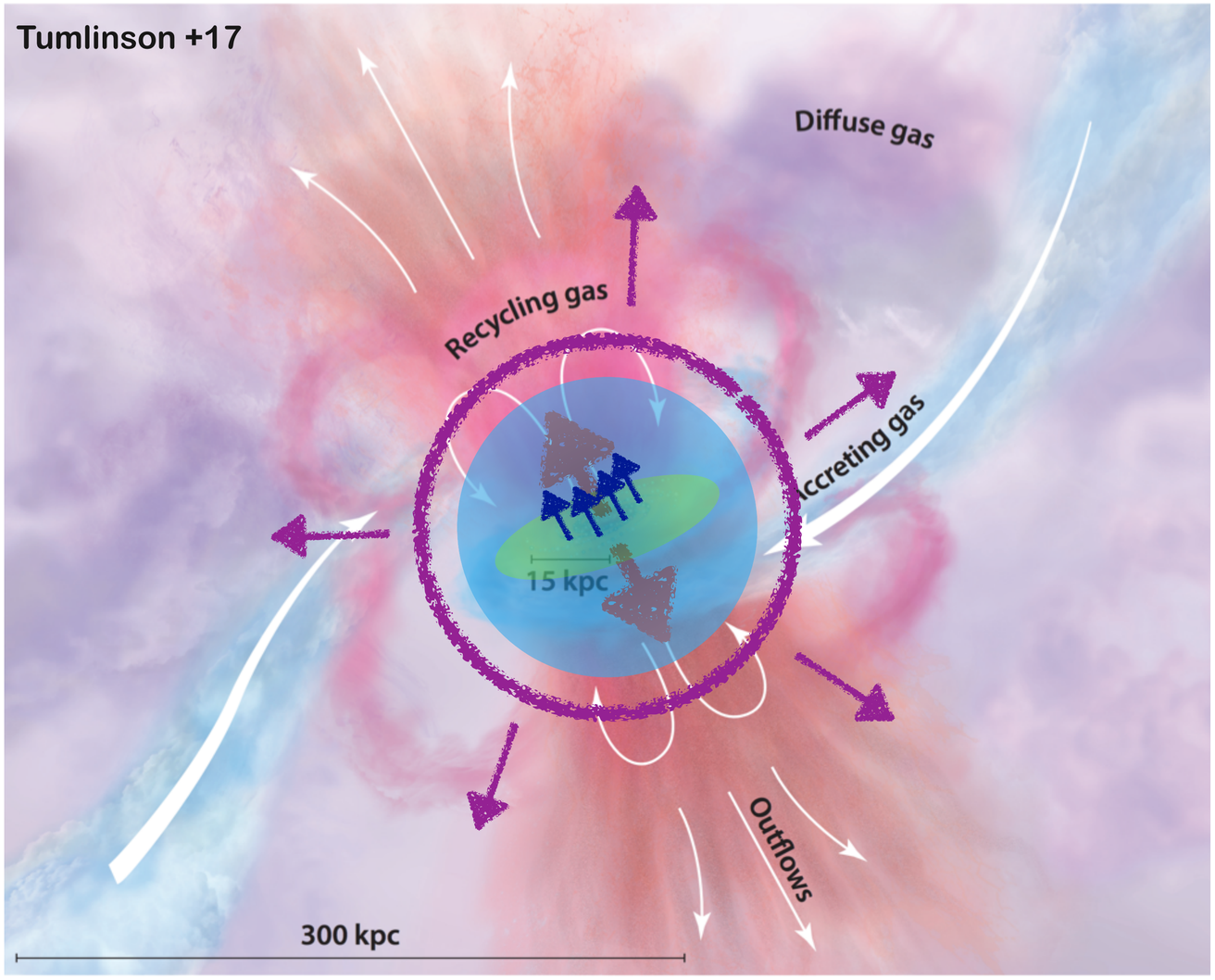

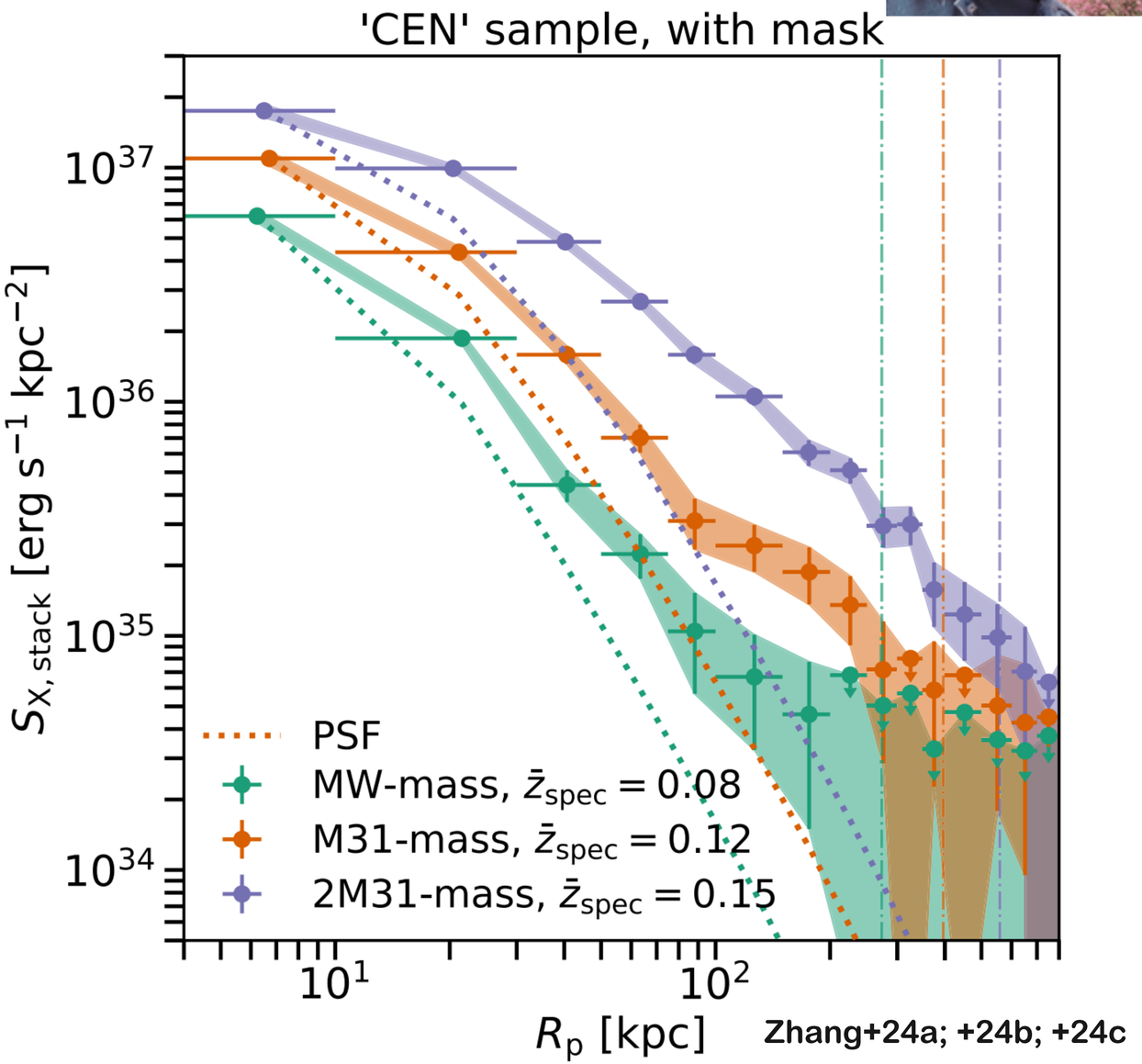

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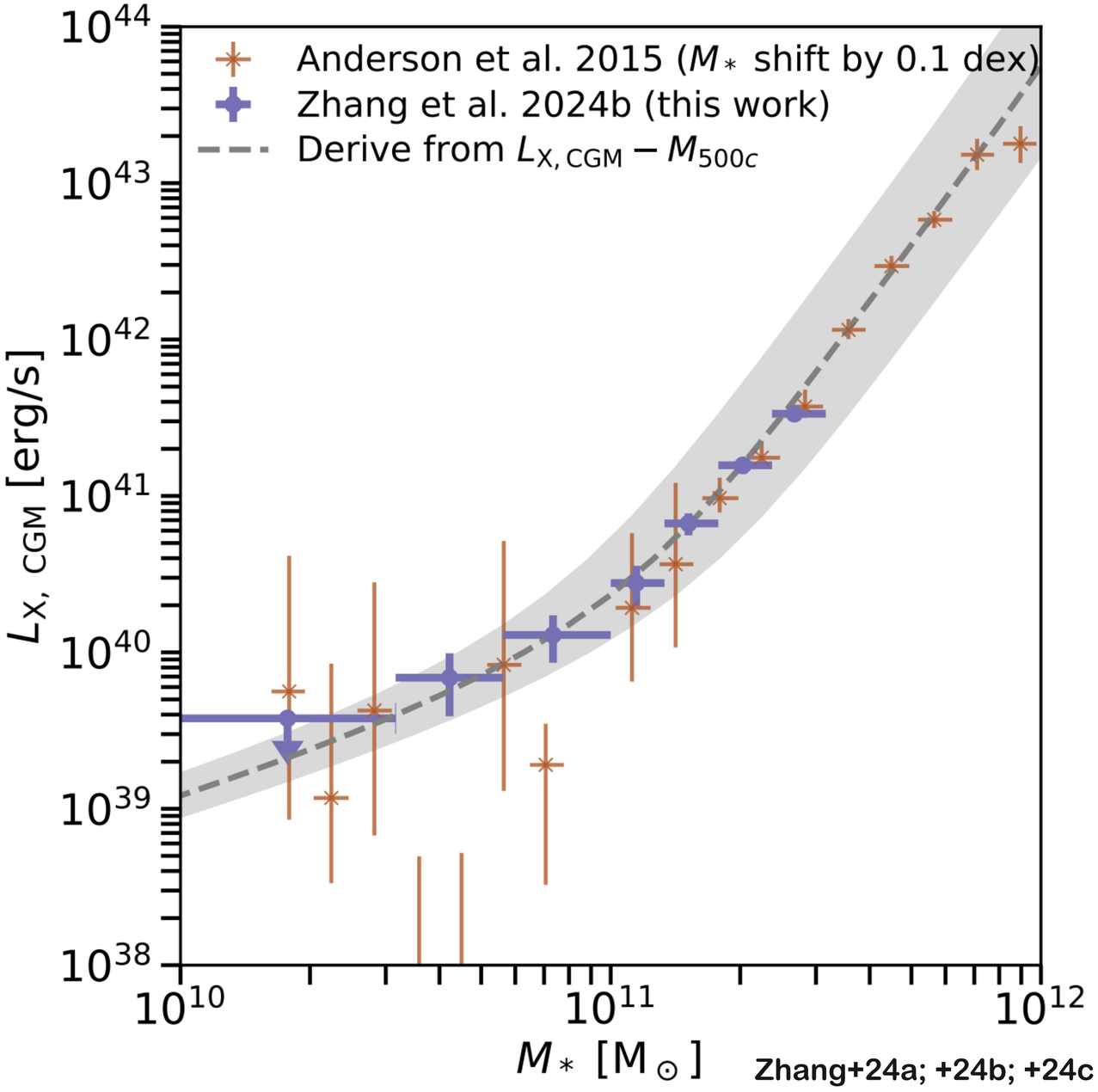

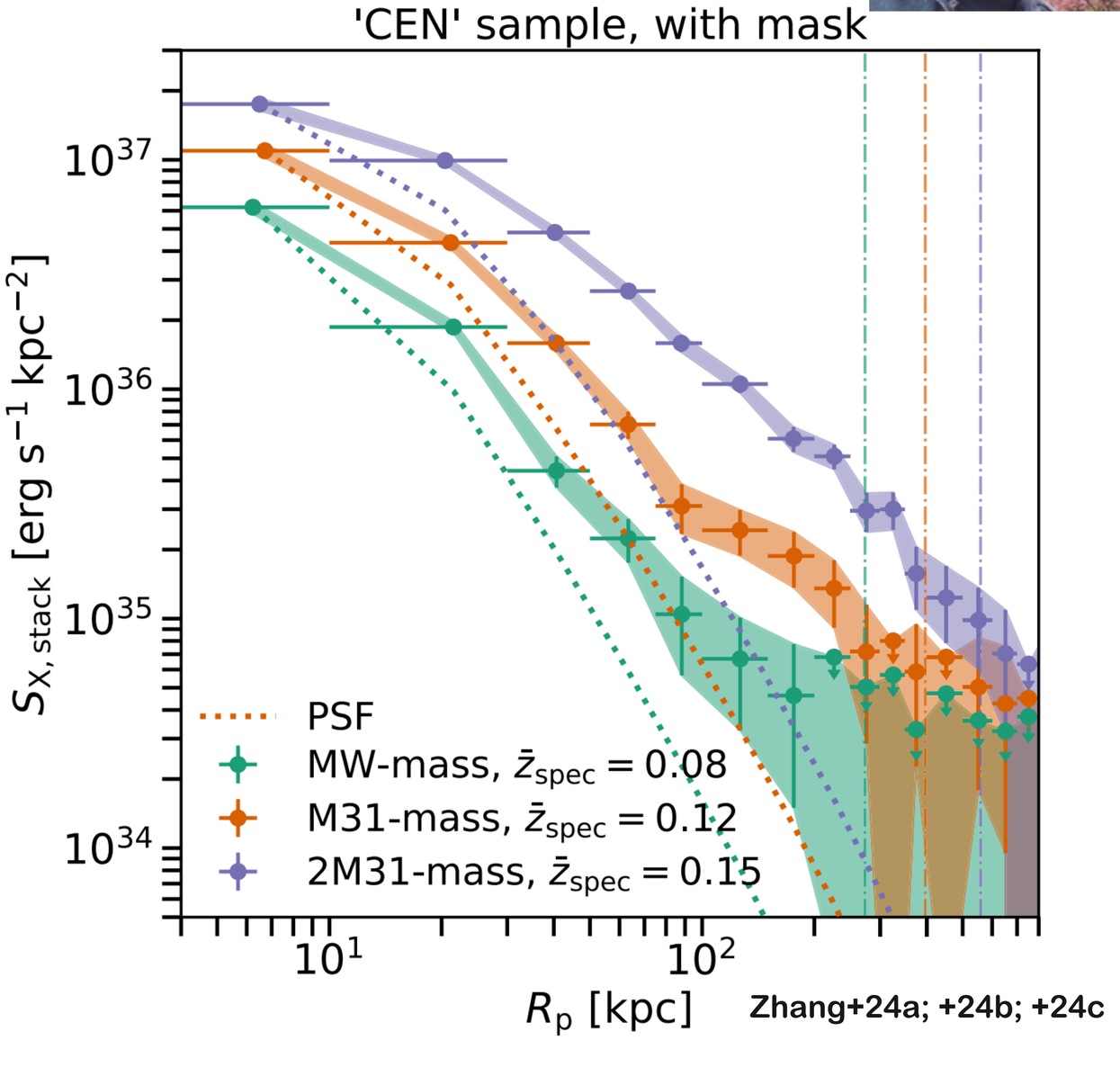

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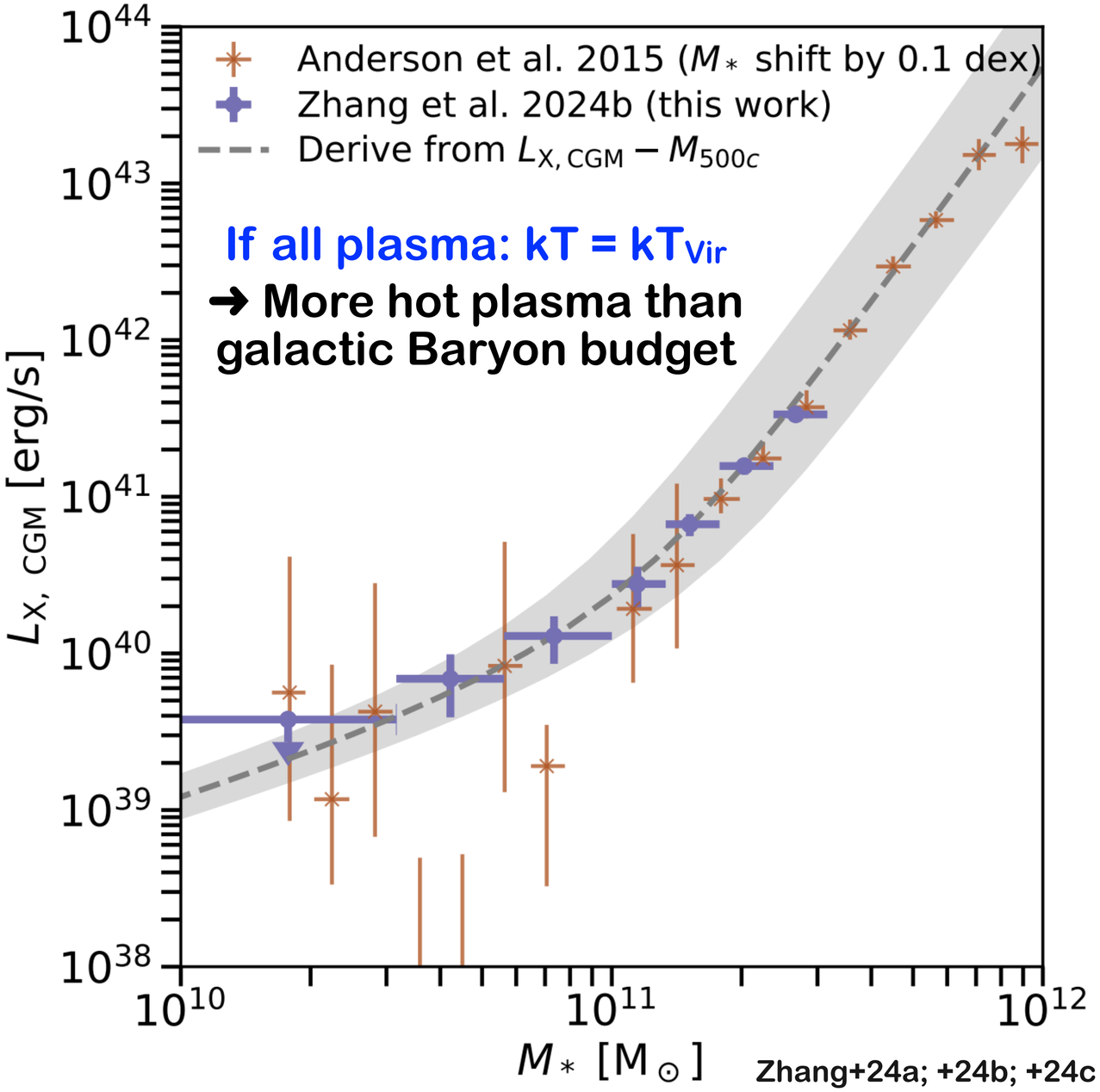

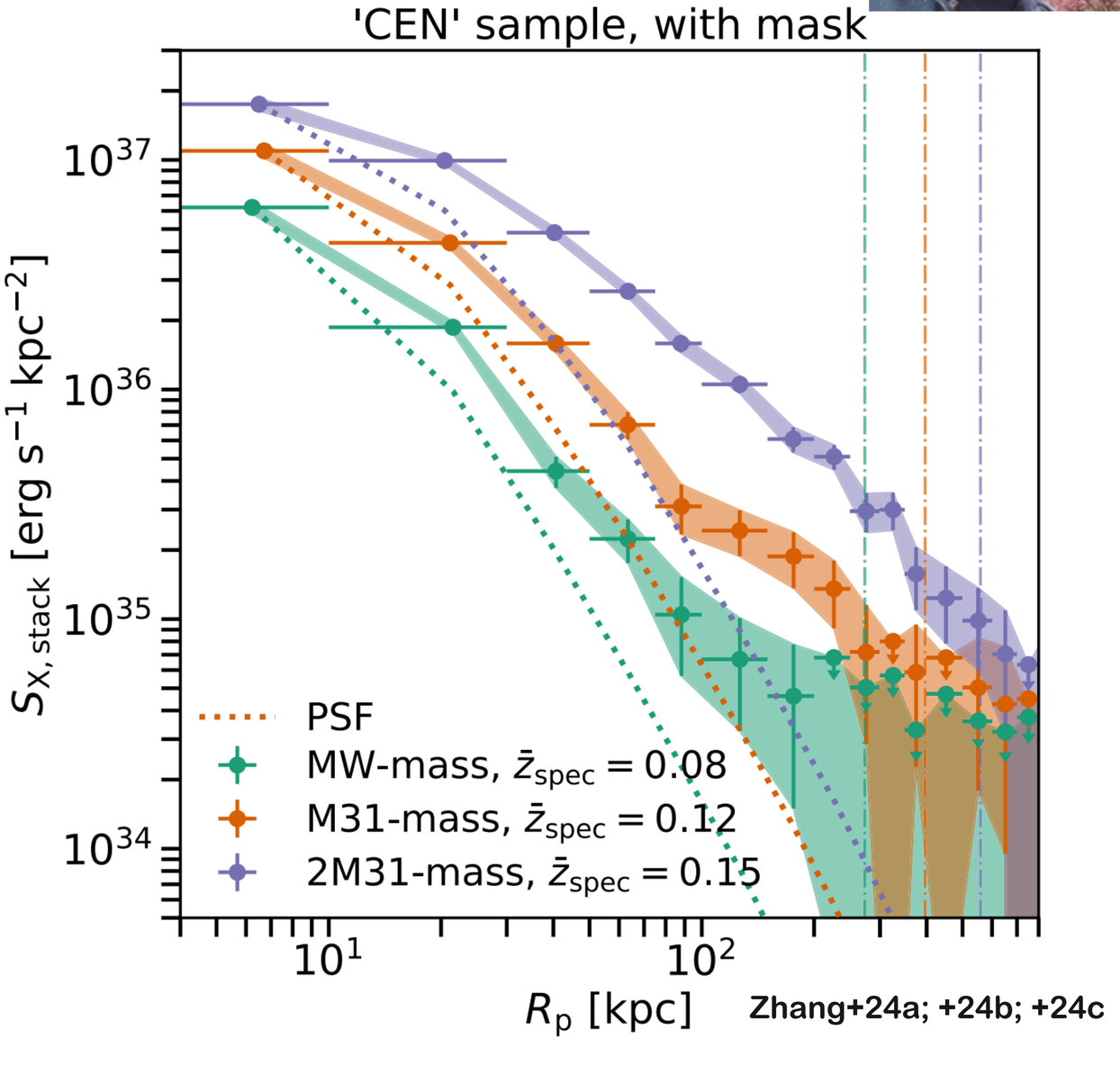

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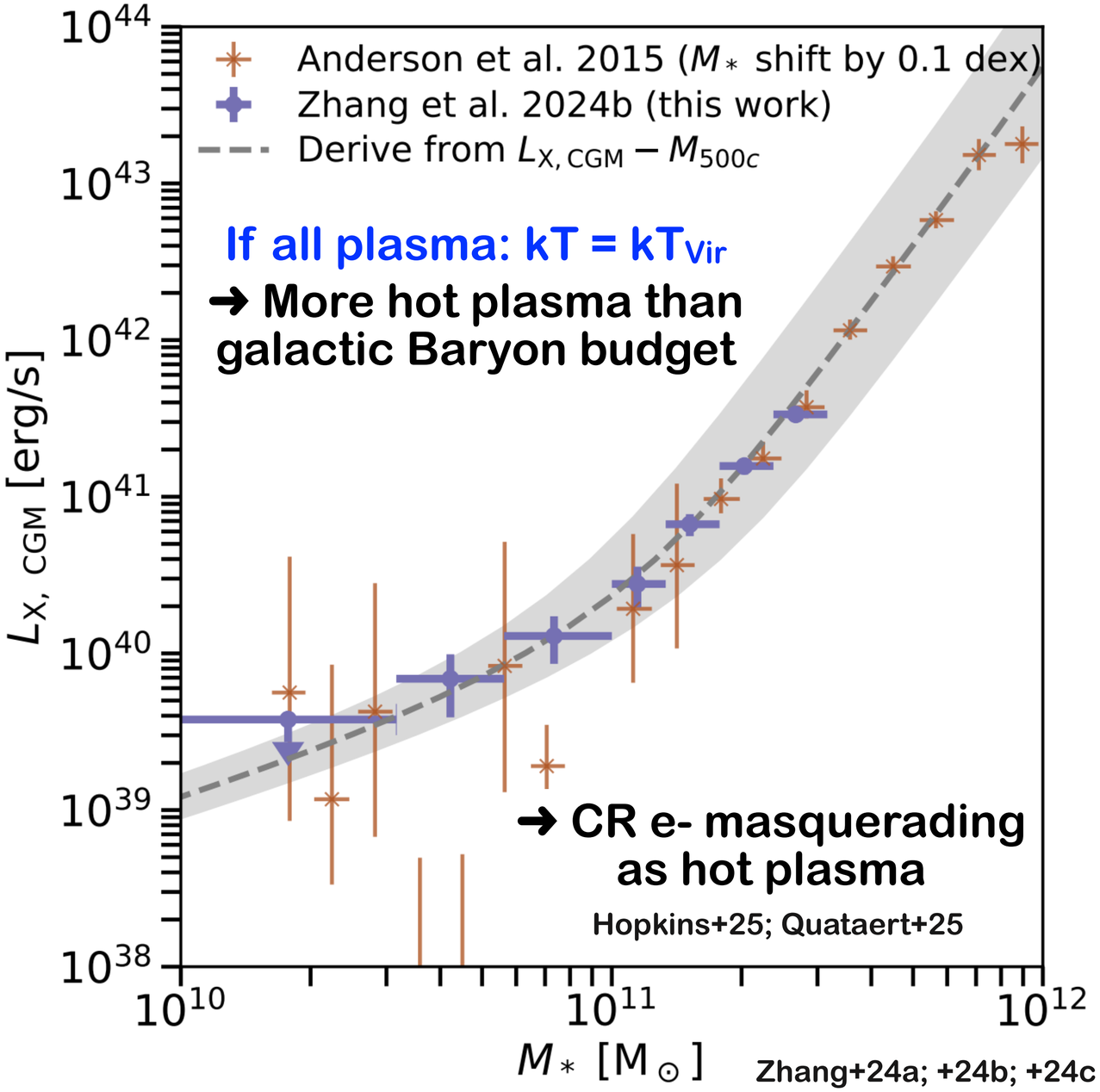

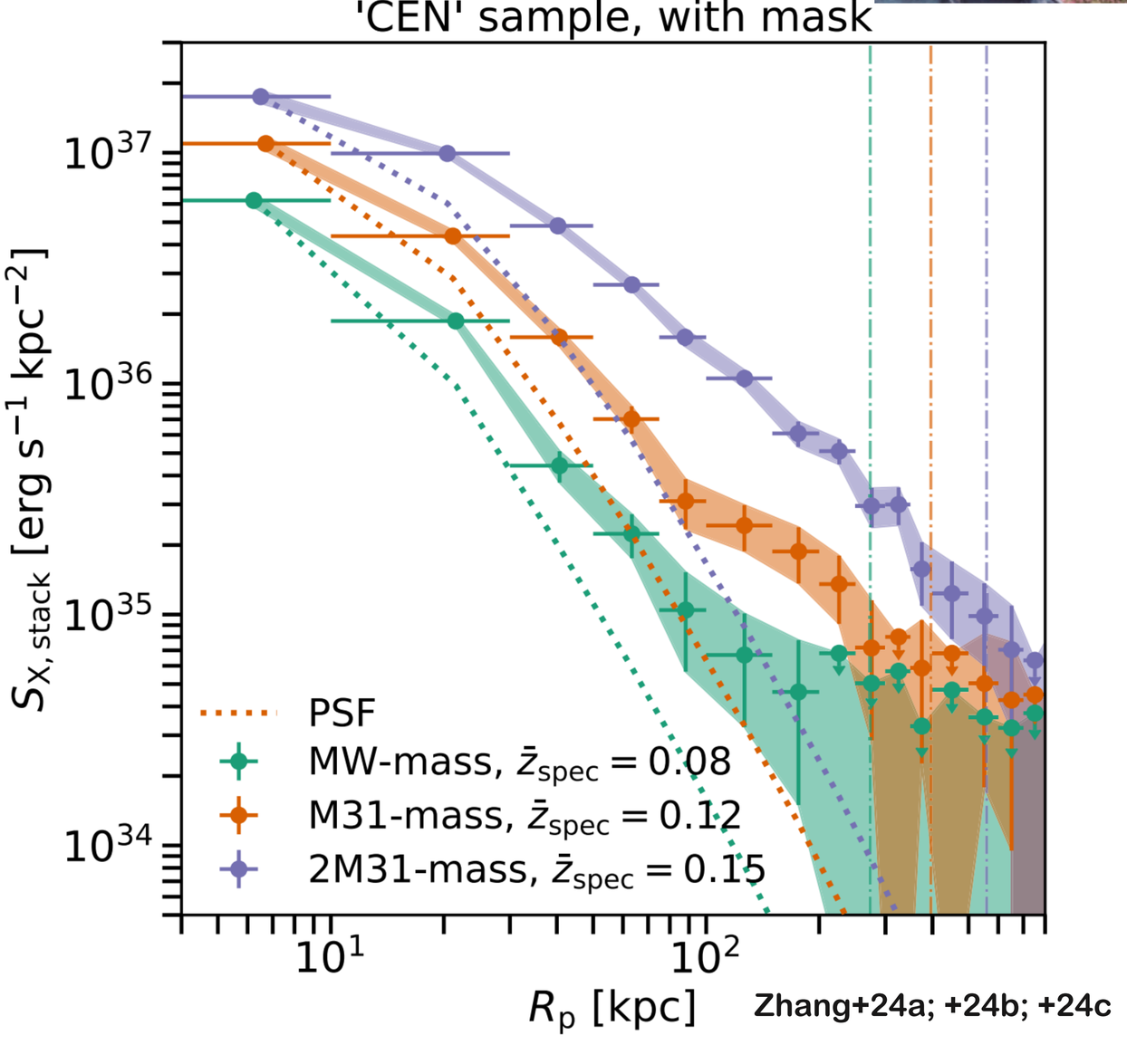

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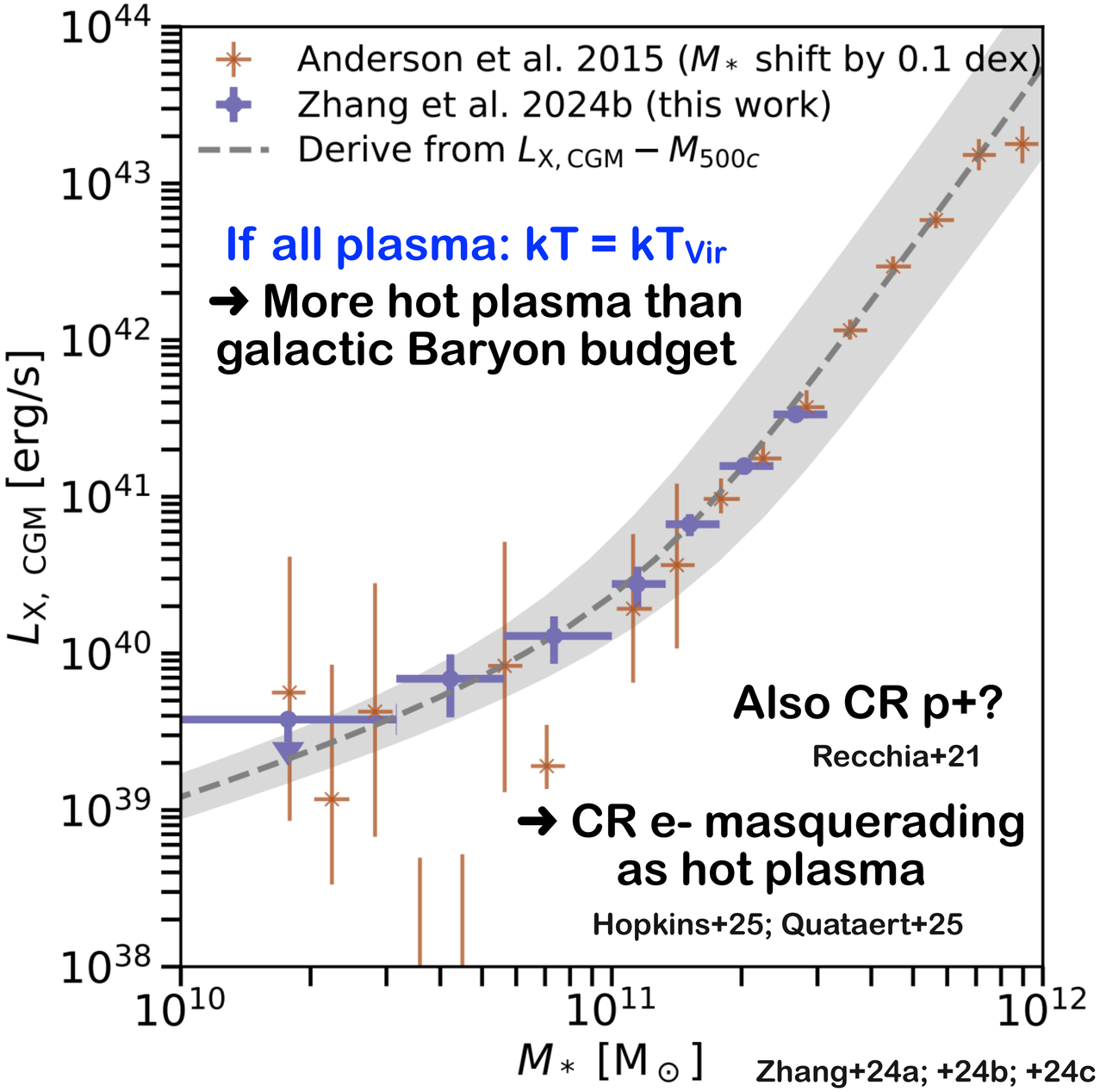

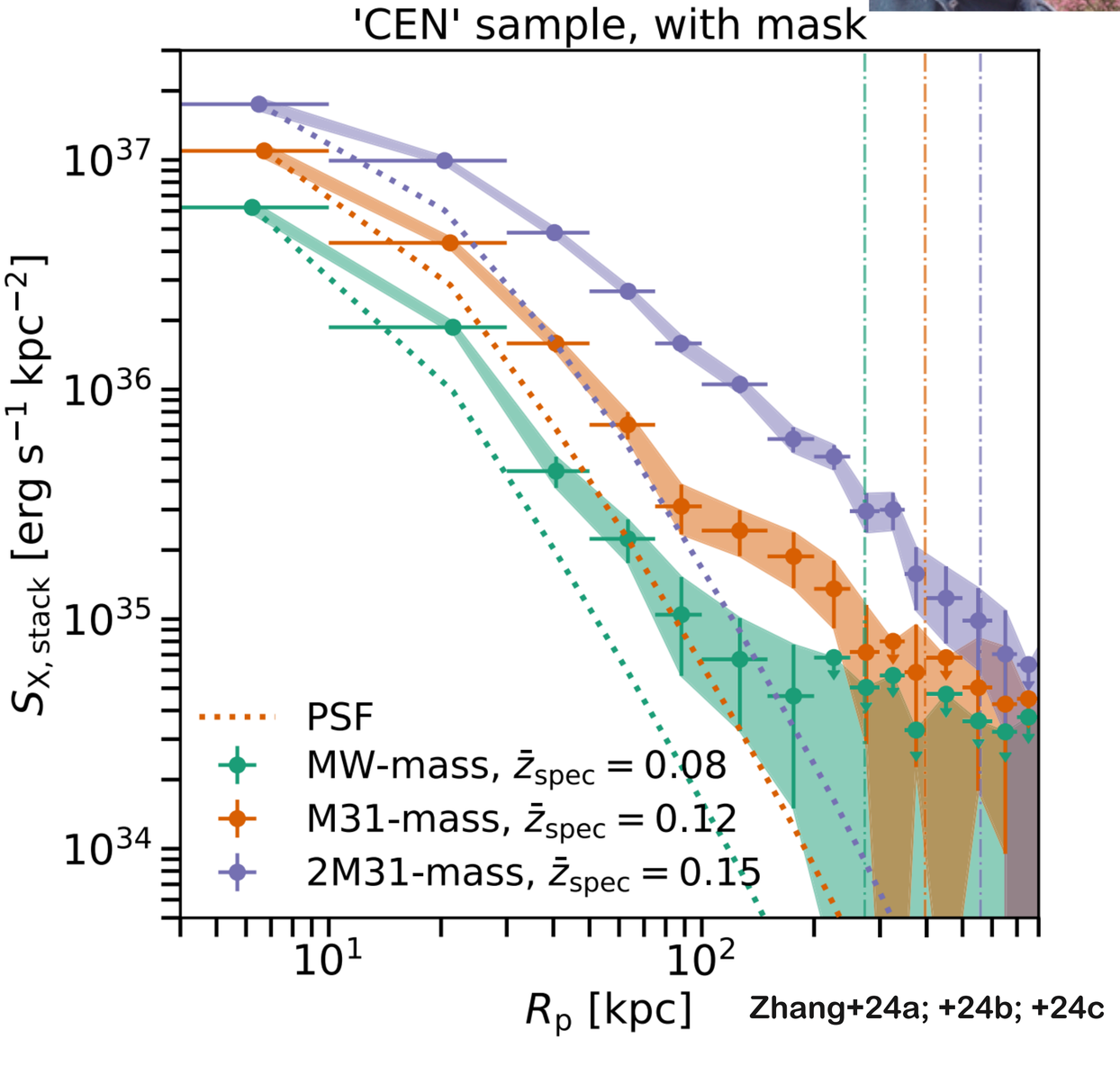

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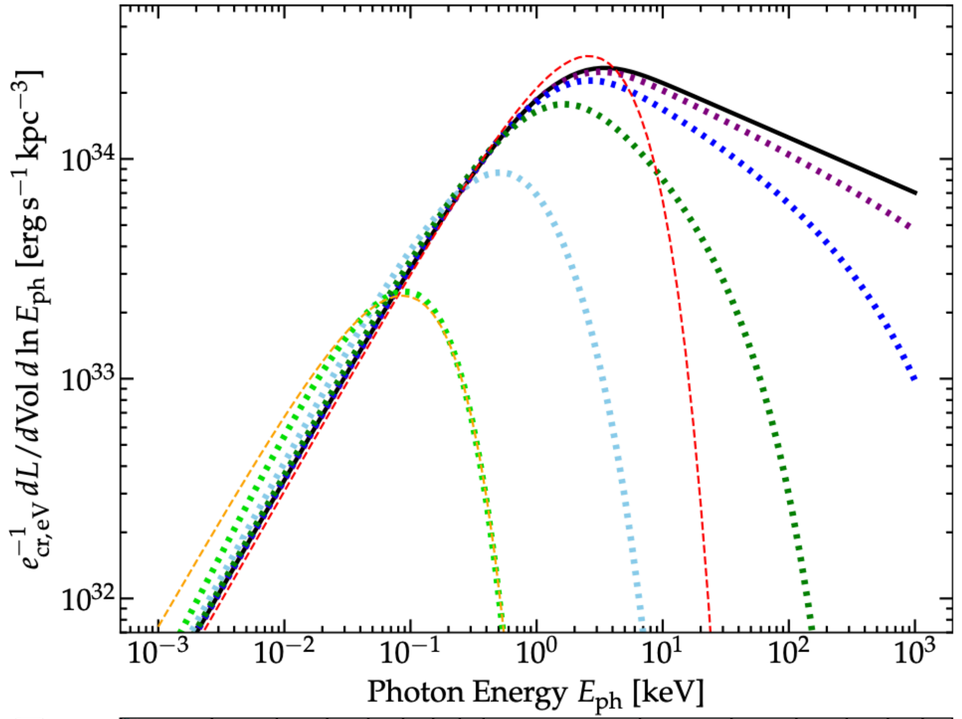
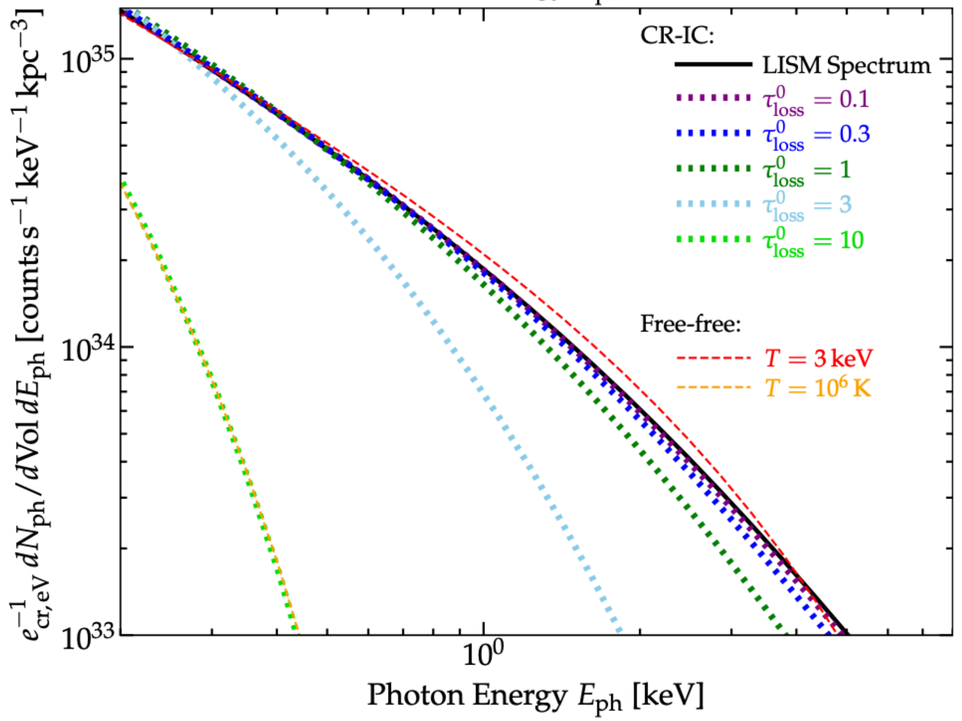
But possible contribution from cosmic ray electrons or protons

Recchia+21; Hopkins+25; Quataert+25

CR e- on CMB as hot CGM





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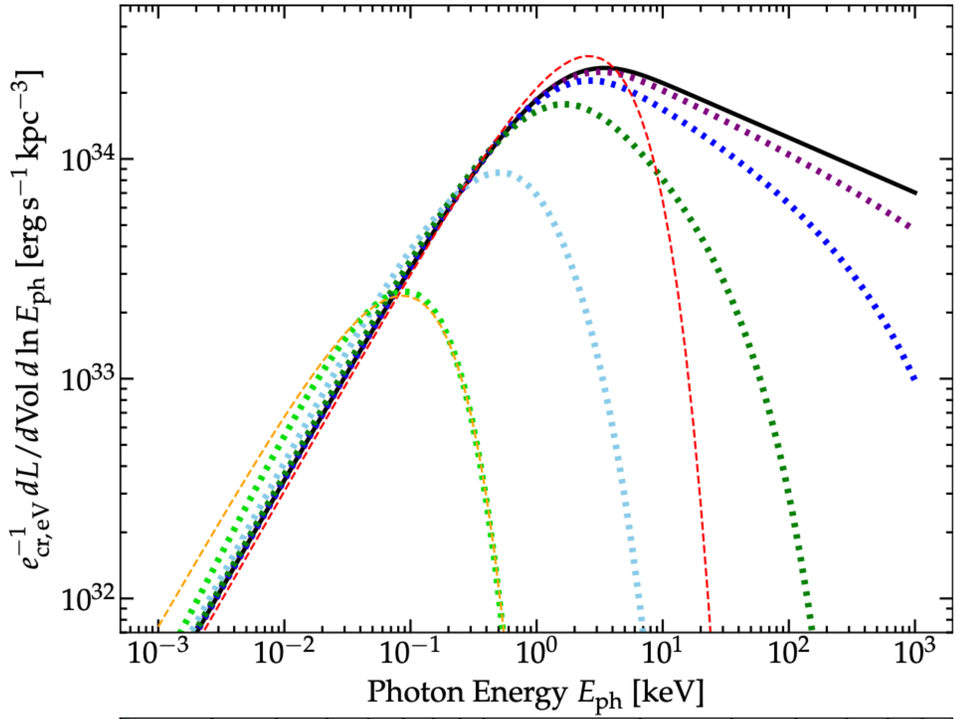

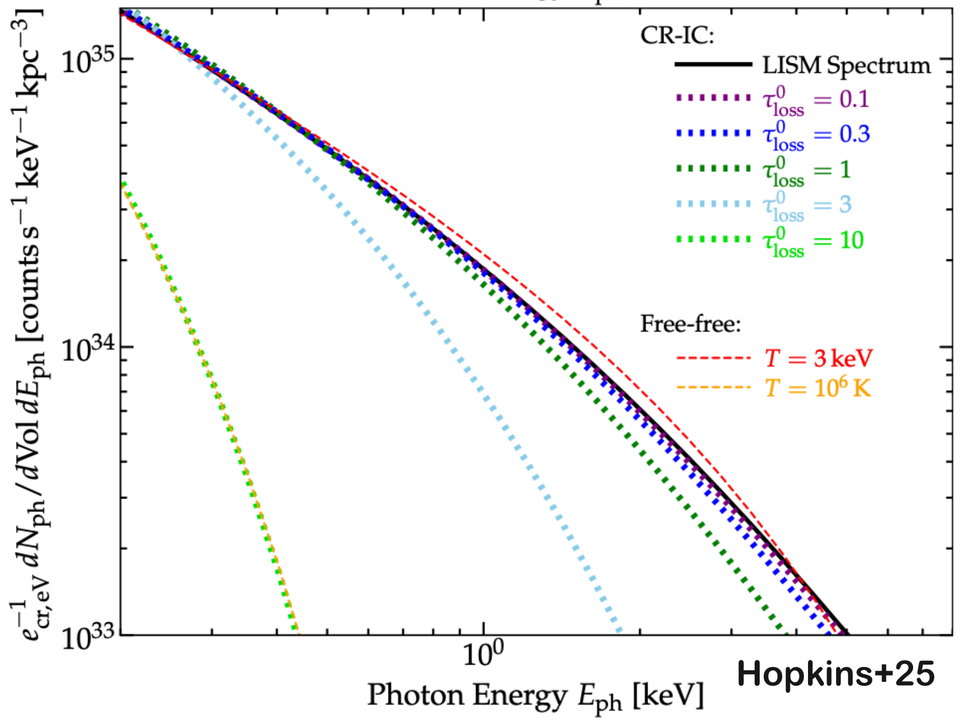

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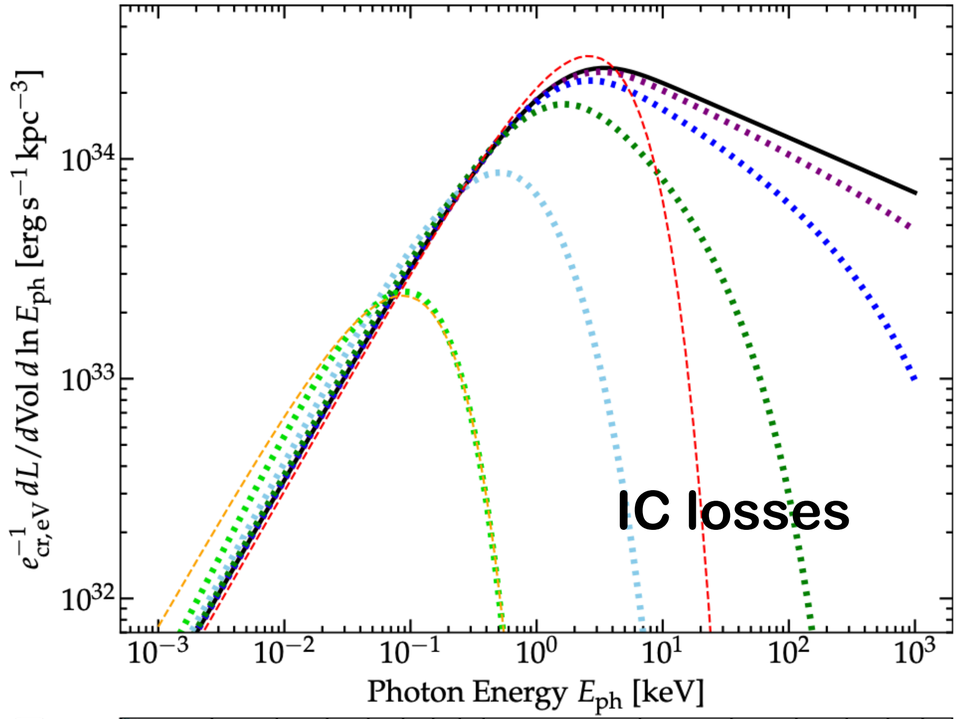

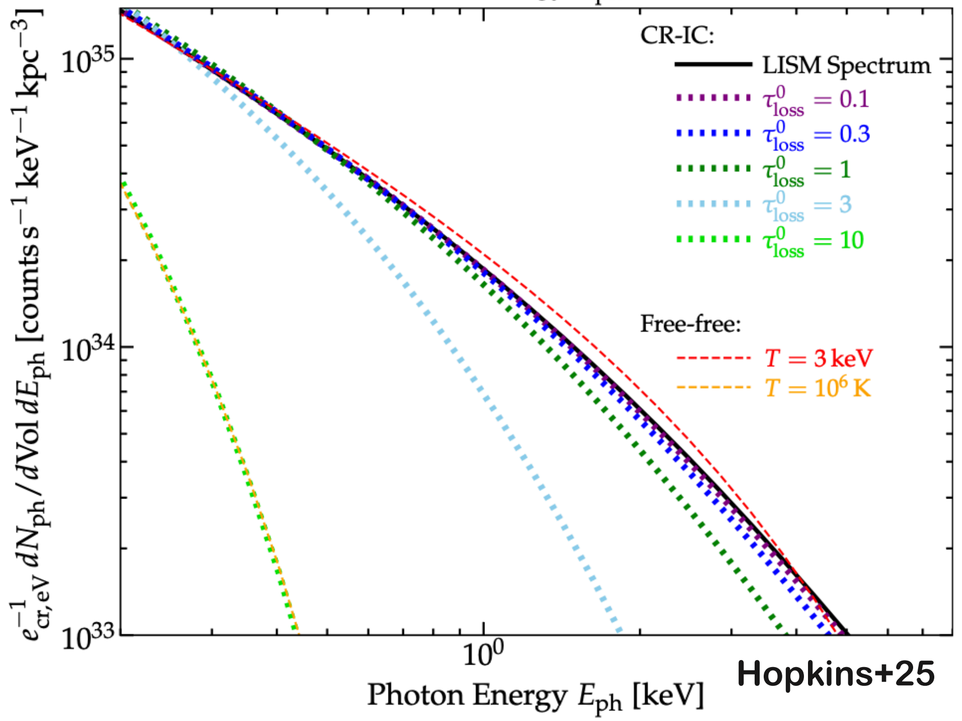

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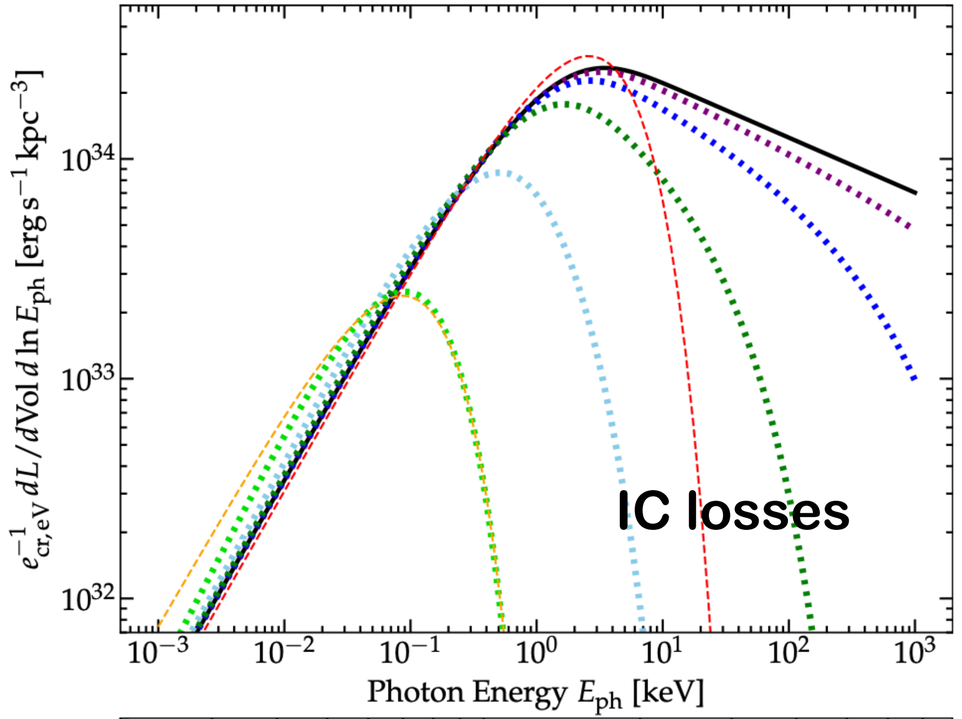

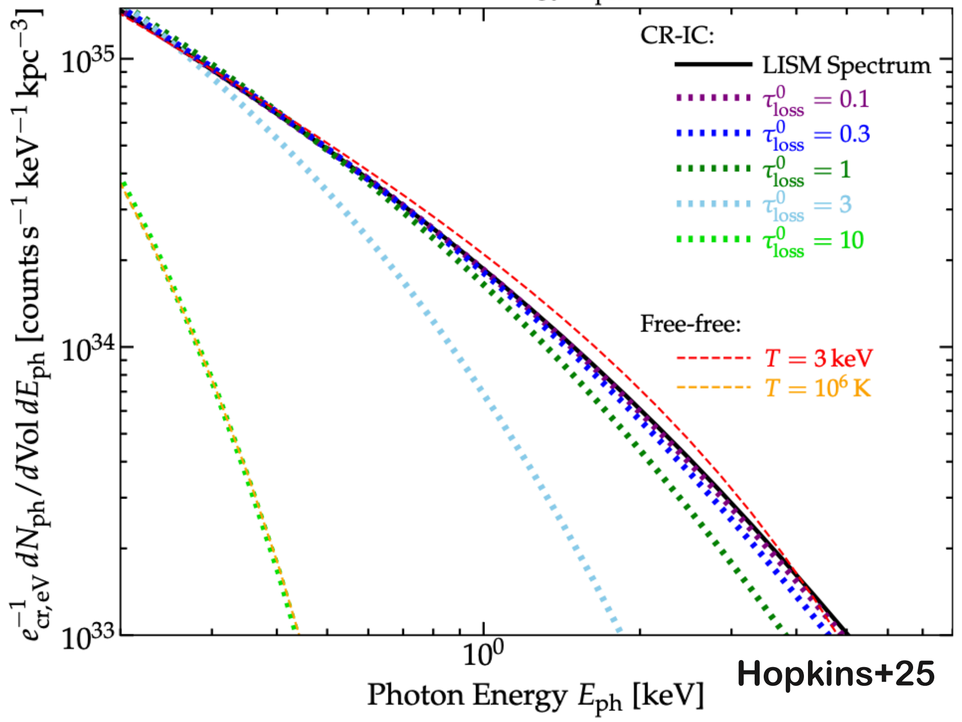

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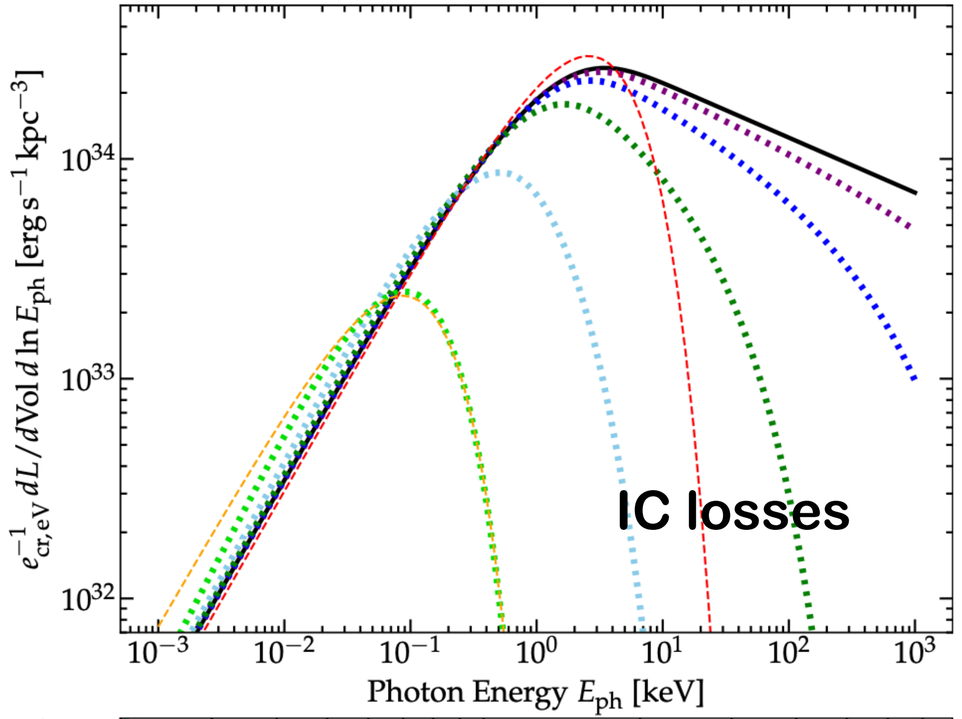
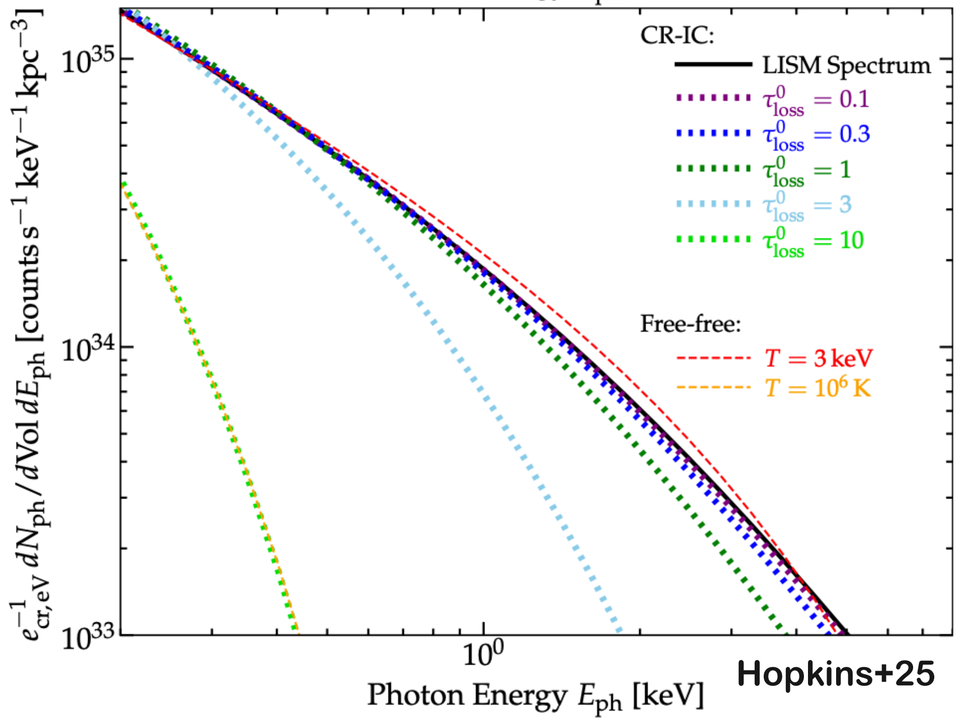
With IC losses





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Similar to hot plasma with kT~0.2 keV