one coin, two sides:

the microwave and gamma-ray haze

Greg Dobler (KITP/UCSB)

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the Fermi haze from DM annihilation:

halo shapes and anisotropic diffusion

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the Fermi haze from DM annihilation:

halo shapes and anisotropic diffusion

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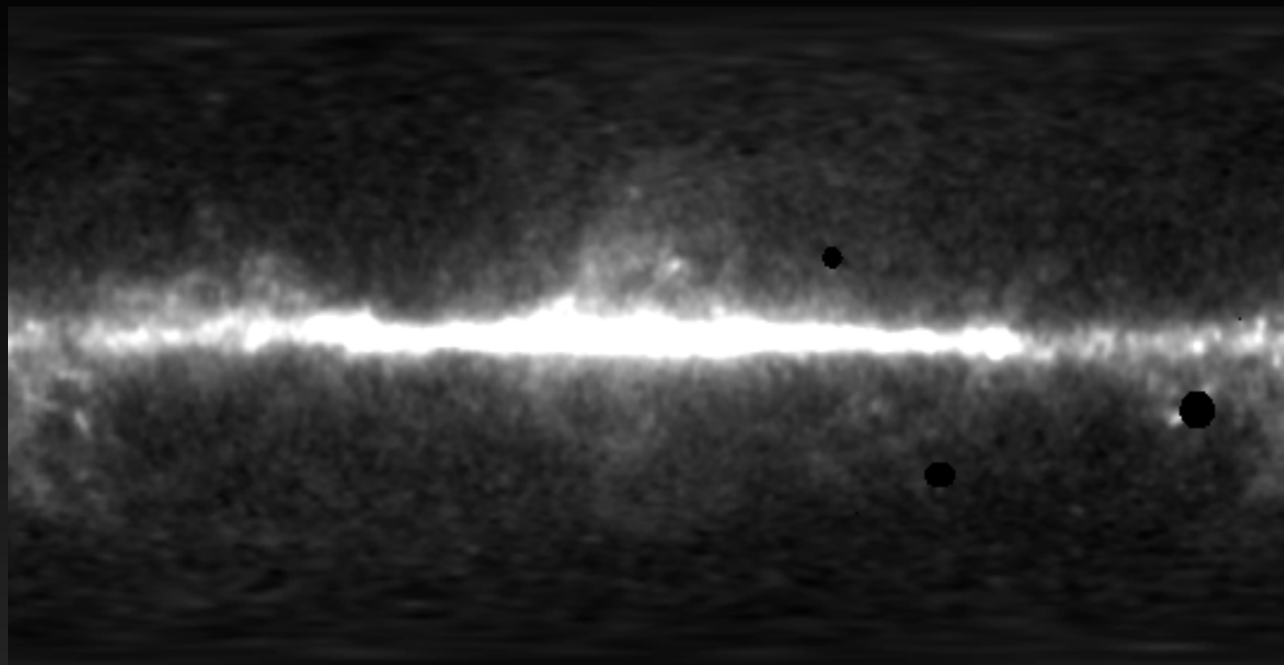
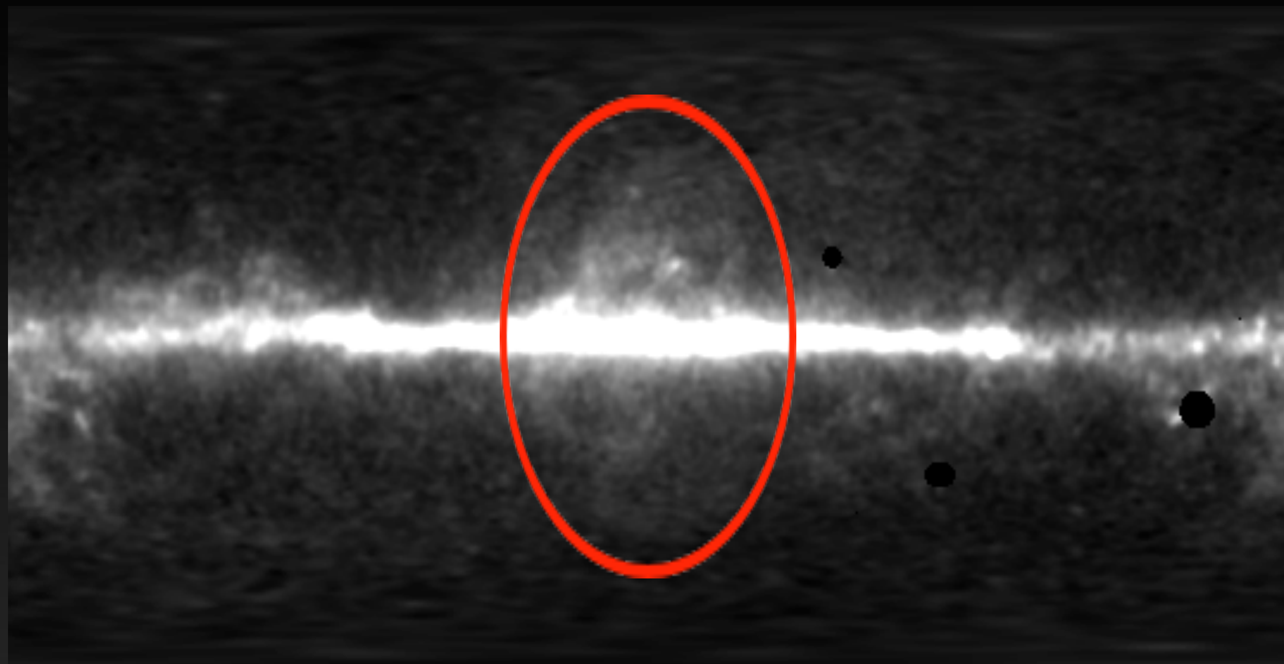
Ilias Cholis (NYU)
Neal Weiner (NYU)
Doug Finkbeiner (Harvard/CfA)
Tracy Slatyer (Harvard/CfA)
Tongyan Lin (Harvard/CfA)

the Fermi haze



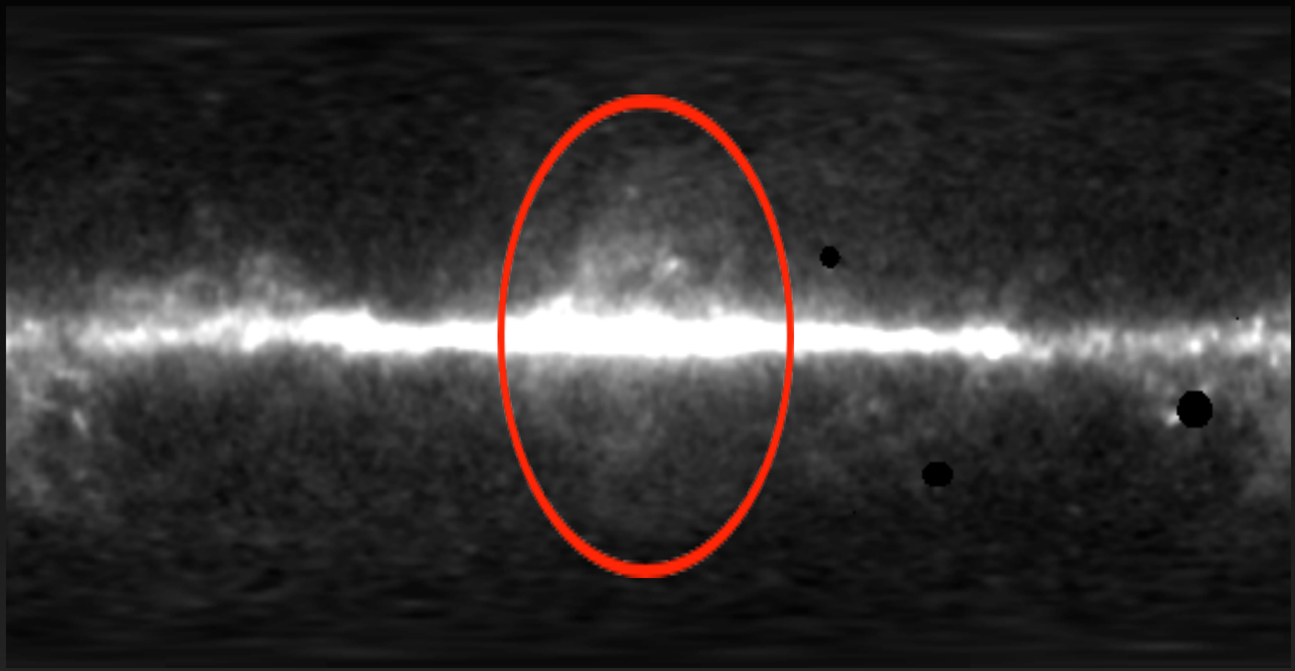
Fermi 2-5 GeV

the Fermi haze



Fermi 2-5 GeV

the Fermi haze



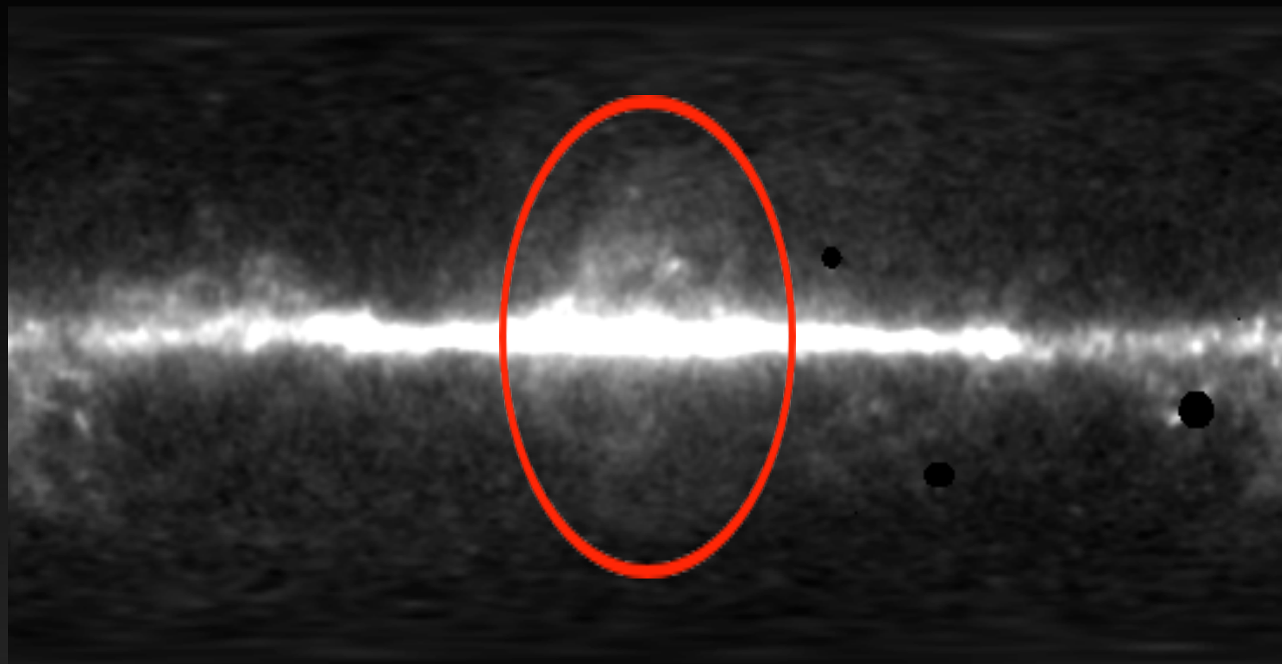
Fermi 2-5 GeV

two ***robust*** features:

. ***elongated*** in *b* with an axis ratio *~1.7*

. spectrum is ***harder*** than elsewhere

the Fermi haze (spectrum)



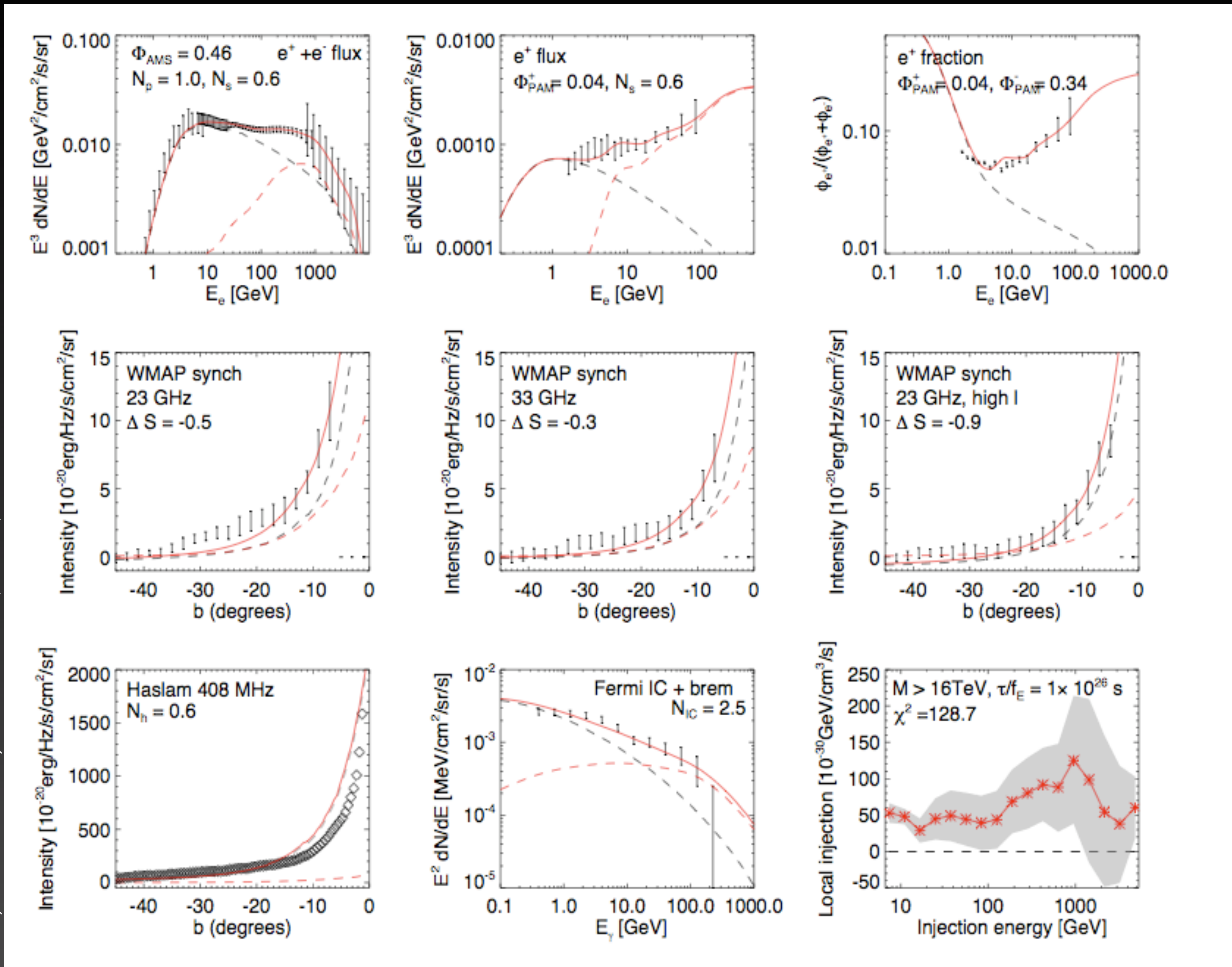
Fermi 2-5 GeV

spectrum is consistent with IC emission from a hard population of electrons

. amplitude/shape can be fit model-independently

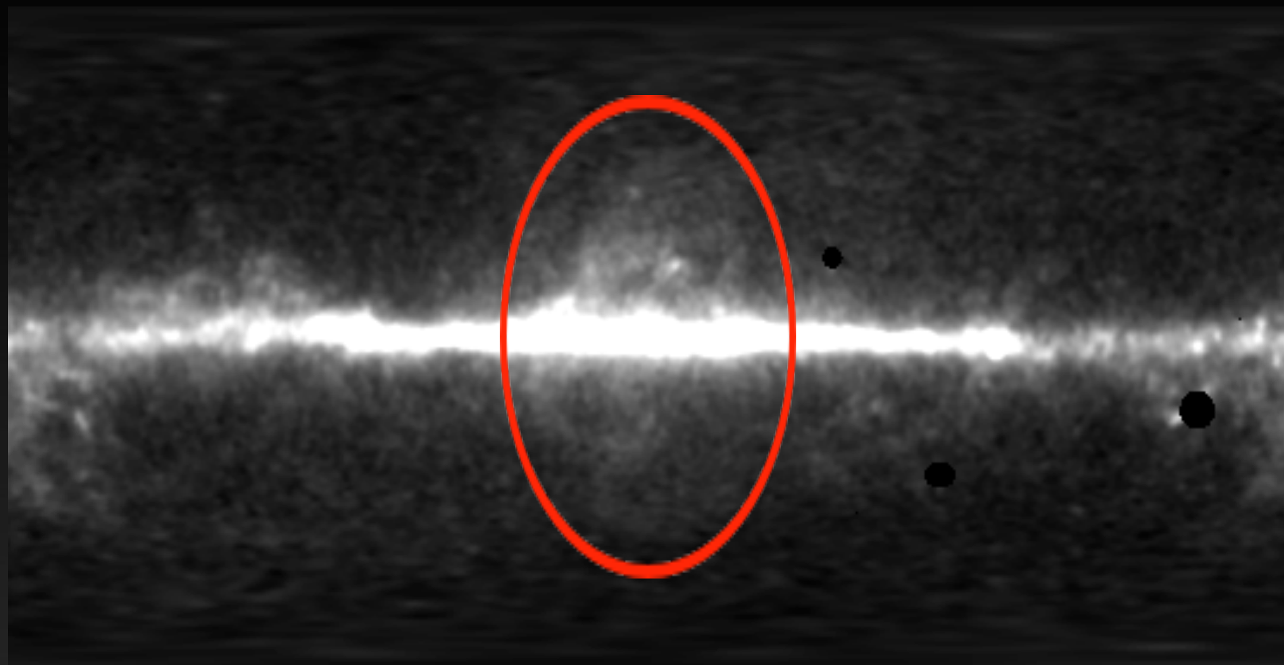
. consistent with leptonic DM annihilations

the Fermi haze (spectrum)



Lin, Finkbeiner, & Dobler (2010)

the Fermi haze (morphology)



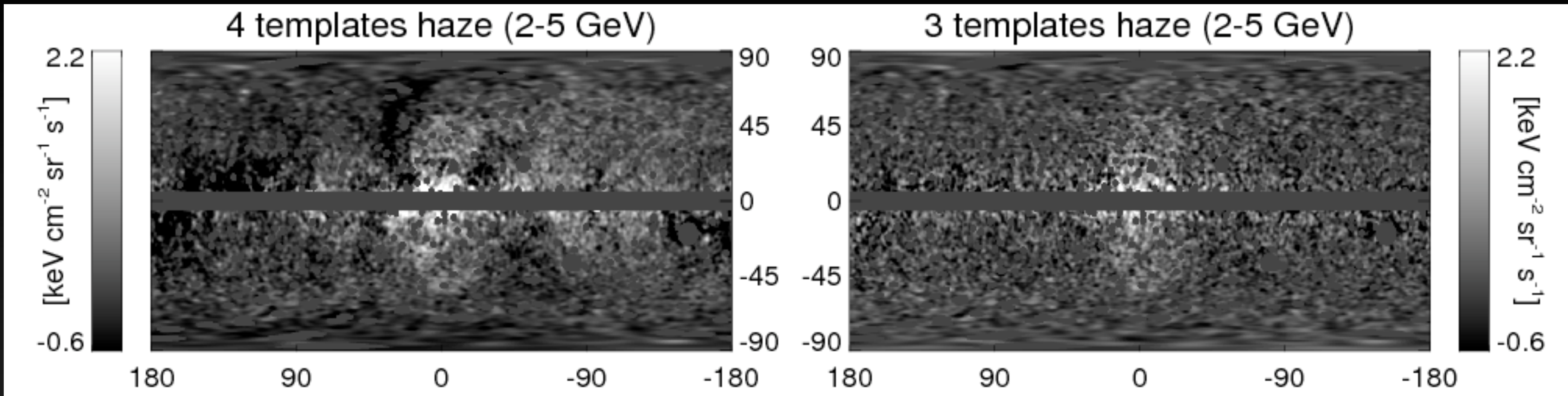
Fermi 2-5 GeV

morphology... ***much*** more difficult:

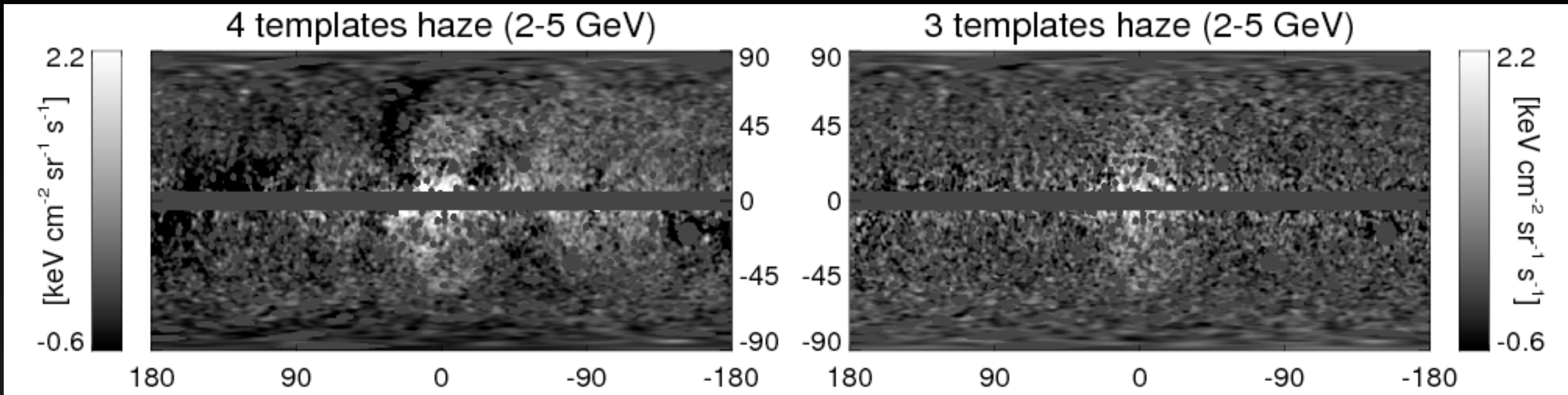
. north/south "edge"?

. what happens towards the center?

haze residuals



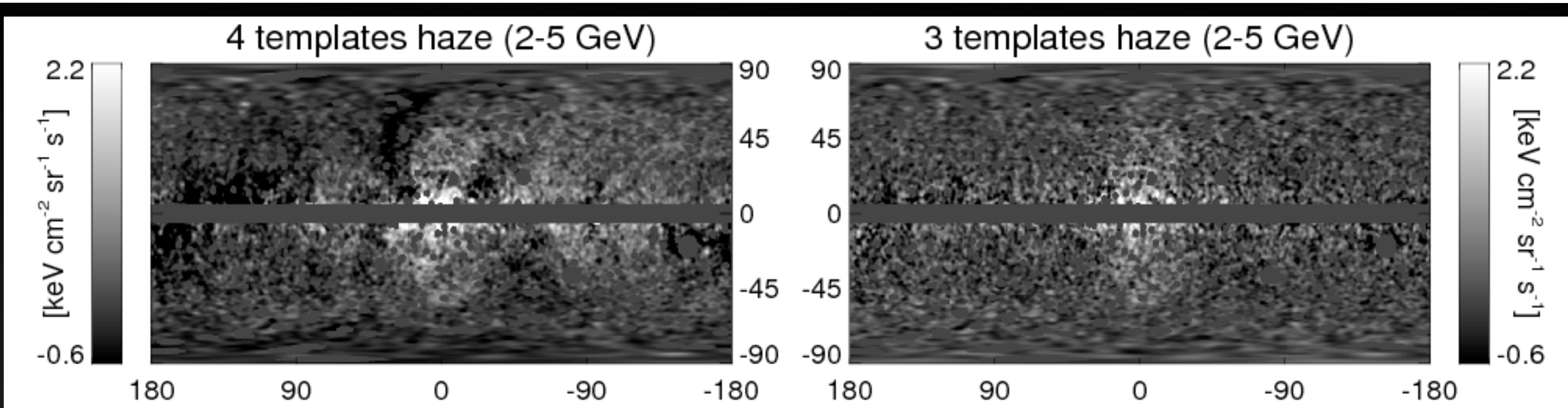
haze residuals



SFD
Uniform
Haslam
Bubbles

0.5<E<1.0 GeV
Uniform
GALPROP (modified)

haze residuals



SFD

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0.5<E<1.0 GeV

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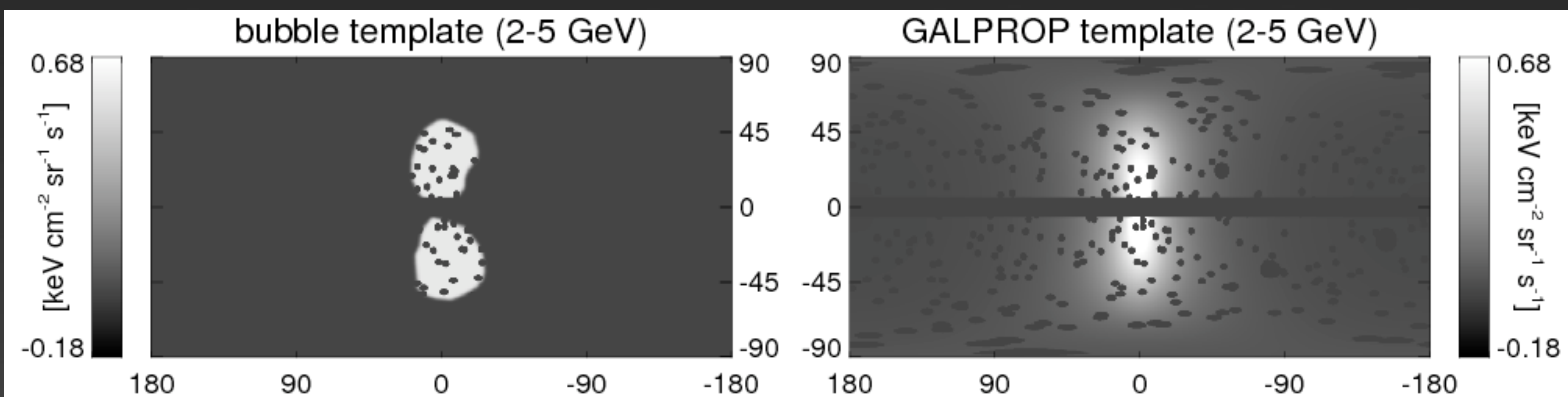
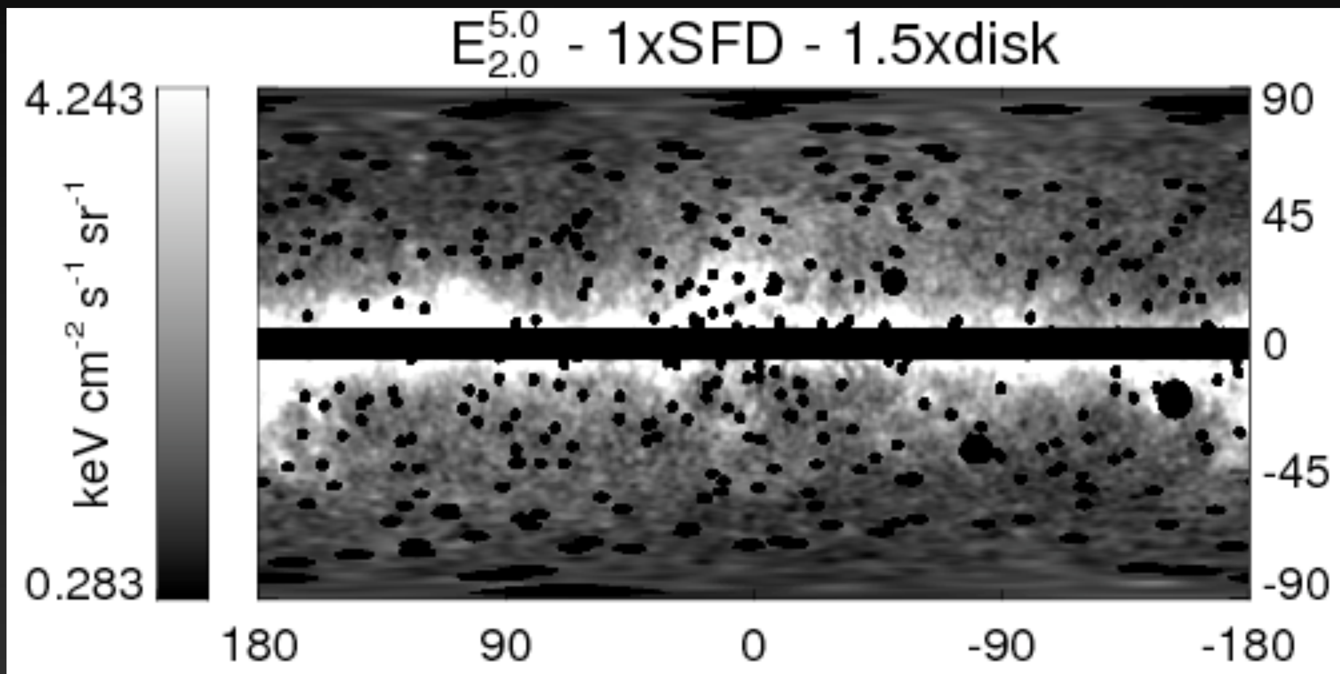
GALPROP (modified)



hourglass or oval?

line of sight gas density issues?



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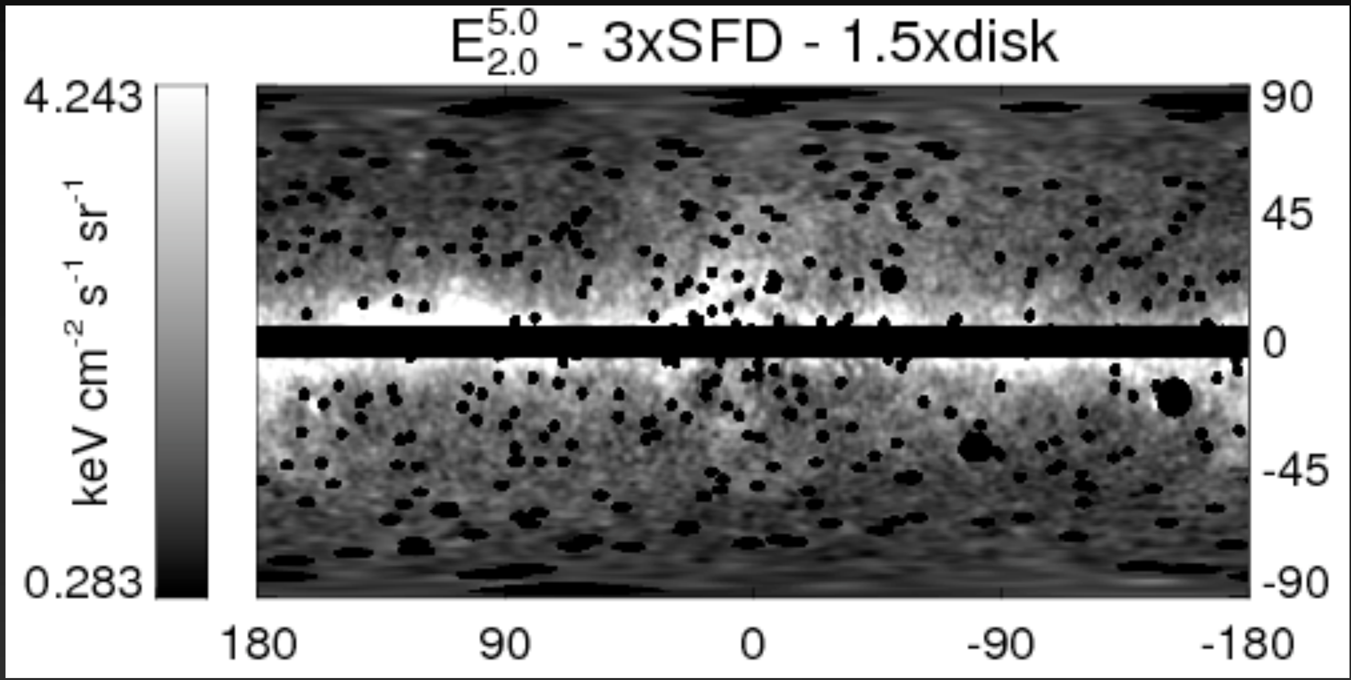

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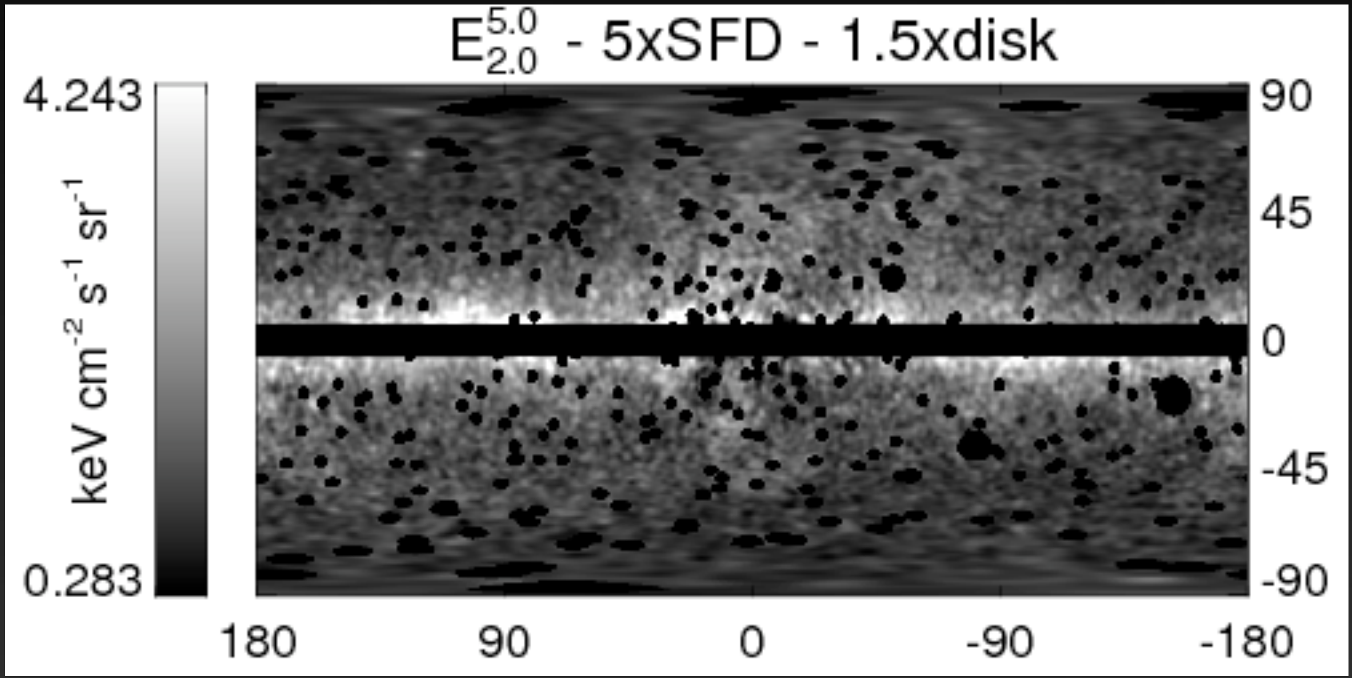

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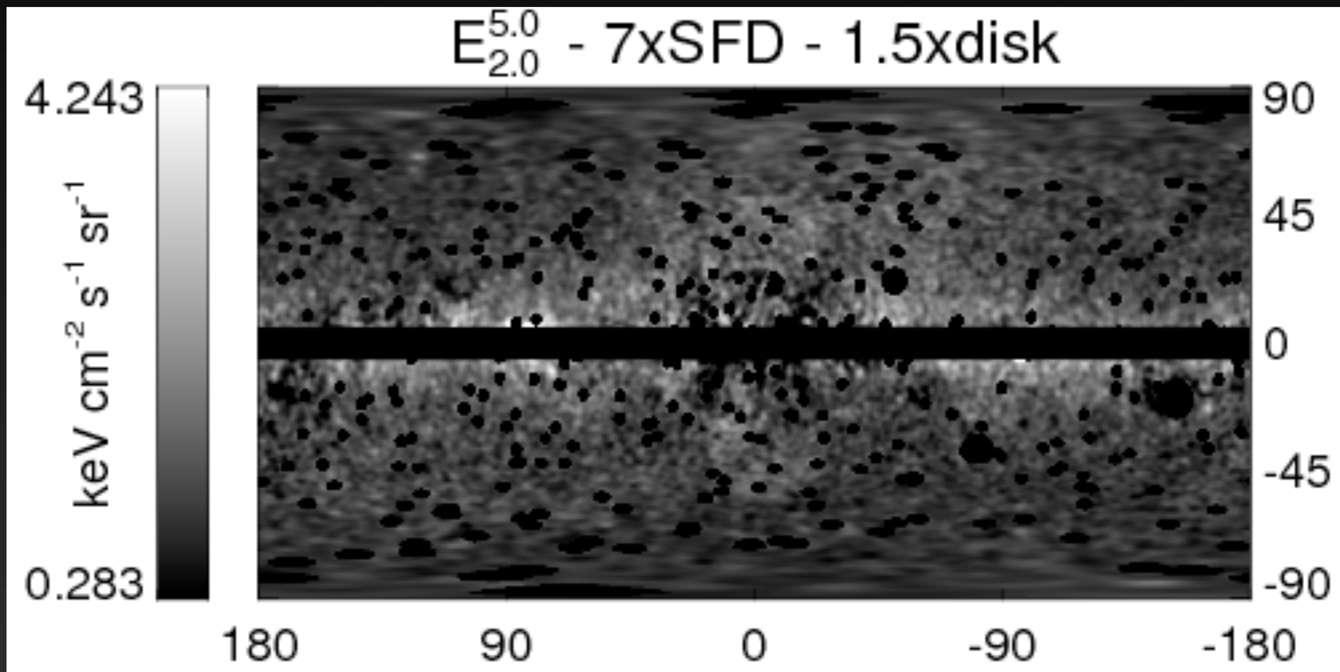

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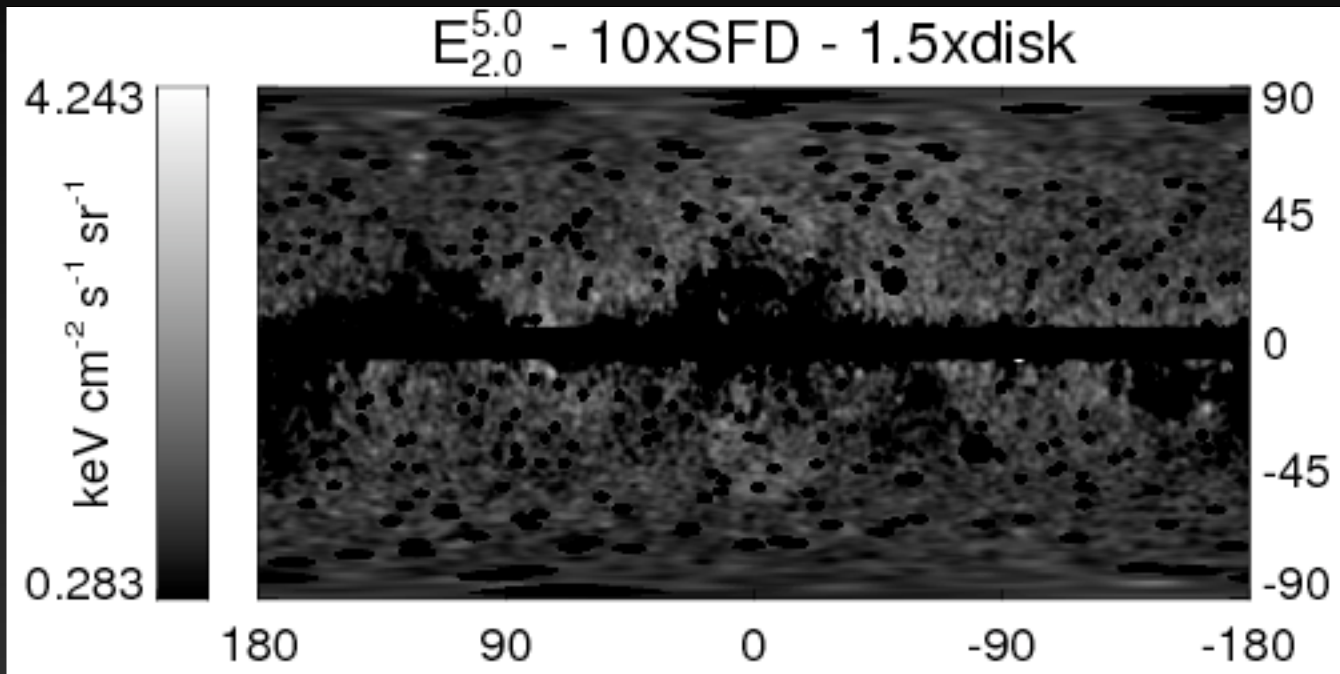
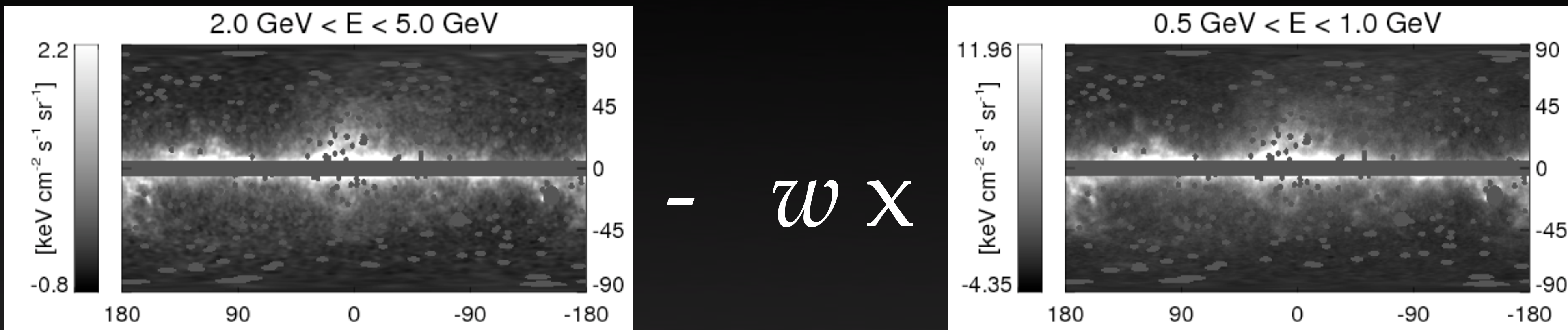
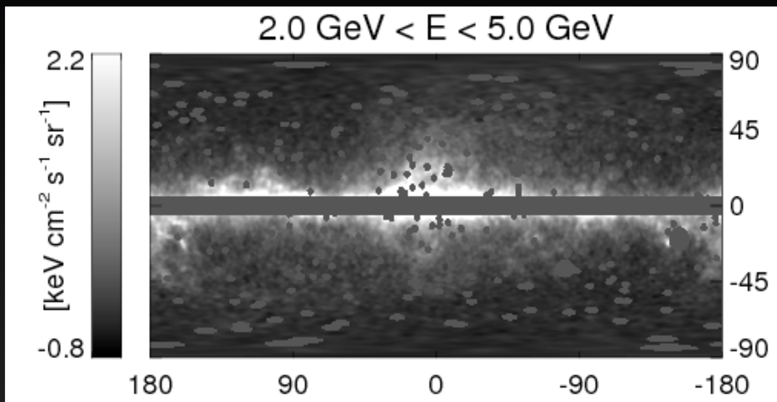


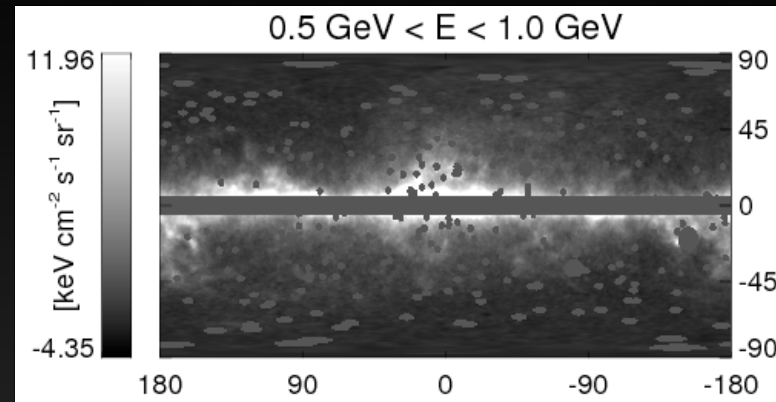
Fermi haze morphology

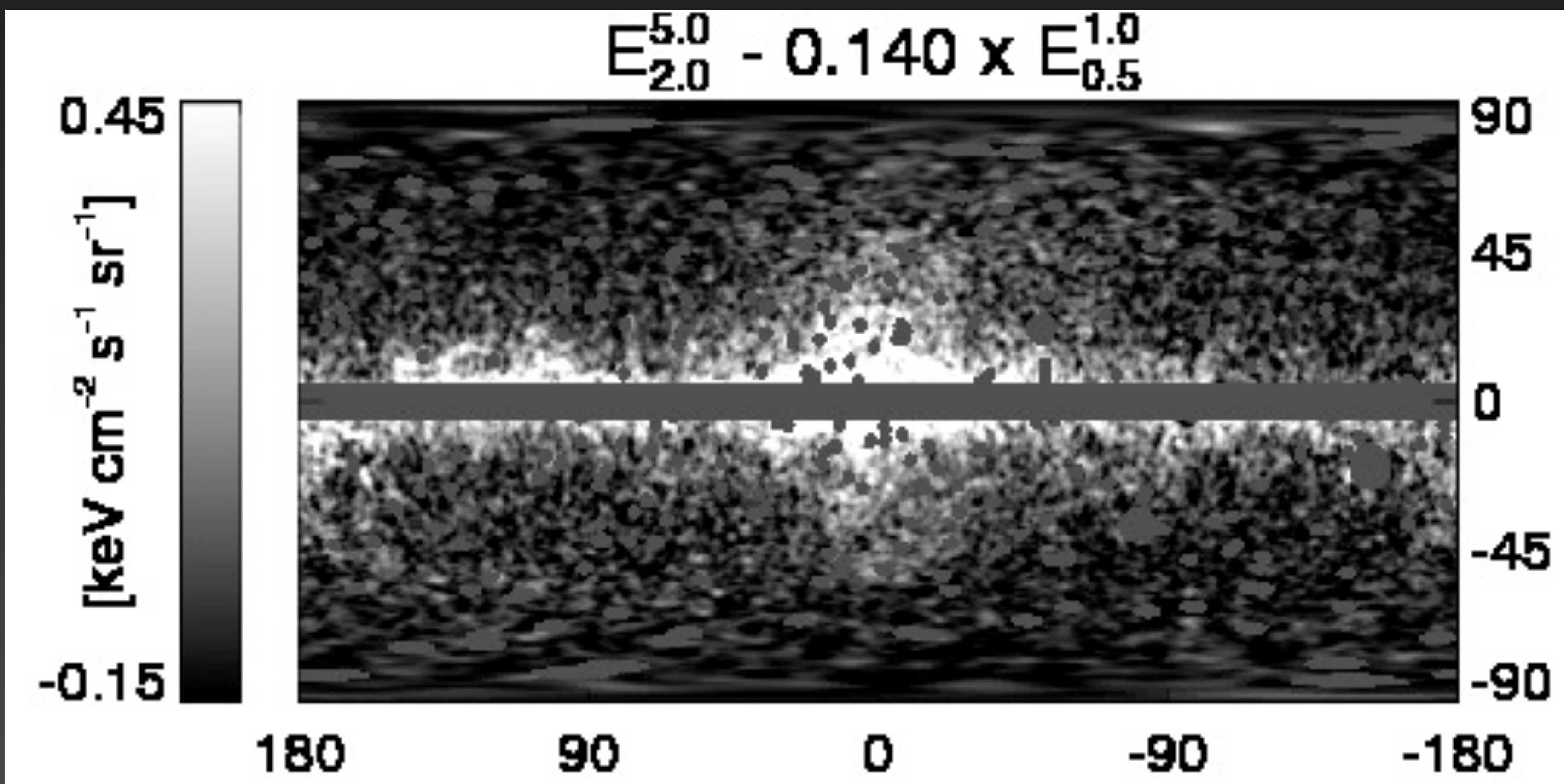


Fermi haze morphology

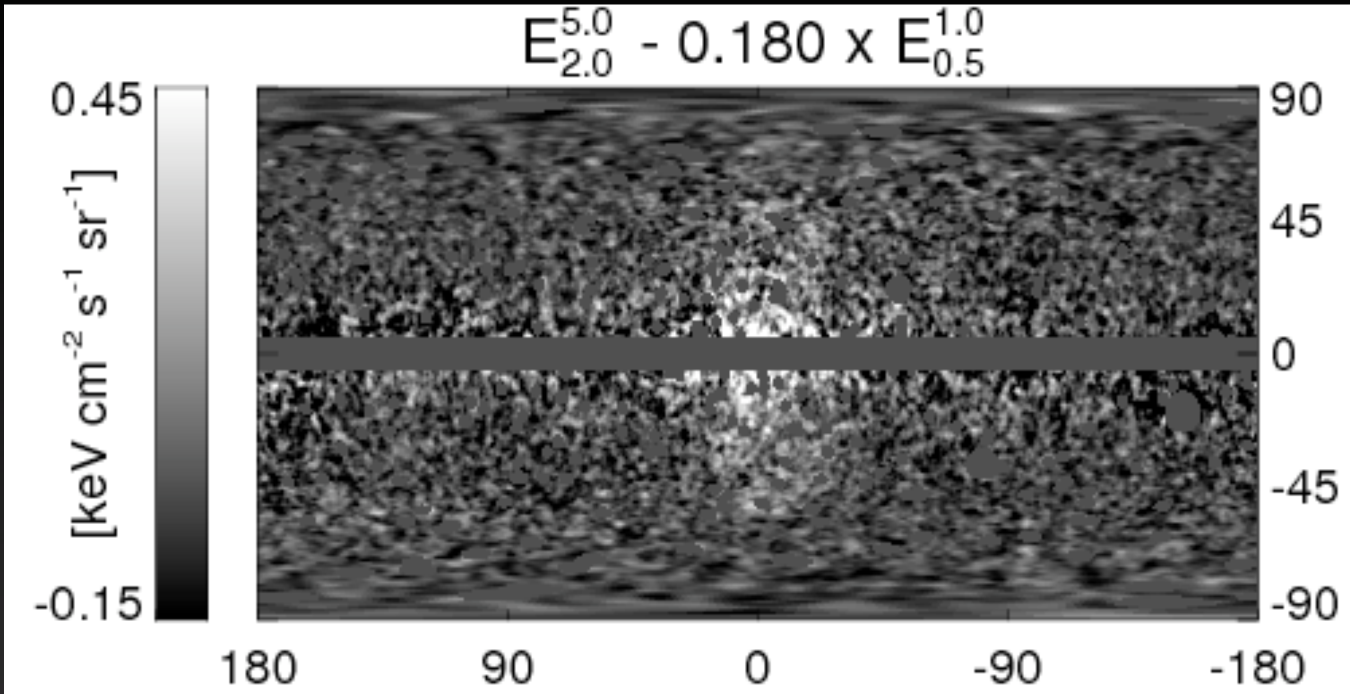


- w x



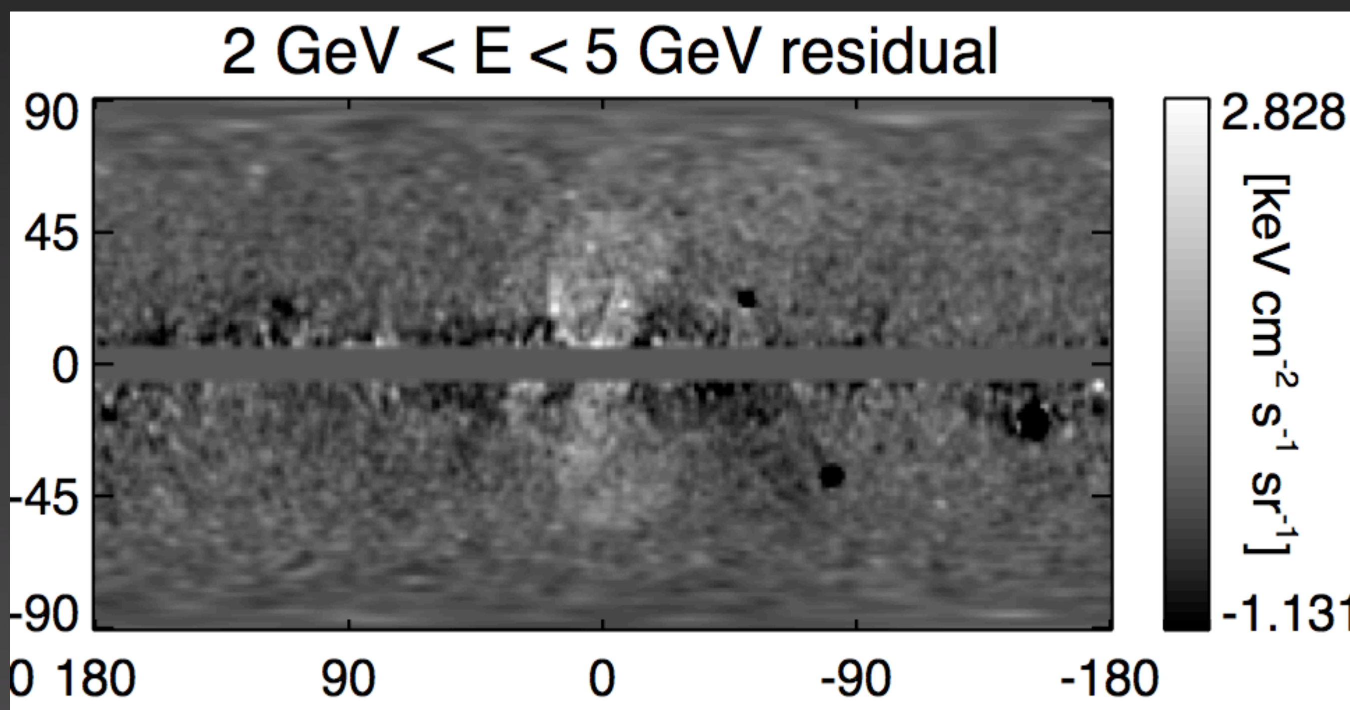


Fermi haze morphology

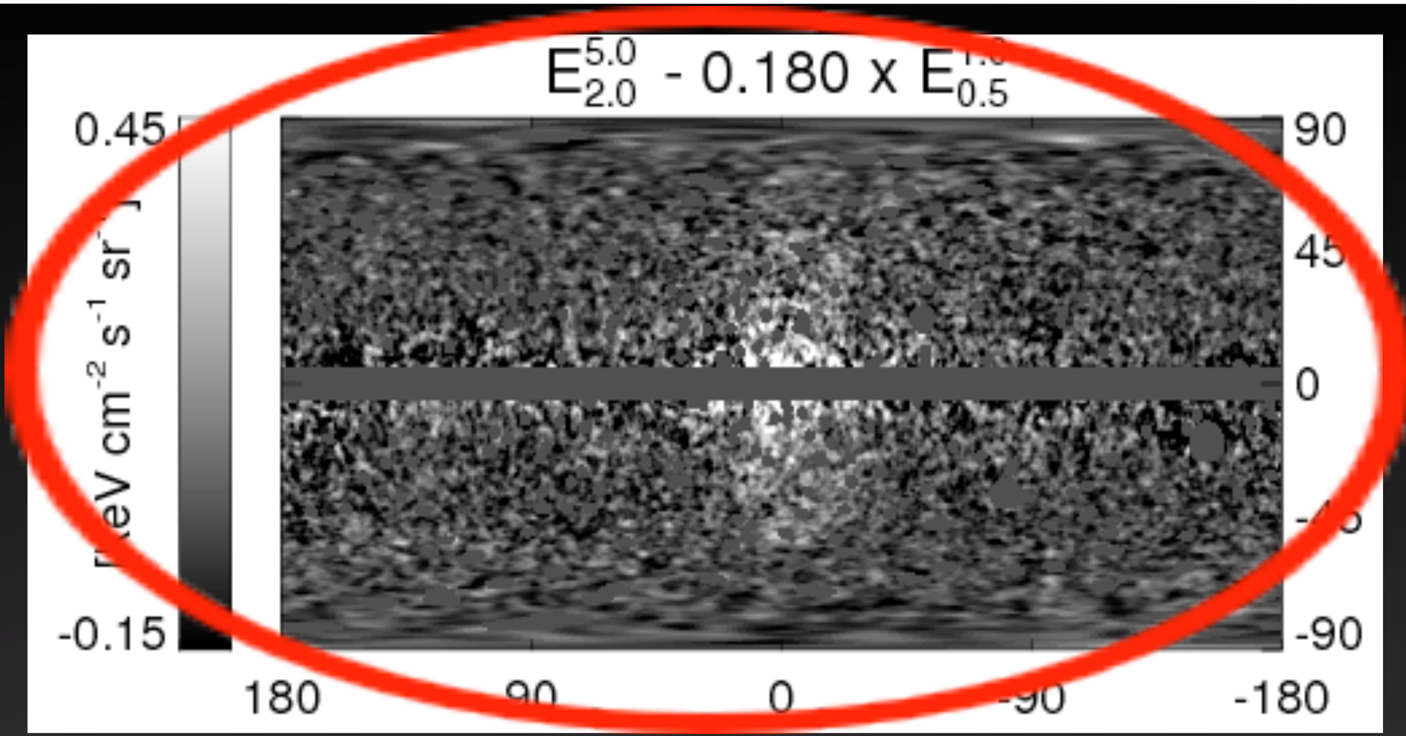


very little "pinching", but… slightly under-subtracted disk, noisier

significant "pinching", but… over-subtracted disk, less noisy



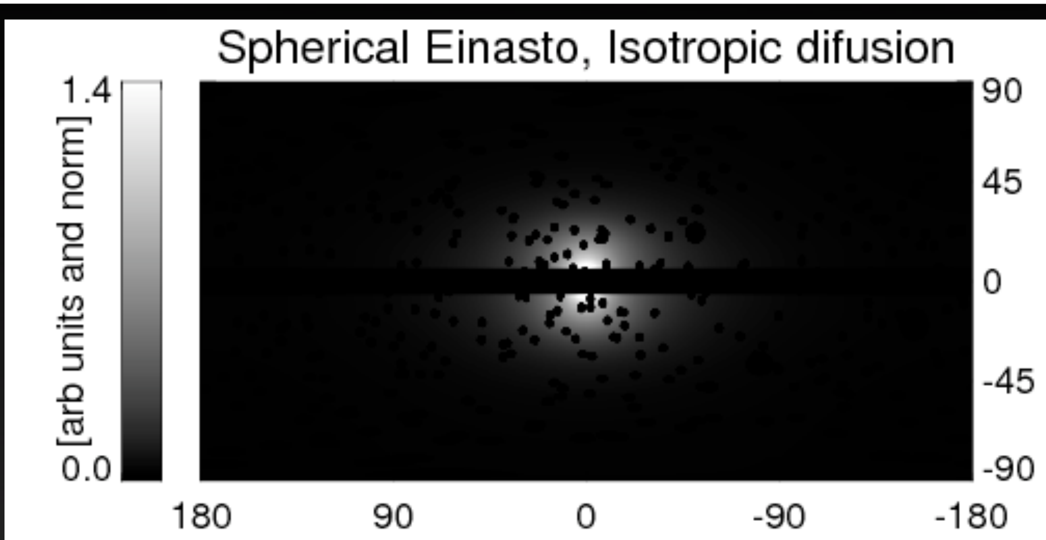
Fermi haze morphology



let's run with this one for now...

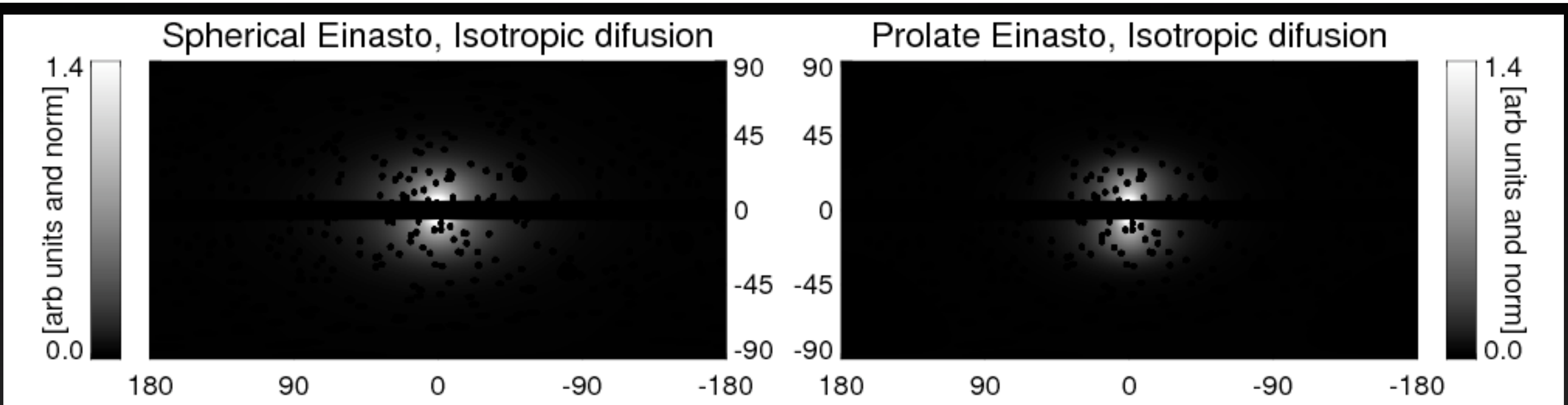
does an IC signal from DM annihilation electrons produce this shape???

dark matter IC morphology



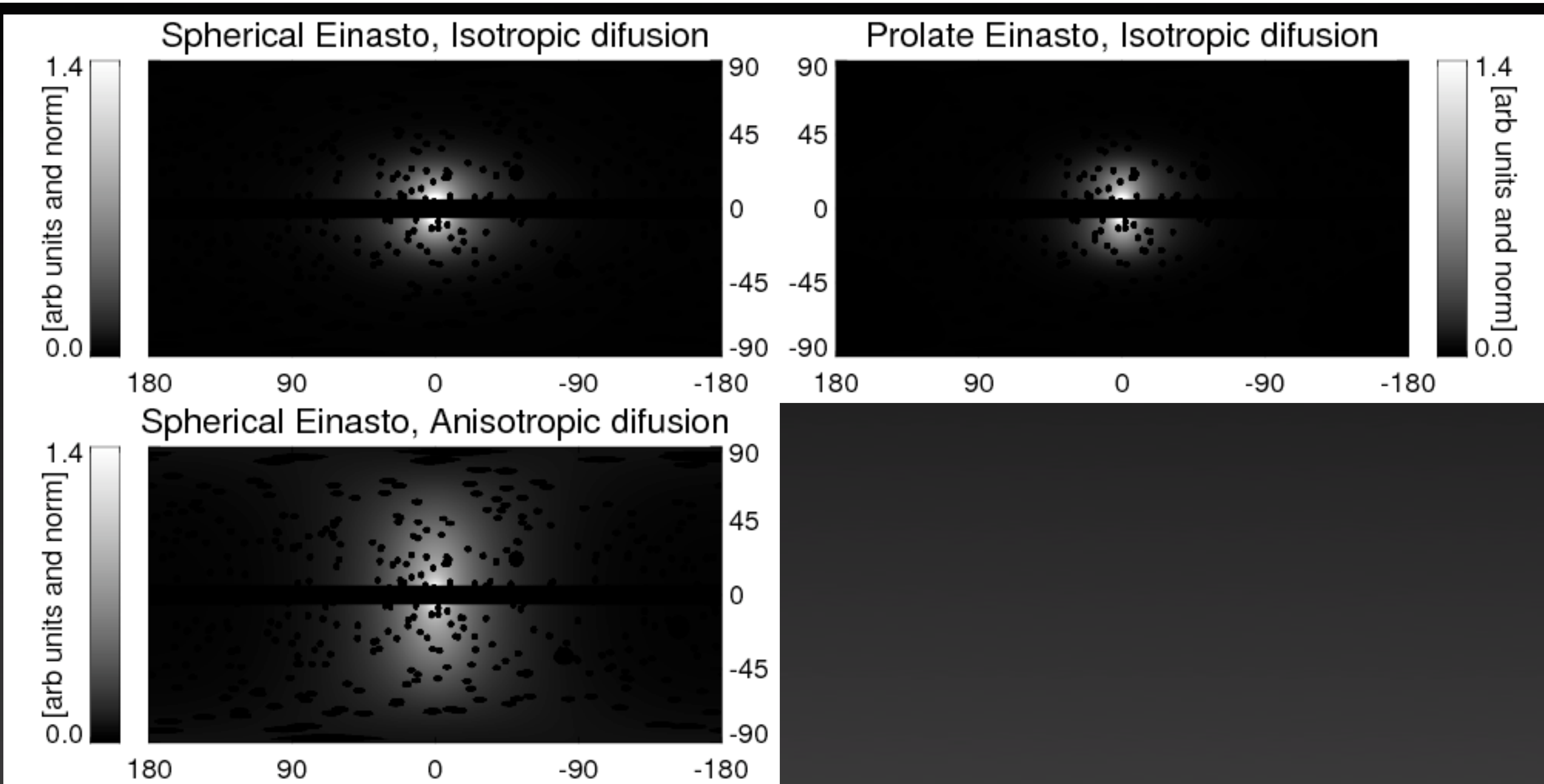
not for "typical" diffusion parameters, but...

dark matter IC morphology



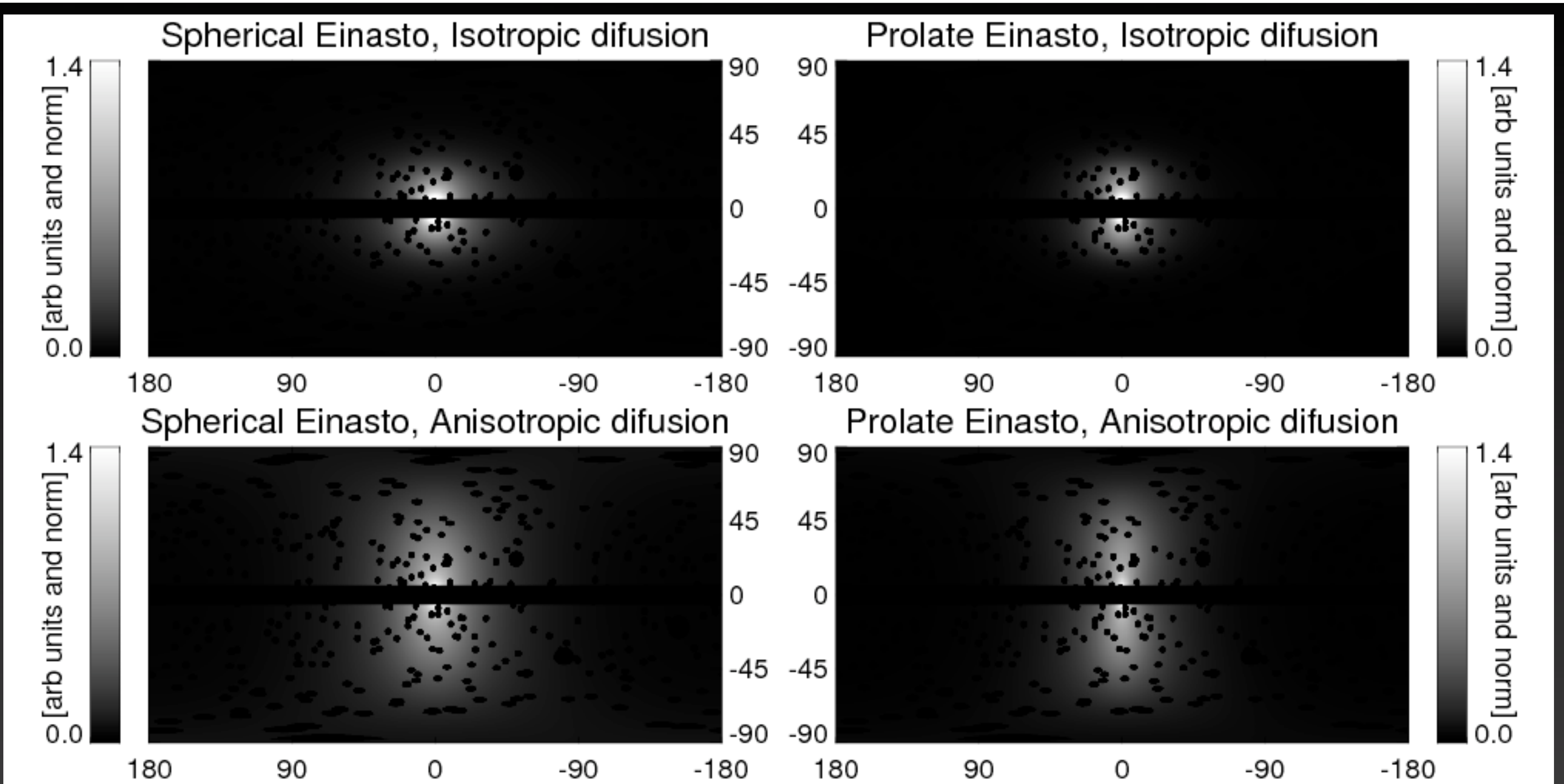
not for “typical” diffusion parameters, but...

dark matter IC morphology



not for “typical” diffusion parameters, but...

dark matter IC morphology



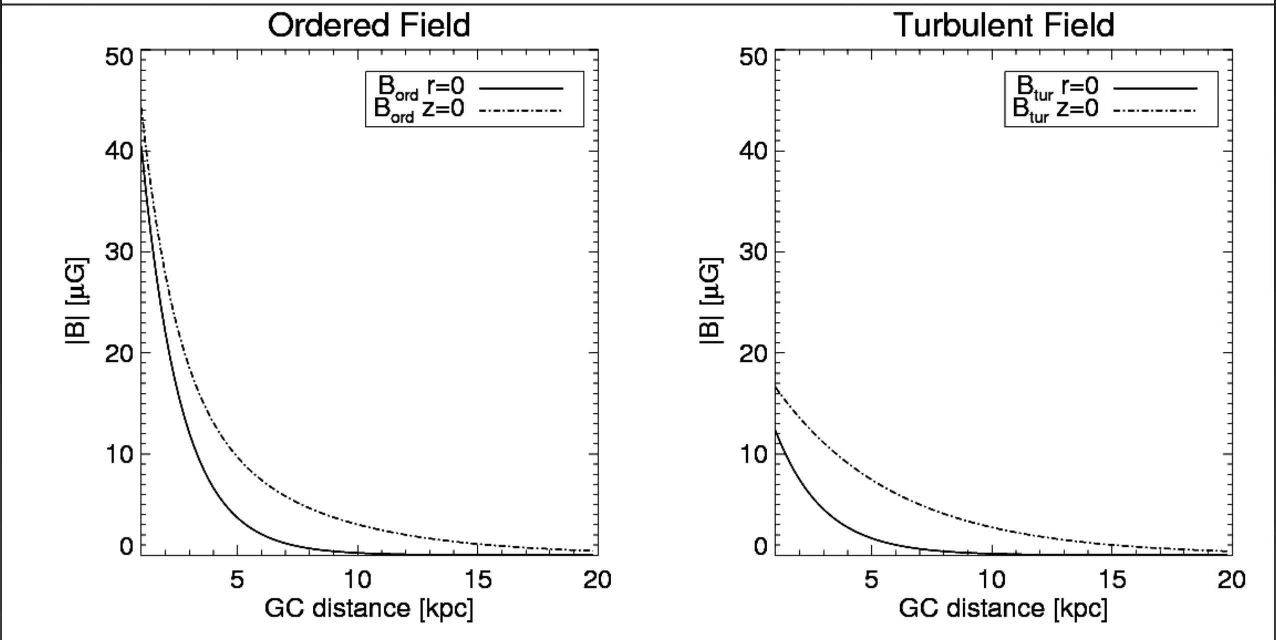
not for "typical" diffusion parameters, but...
for anisotropic diffusion **yes**!!!

anisotropic diffusion via ordered fields

electrons travel along **ordered** magnetic fields, we motivate anisotropic diffusion by including both turbulent and ordered components:

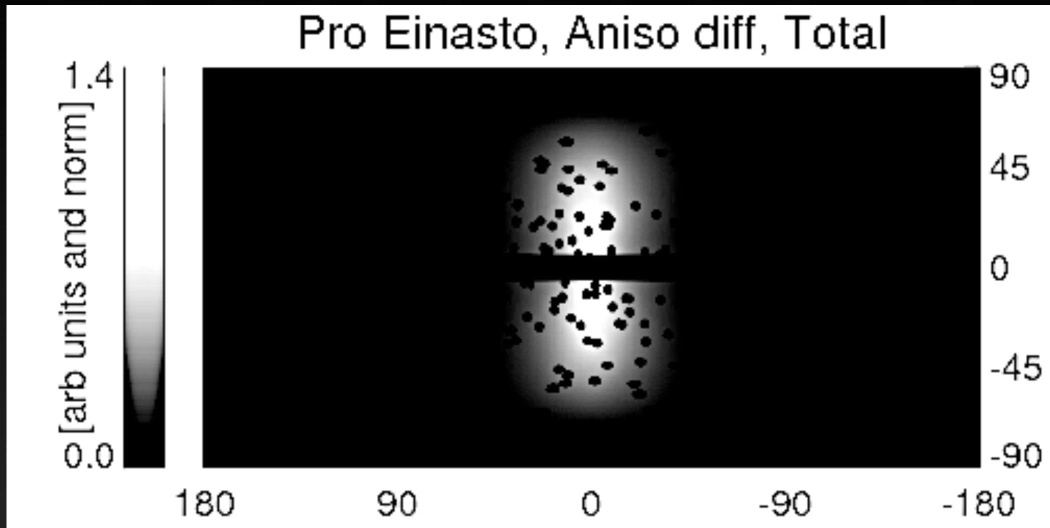
$$B_{\rm ord} = 22\mu{\rm G}\ e^{-r/5-|z|/2}\left(1+2.4\ e^{-r/2-|z|/6}\right)$$

$$B_{\rm tur} = 3.7\mu{\rm G}\ e^{-(r-R_\odot)/5-|z|/2}$$

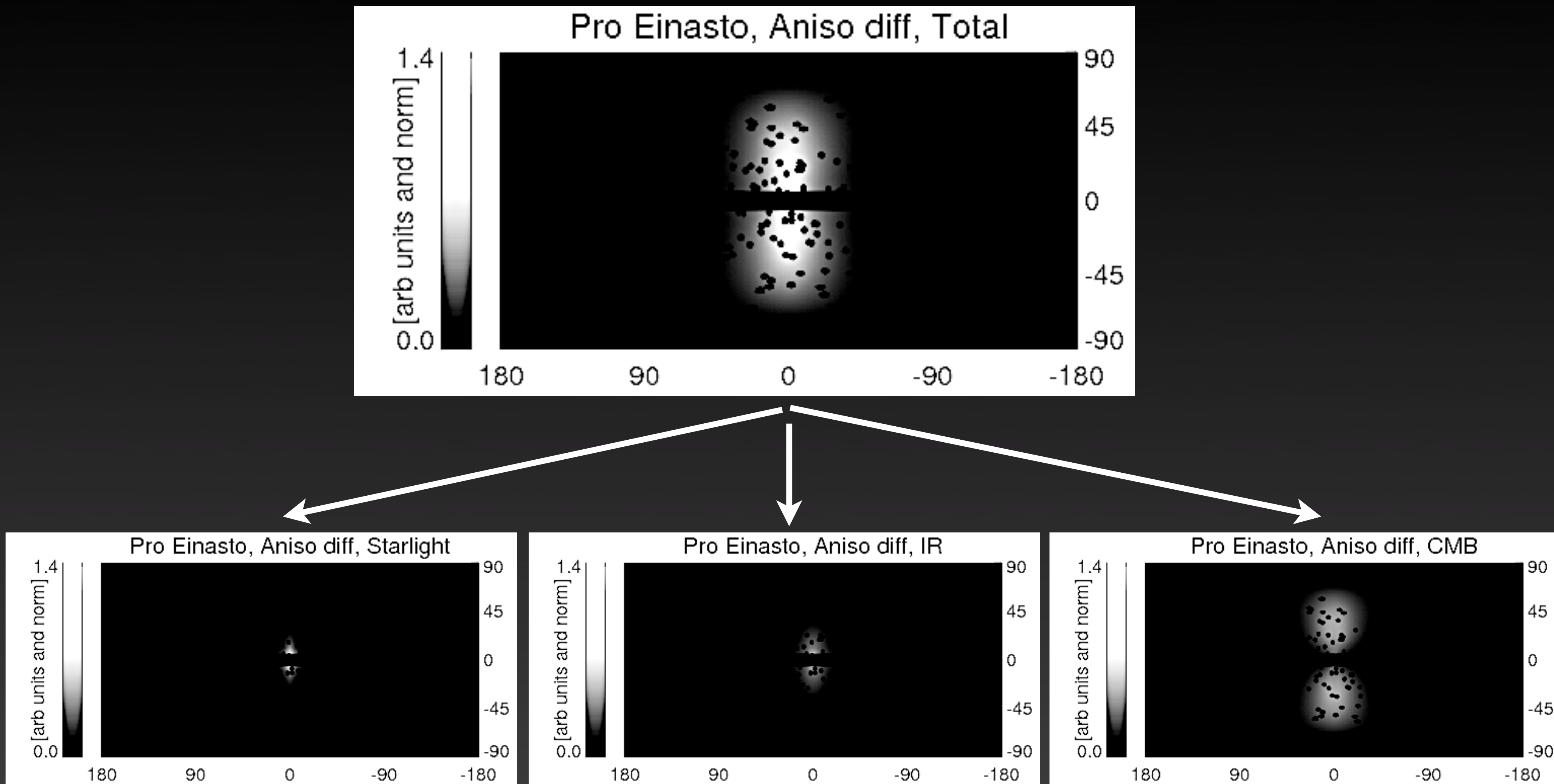


diffusion coefficients along *r* and *z* are related to the ratio of ordered vs turbulent field

three IC components

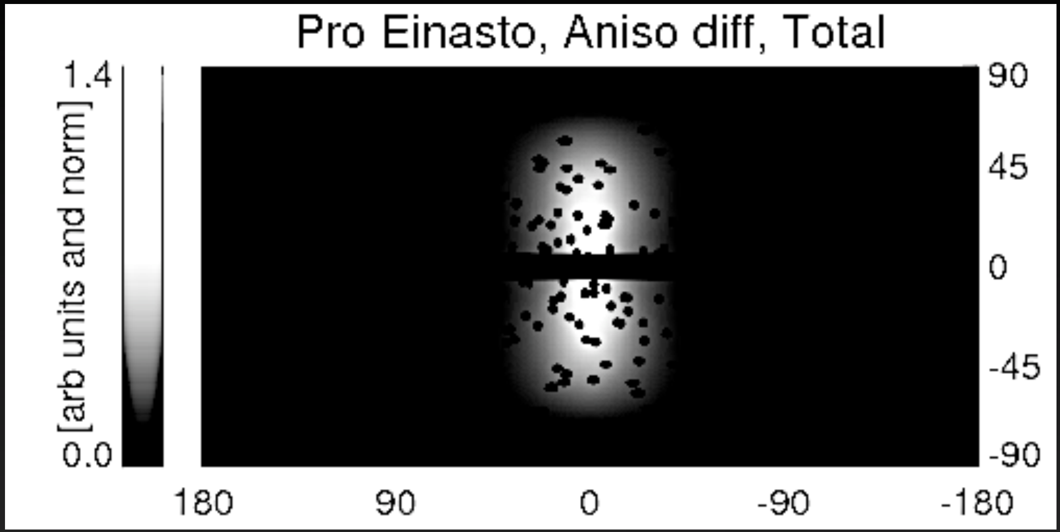


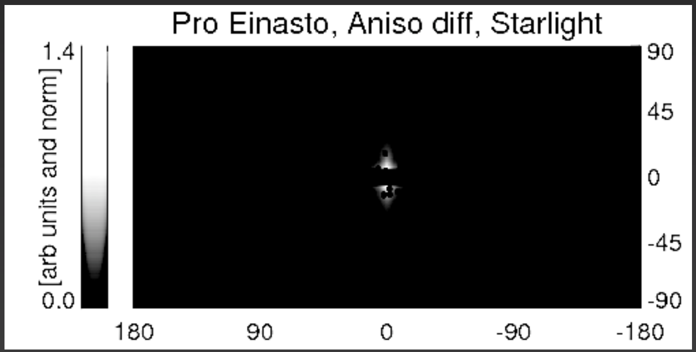
three IC components

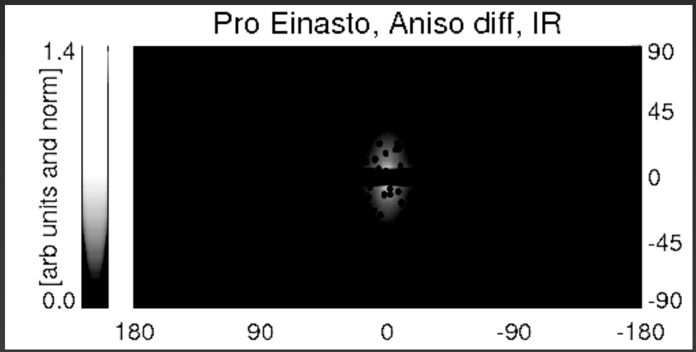


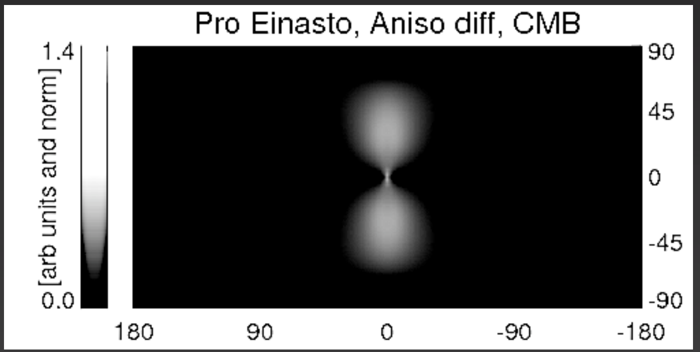
starlight IC + infrared IC + CMB IC

three IC components





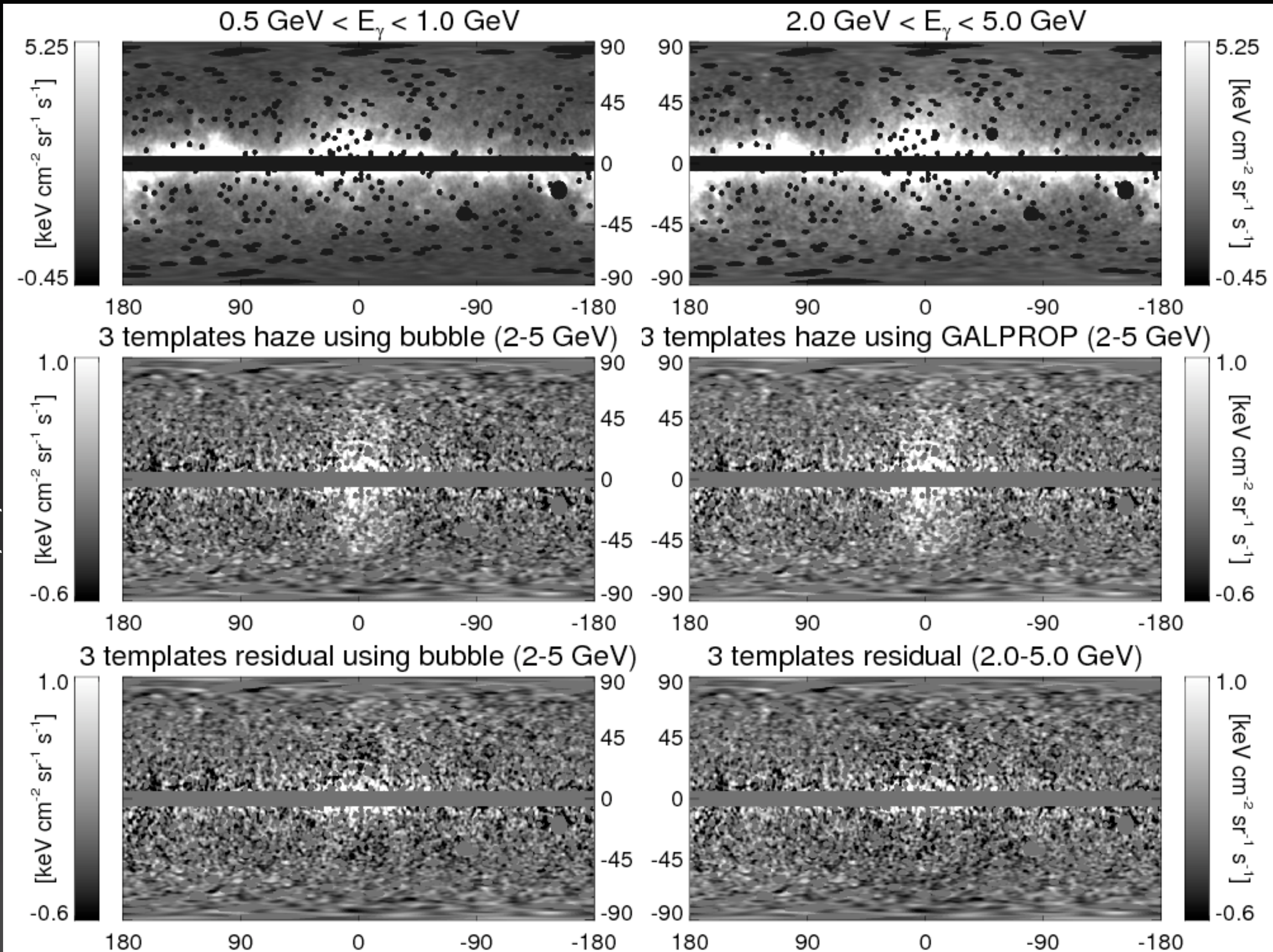




starlight IC + infrared IC + CMB IC

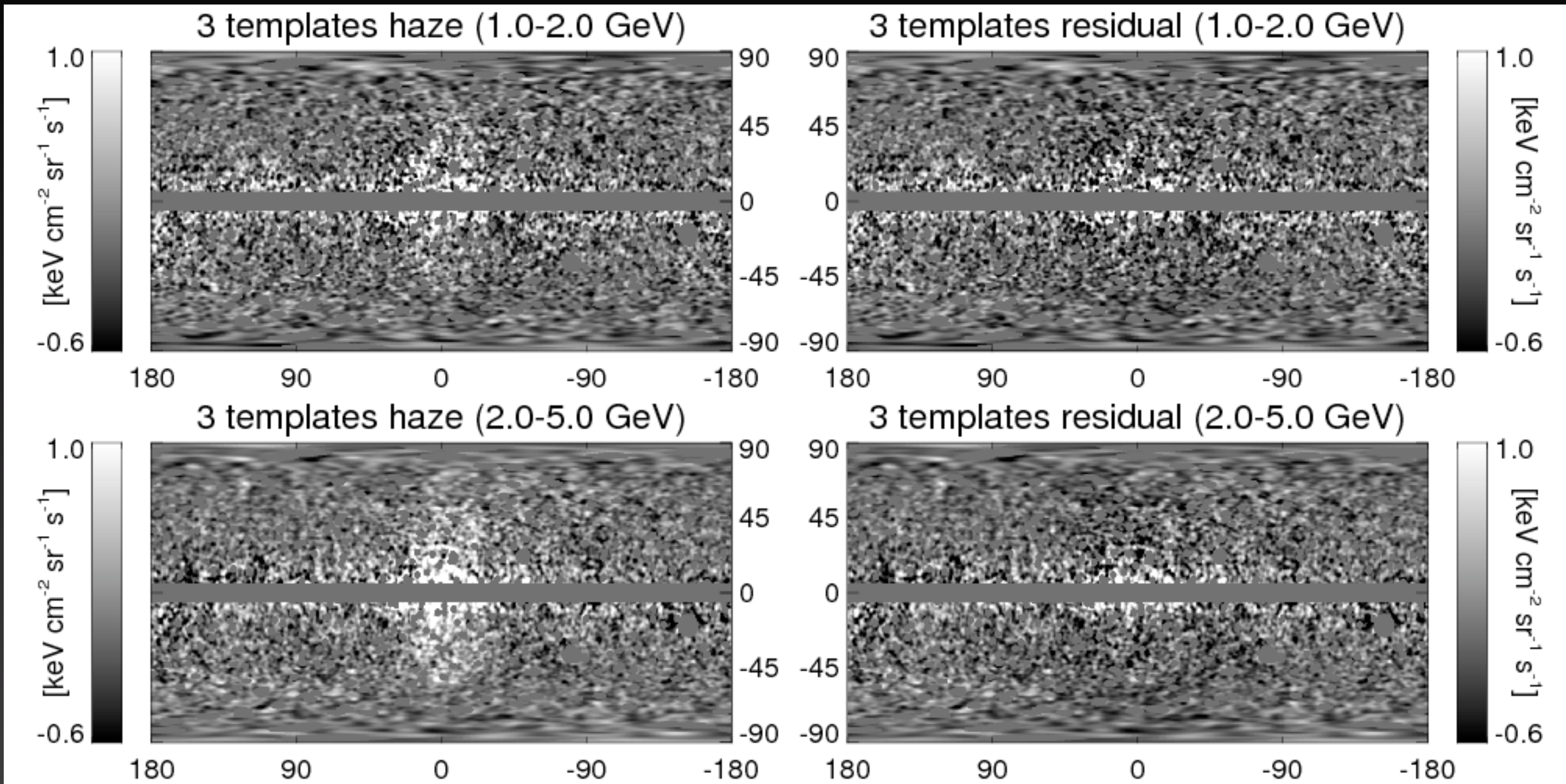
template fitting ***may*** "soak up" star and IR components leaving a more hourglass-like shape...

Fermi haze residuals



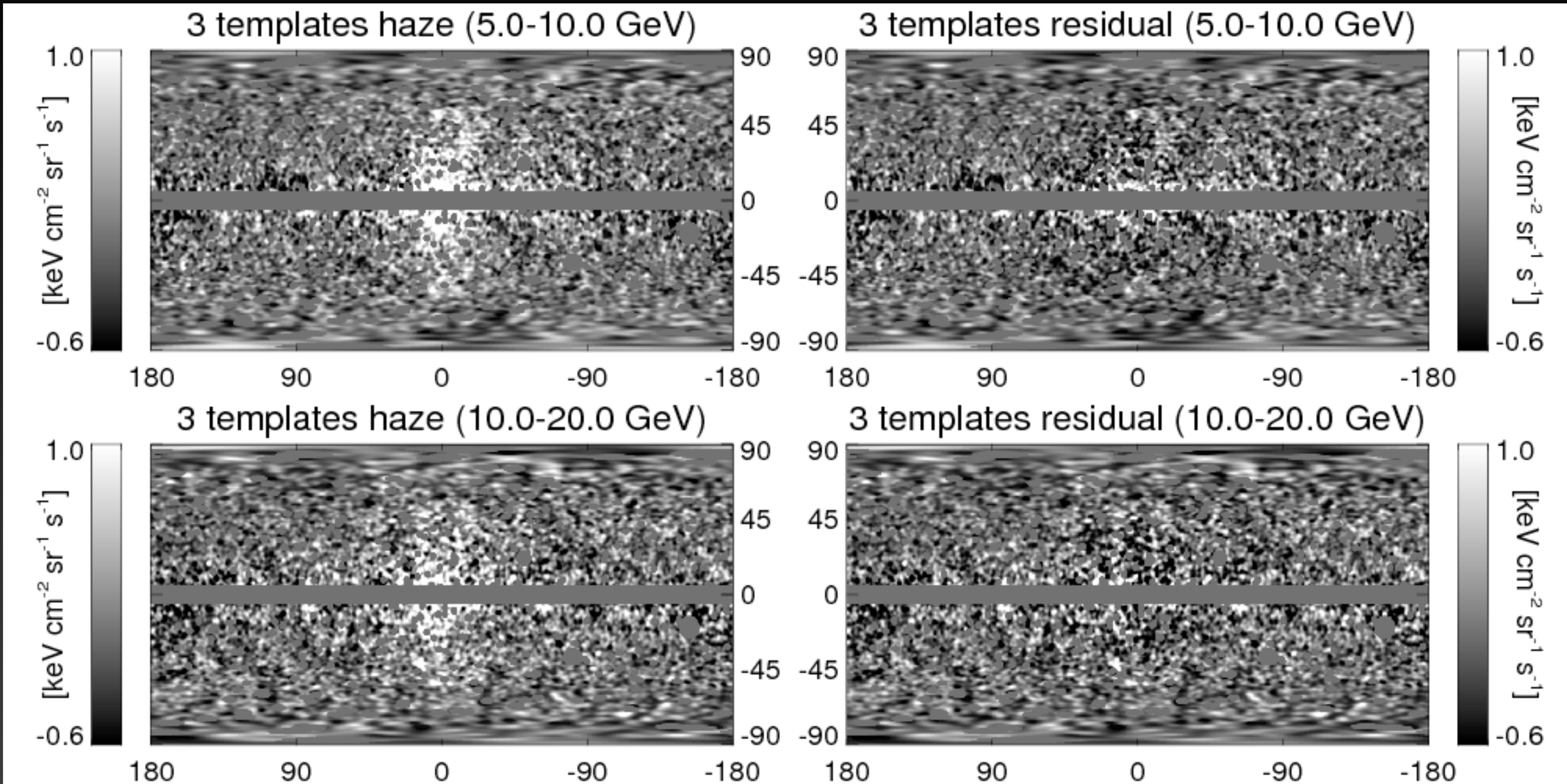
Cholis, Dobler, & Weiner, in prep

Fermi haze residuals



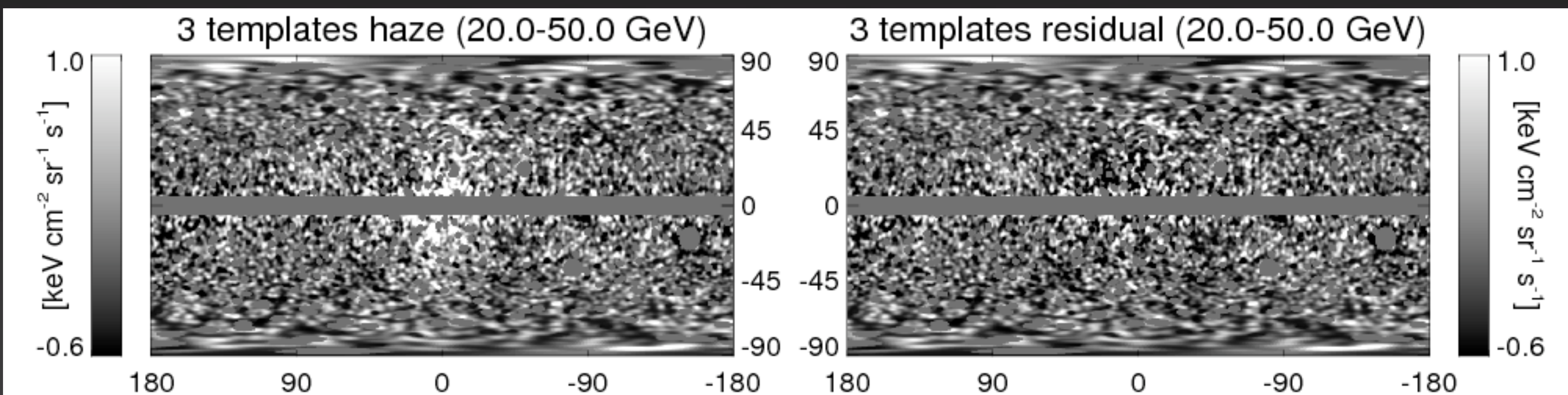
Cholis, Dobler, & Weiner, in prep

Fermi haze residuals



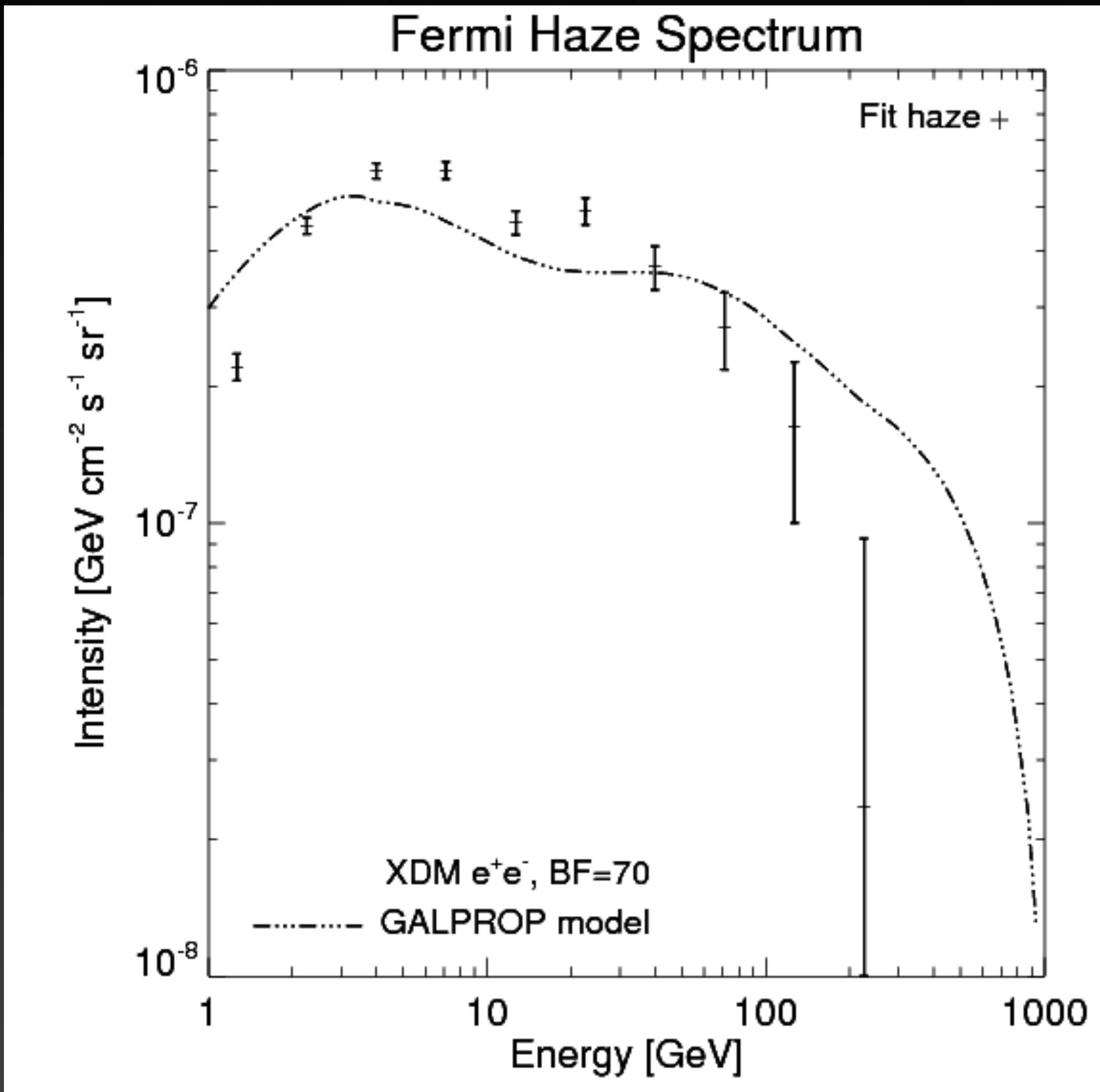
Cholis, Dobler, & Weiner, in prep

Fermi haze residuals



Cholis, Dobler, & Weiner, in prep

Fermi haze spectrum



Cholis, Dobler, & Weiner, in prep

- anisotropic diffusion
- prolate Einasto, $q=2/3$
- $M\chi=1.2$ TeV, XDM, $\chi\chi \rightarrow e^+e^-$
- Sommerfeld boost = 70

conclusions

- the *Fermi* haze has two unique features:
  . morphology (elongated in *b* with respect to *l*)
  . spectrum (harder than elsewhere in the Galaxy)

- particle DM models can reproduce the spectrum of IC emission and amplitude with cross-section enhancement

- morphology is more subtle but doable
  . a spherical DM halo with isotropic diffusion provides a poor fit
  . a prolate DM halo with anisotropic diffusion provides a reasonable fit

- outstanding issues:
  . upper/lower "edge" (the ***most*** tricky part!!!)
  . morphology (bubbles? oval? templates to use?)
  . synchrotron polarization