Dark Gas in the Translucent Cloud MBM 12

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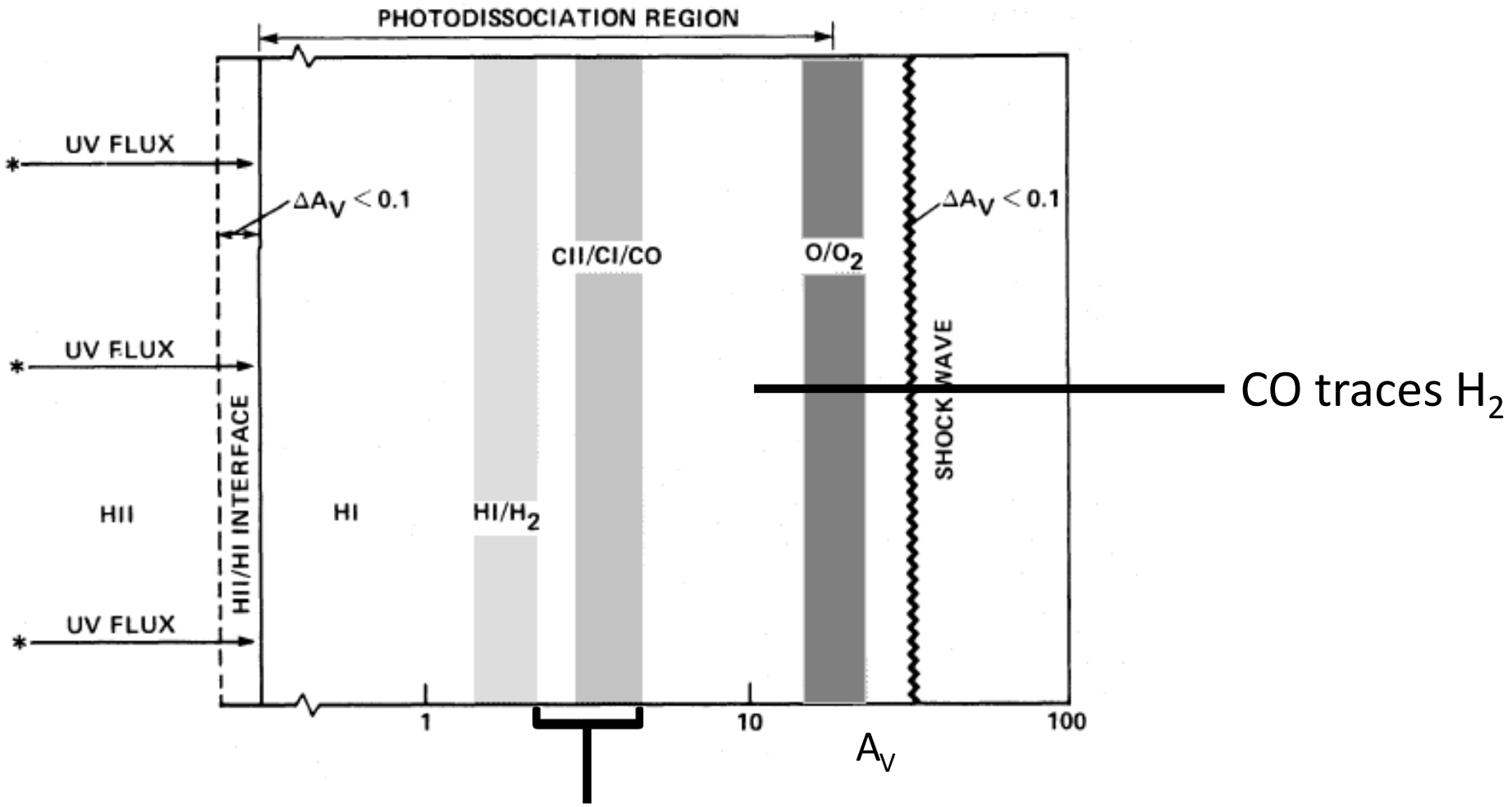
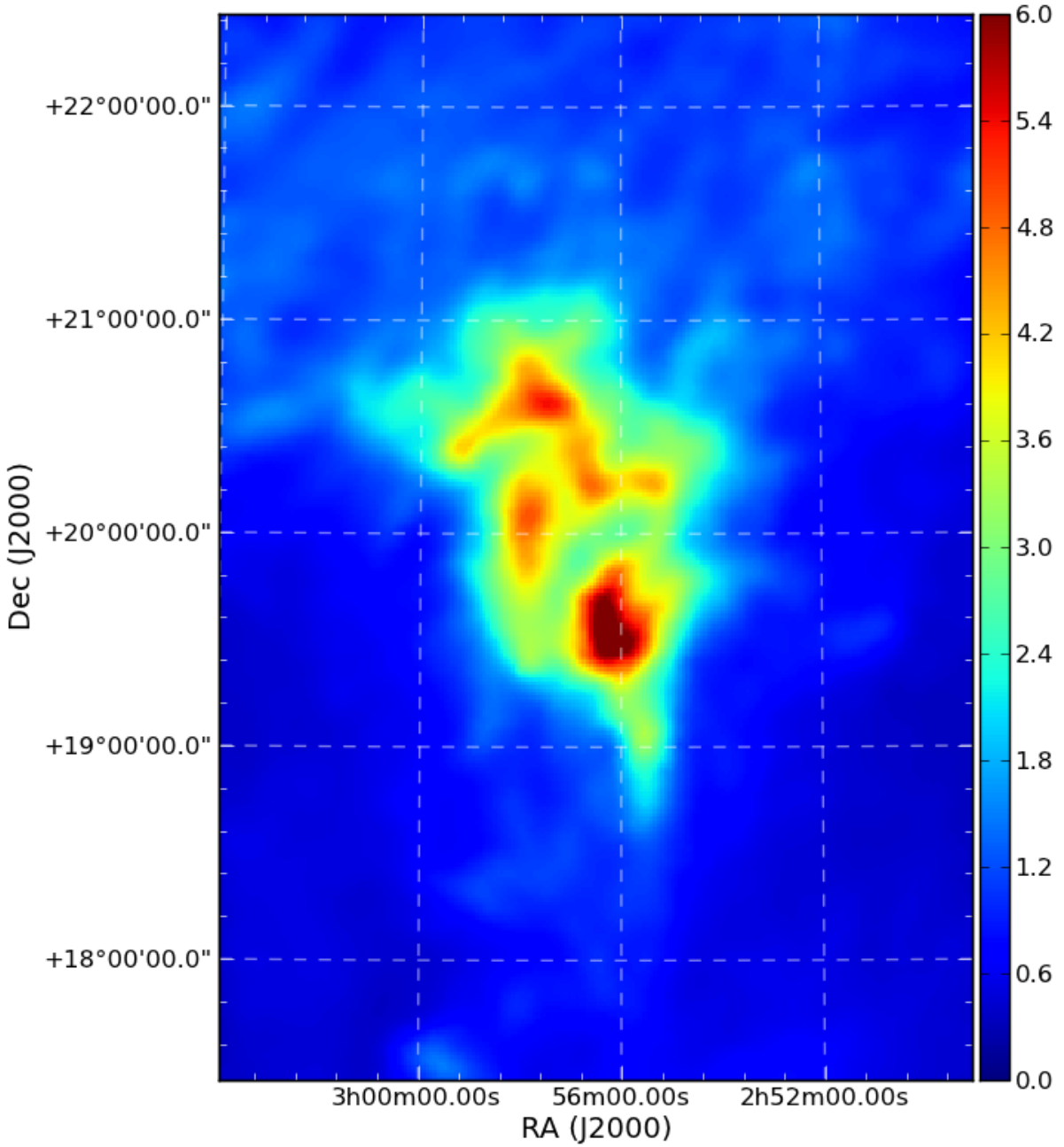
Dark gas is unseen molecular hydrogen



(Teilens & Hollenbach 1985)

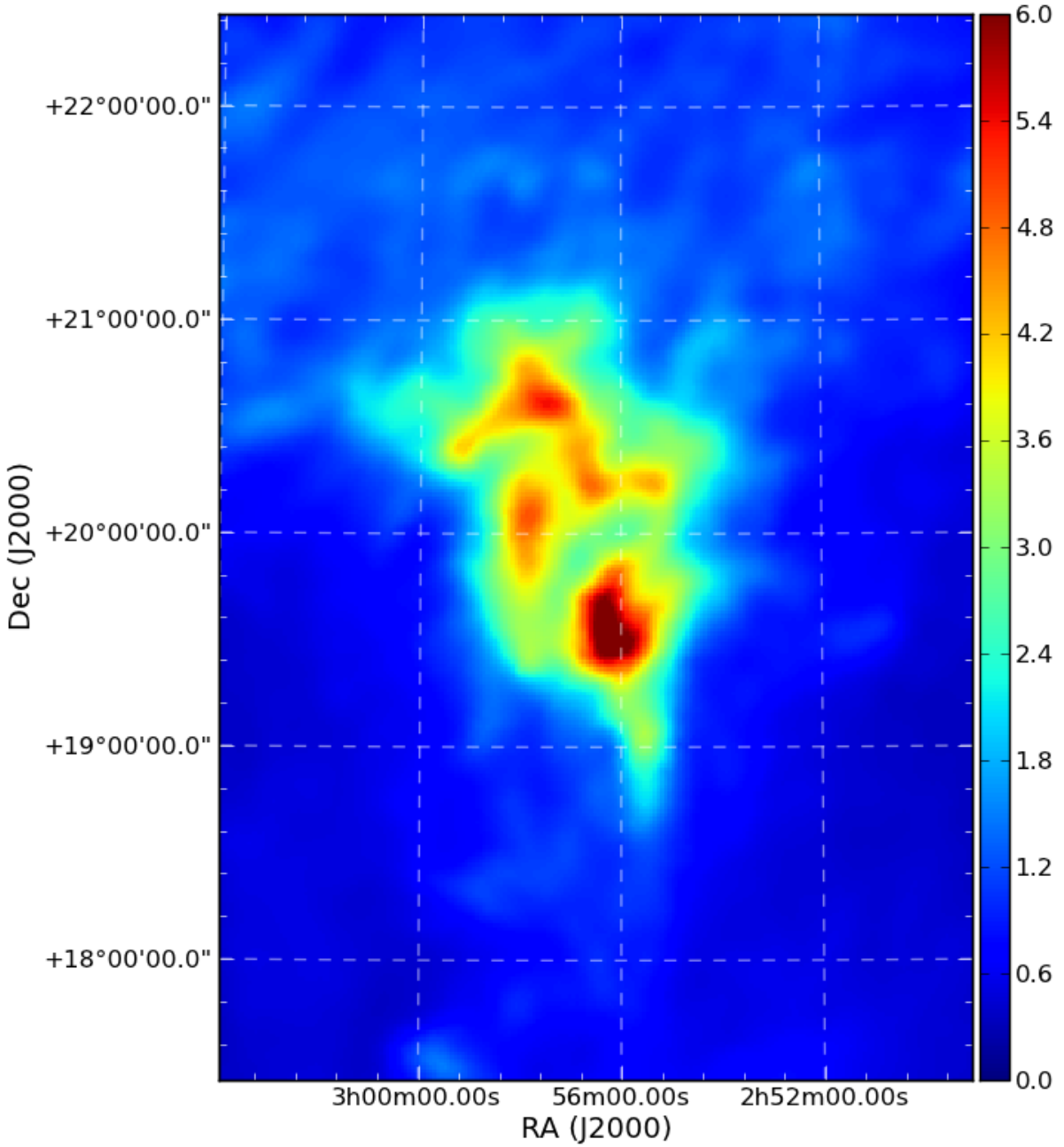
MBM 12 should emphasize the dark gas phenomenon.

Visual extinction map, from SFD 1998. Much of the cloud is in the transition region from atomic to molecular gas.

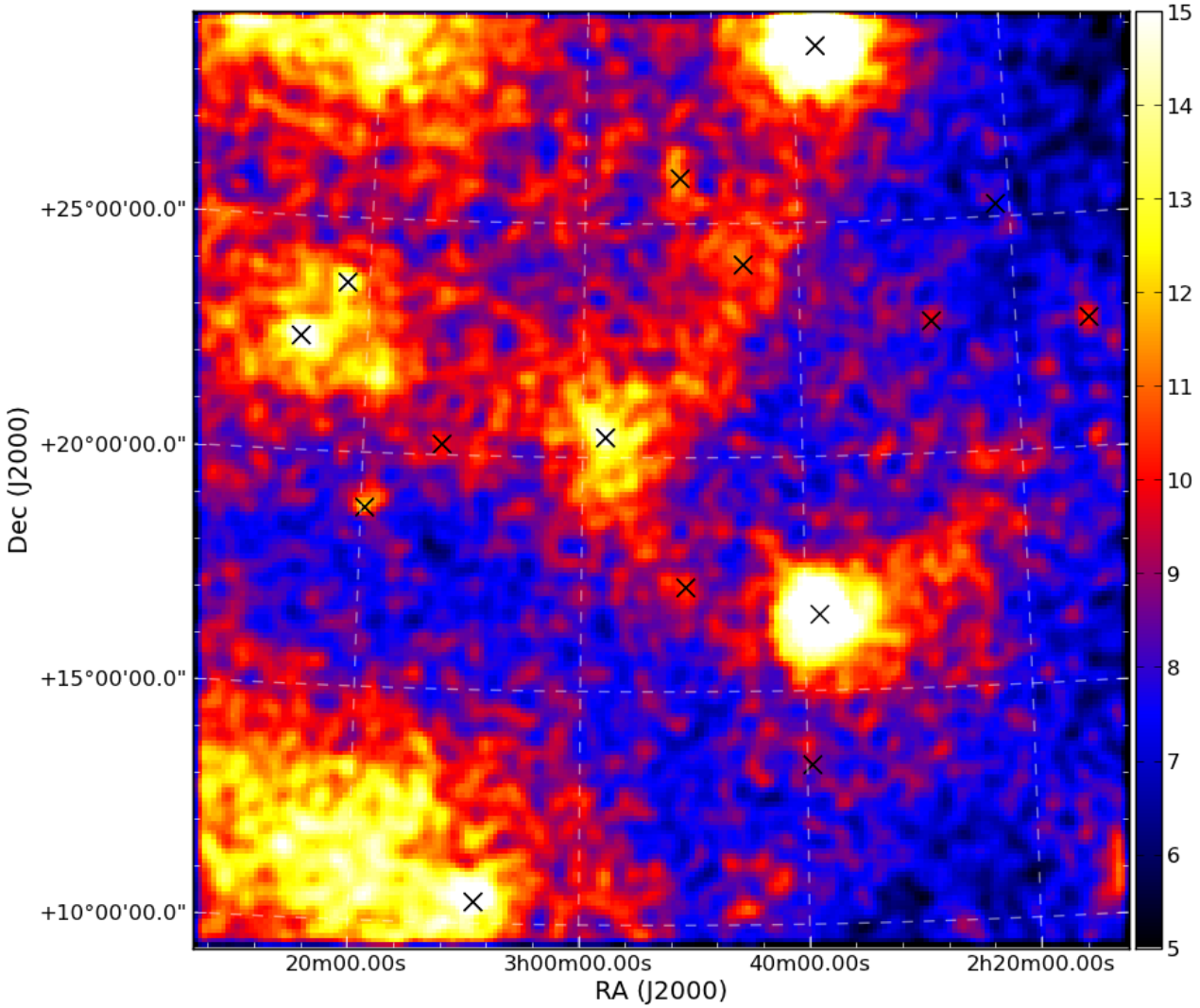


MBM 12 is far from possible cosmic ray accelerators.

No enhancement of gamma-rays due to different cosmic ray flux density.



MBM 12 is nearby; it is resolved by the Fermi-LAT



Gamma-ray counts map centered on MBM 12, (l,b) = (159.4, -34.3), with point sources marked.

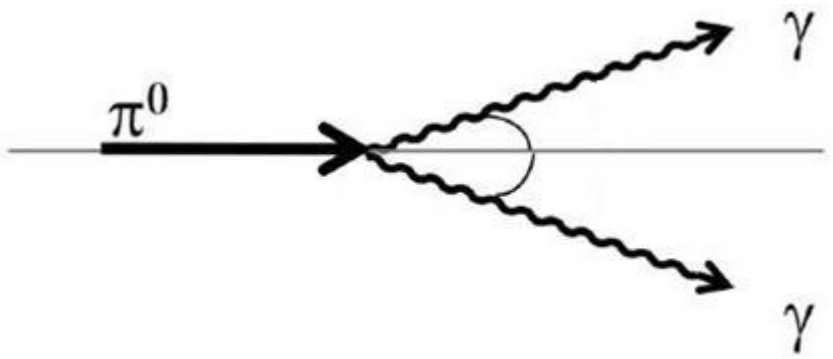
Gamma-rays trace ALL the gas mass

Primary emission mechanism is neutral pion decay, resulting from proton-proton collisions.

$$p + p \rightarrow \pi^0 \rightarrow \gamma\gamma$$

Cosmic ray

Ambient gas



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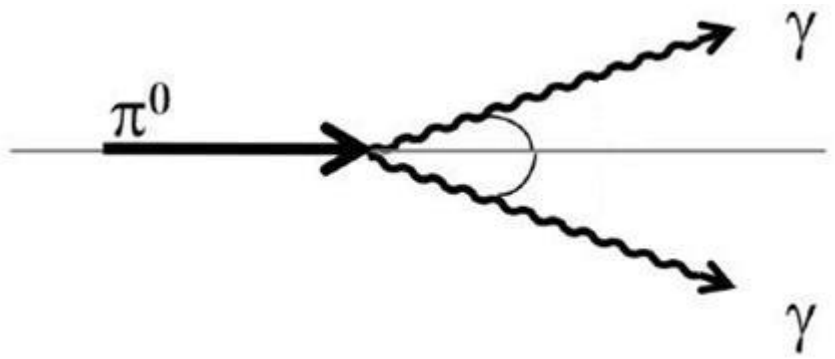
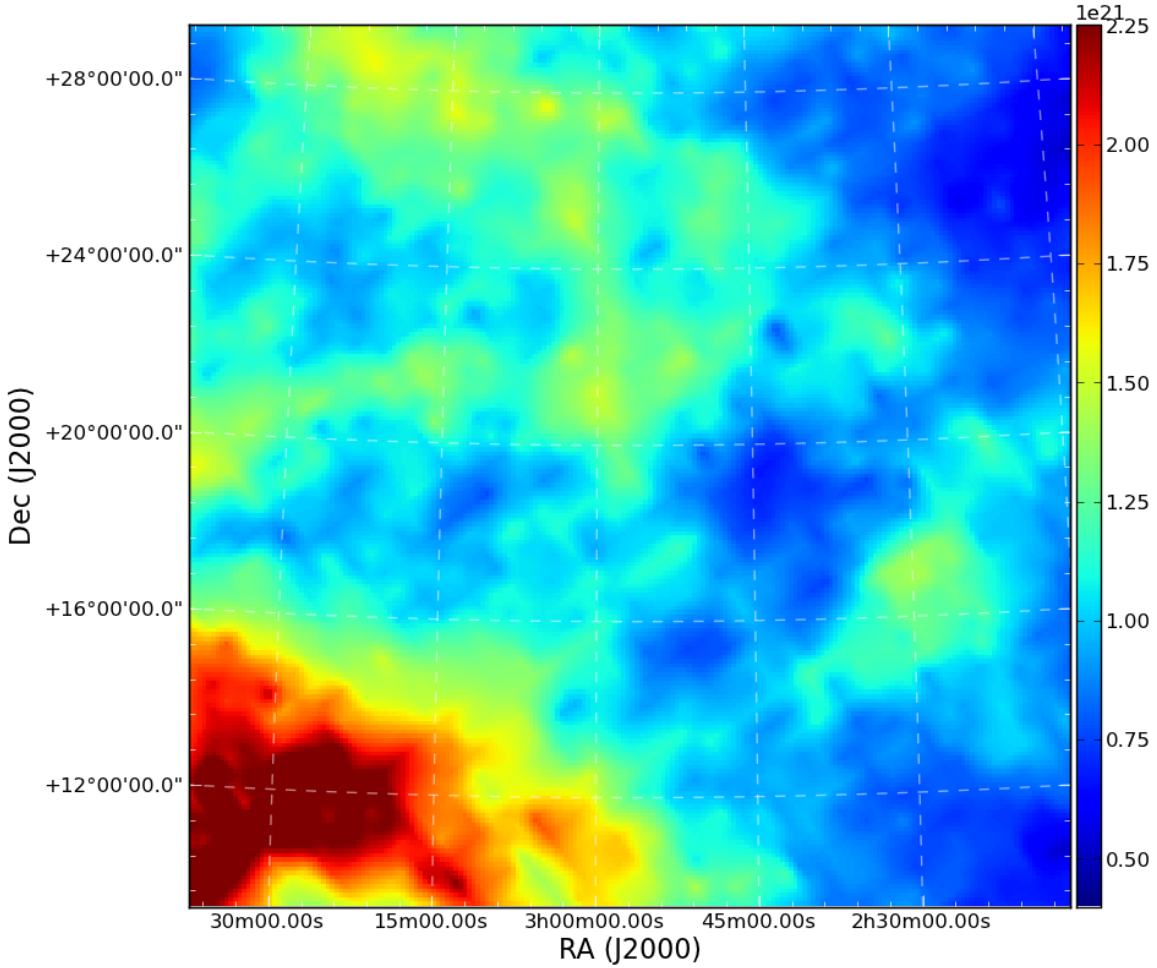


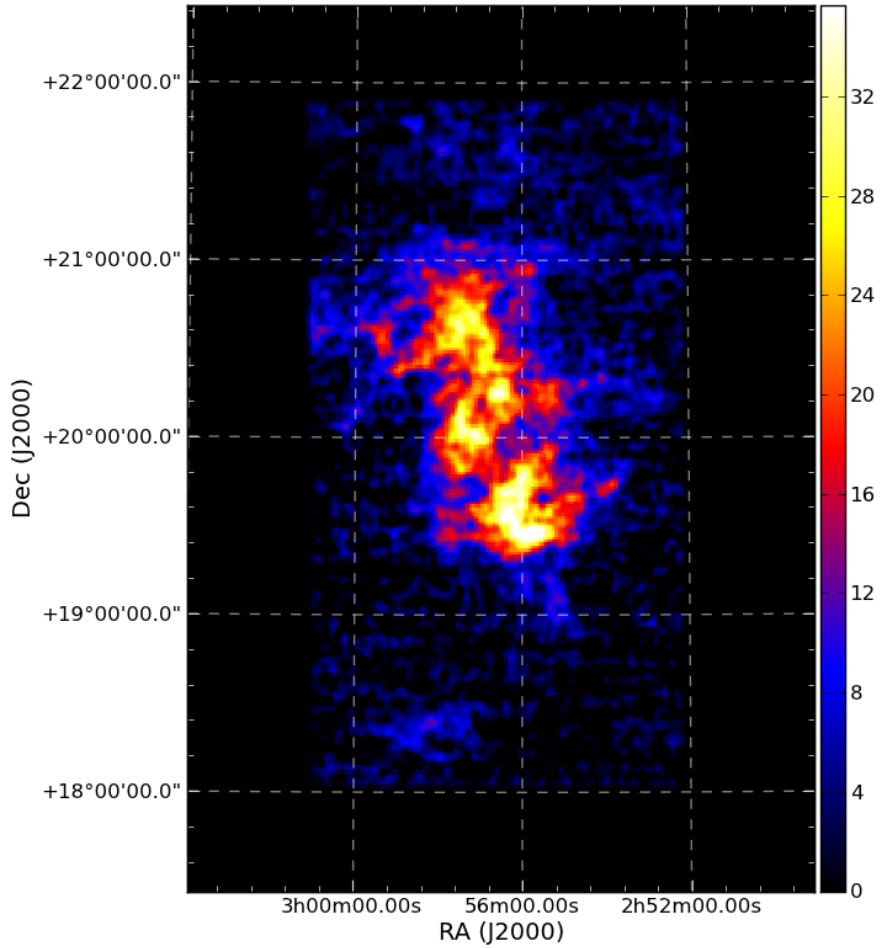
Put in all the gas into the model.

There are plenty of HI data but not a lot of CO data.

HI 21 cm,
LAB survey (Kalberla 2005)



CO(1-0)
(Moriarty-Schieven 1997)



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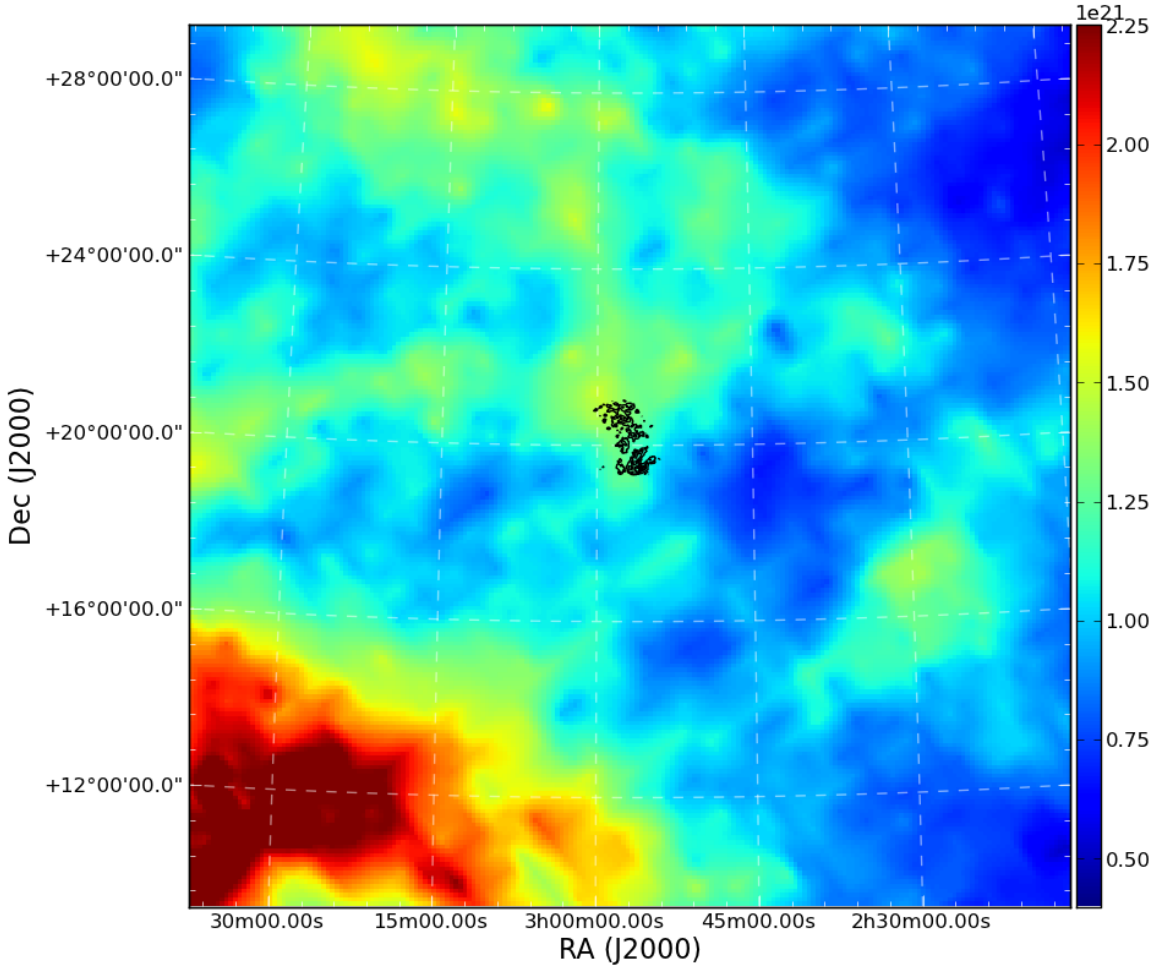

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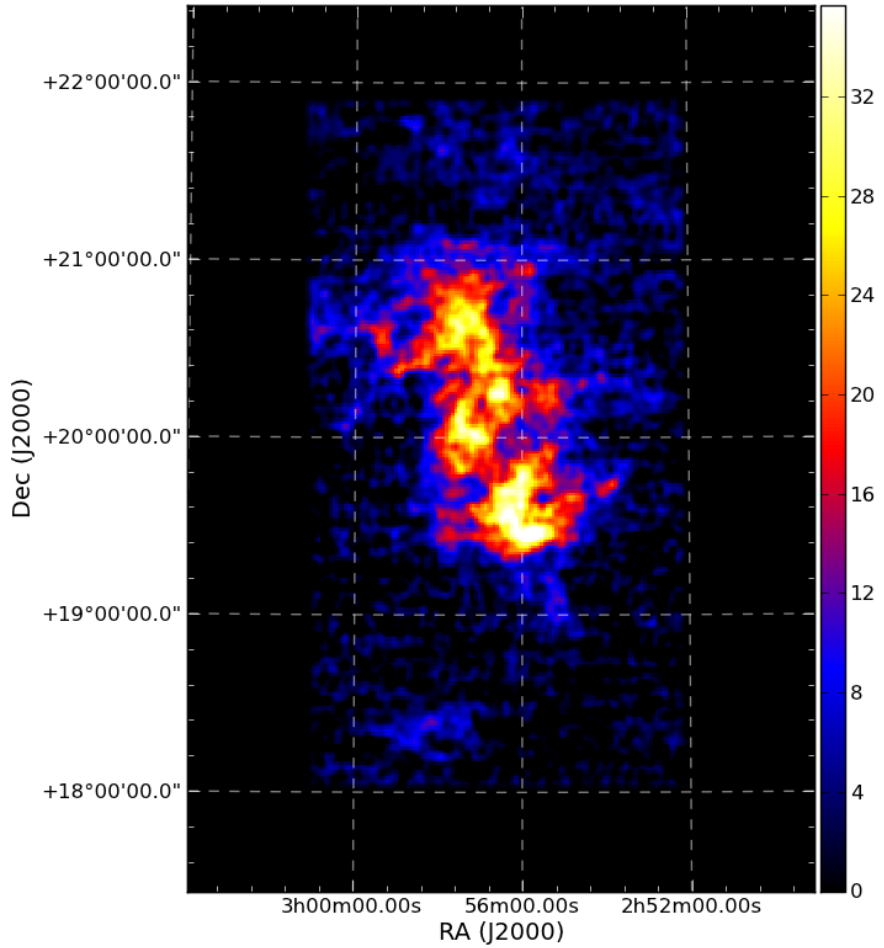

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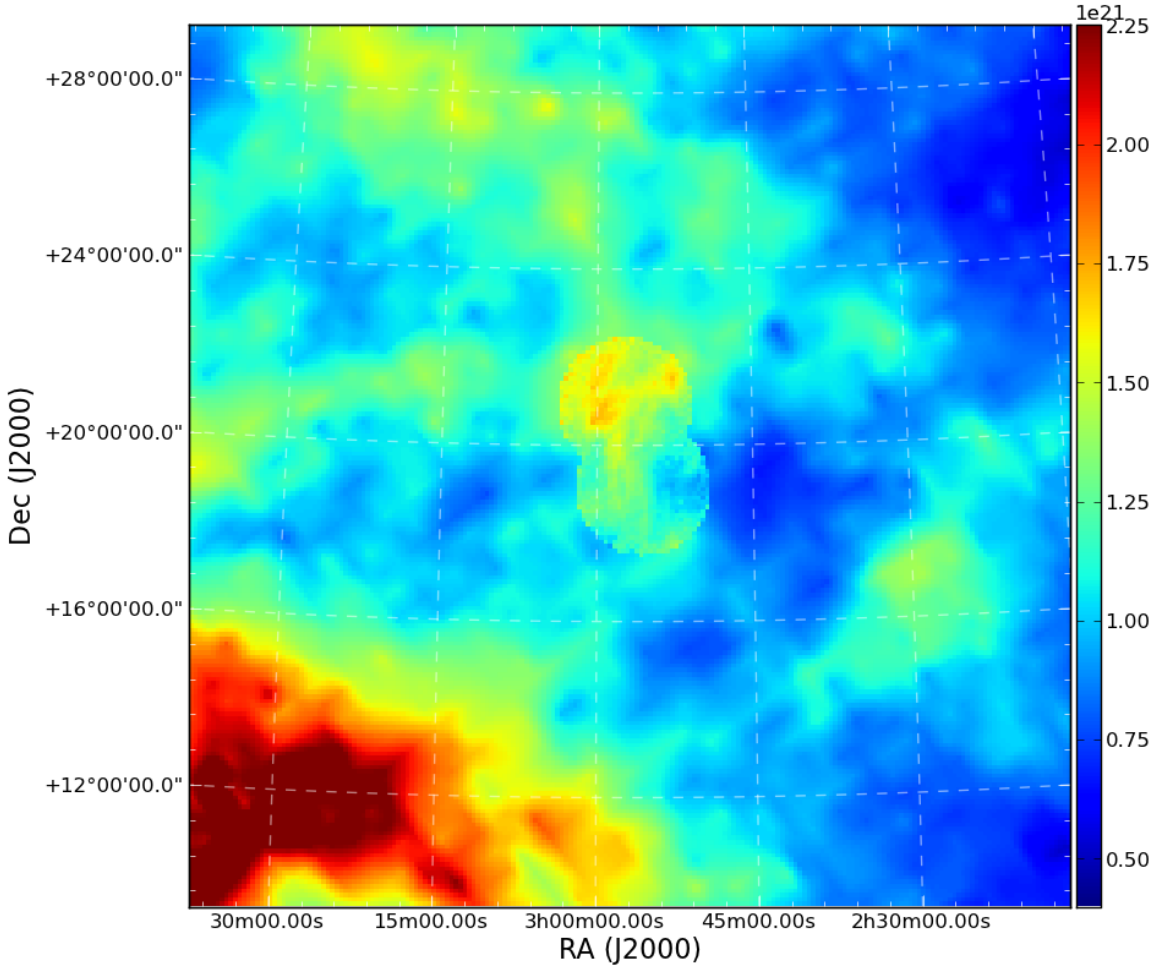

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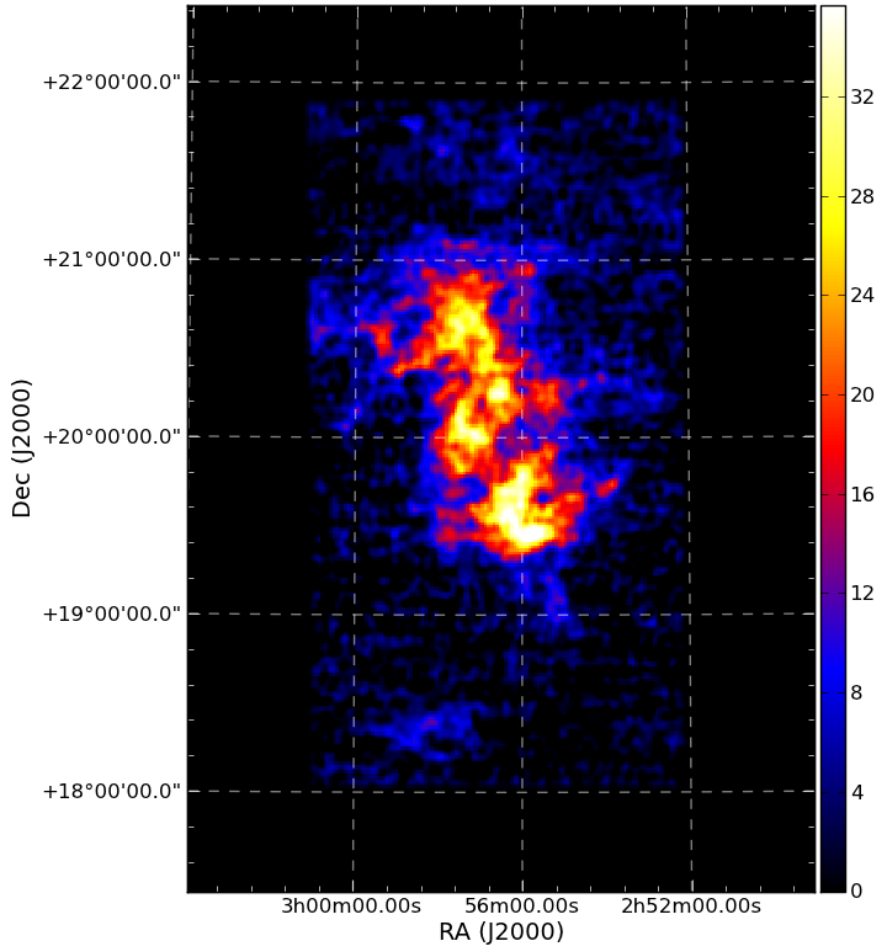

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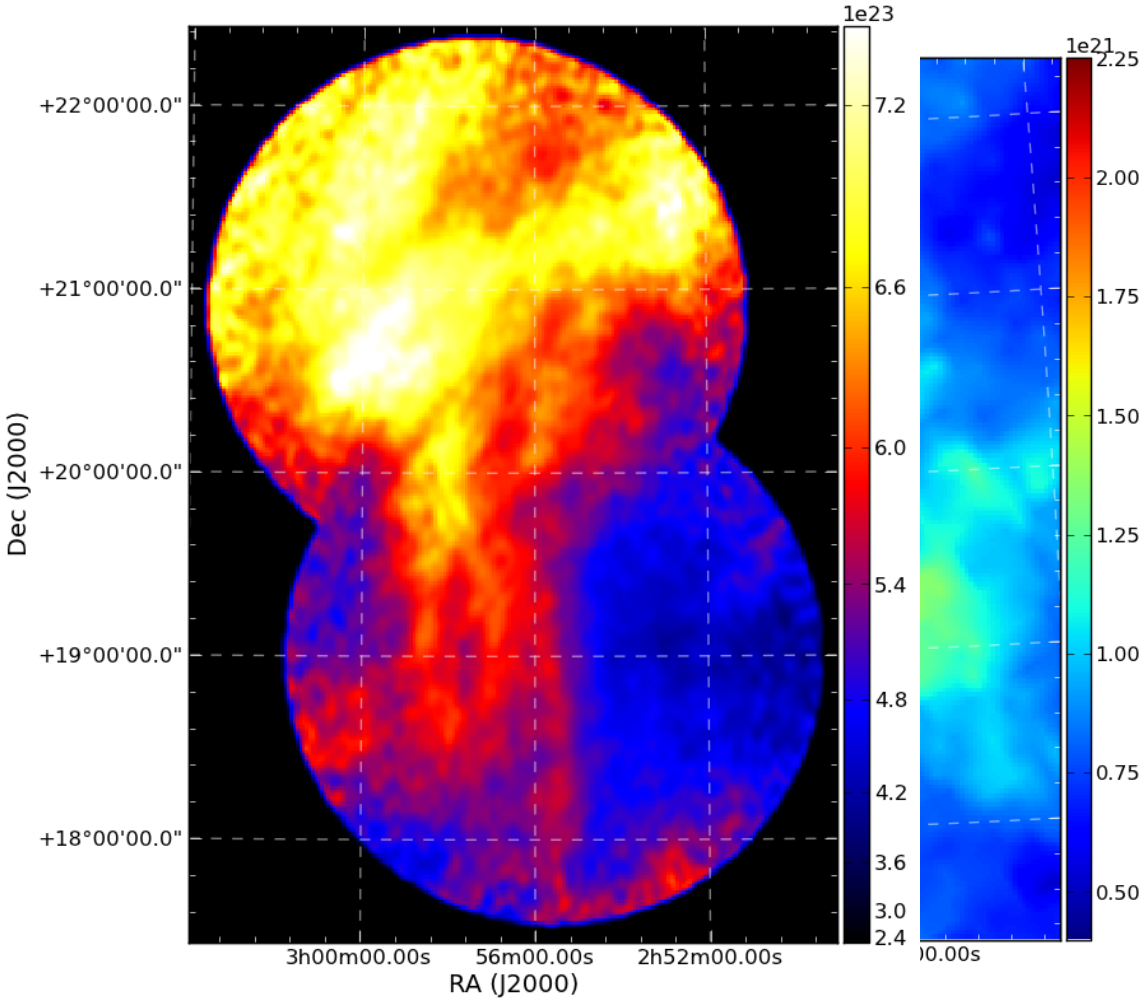

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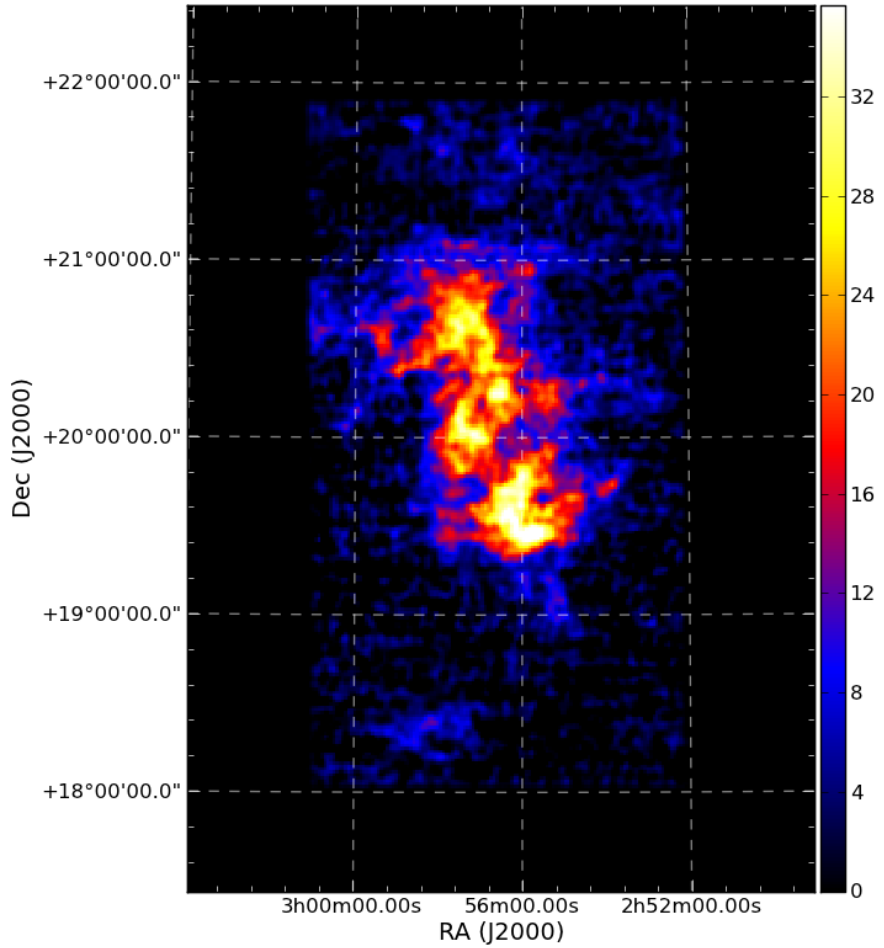
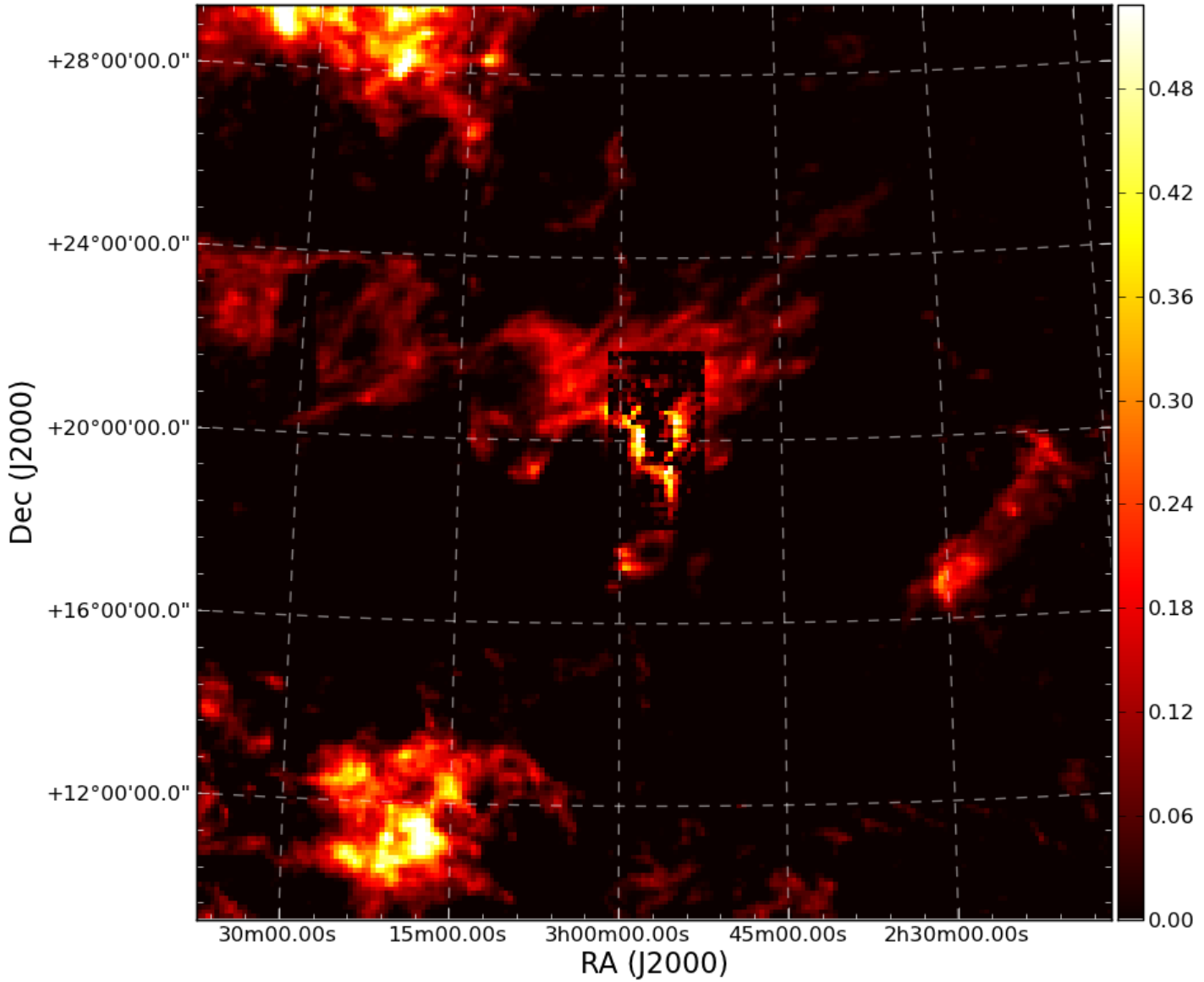


HI and CO does NOT trace the entire gas mass

Visual extinction (A_V) used to trace total mass.

Remove contribution from HI and CO: $A_{V,res}$.

$$E(B\text{-}V) - R^{-1}(N(HI) + q*W_{CO})$$



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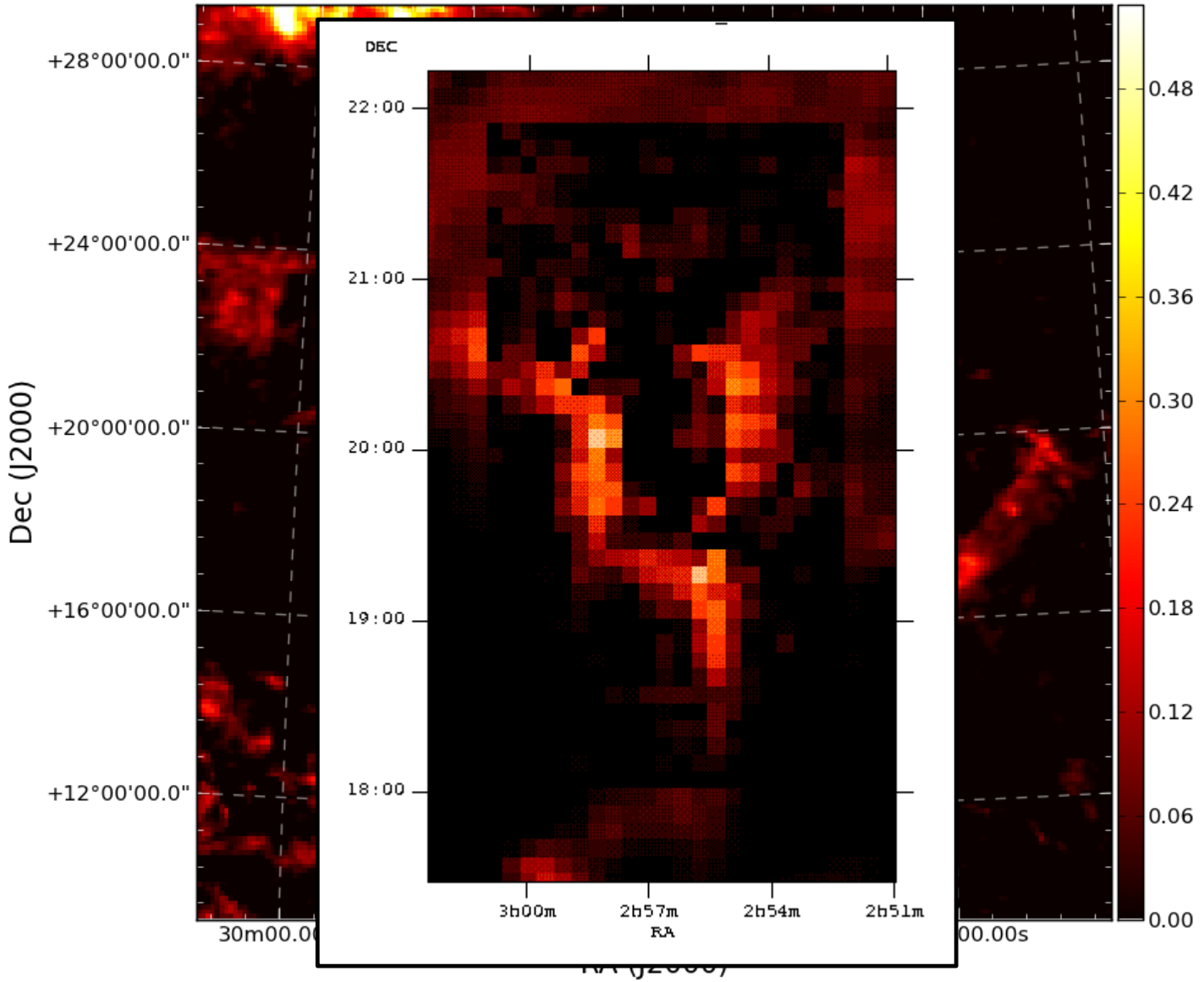
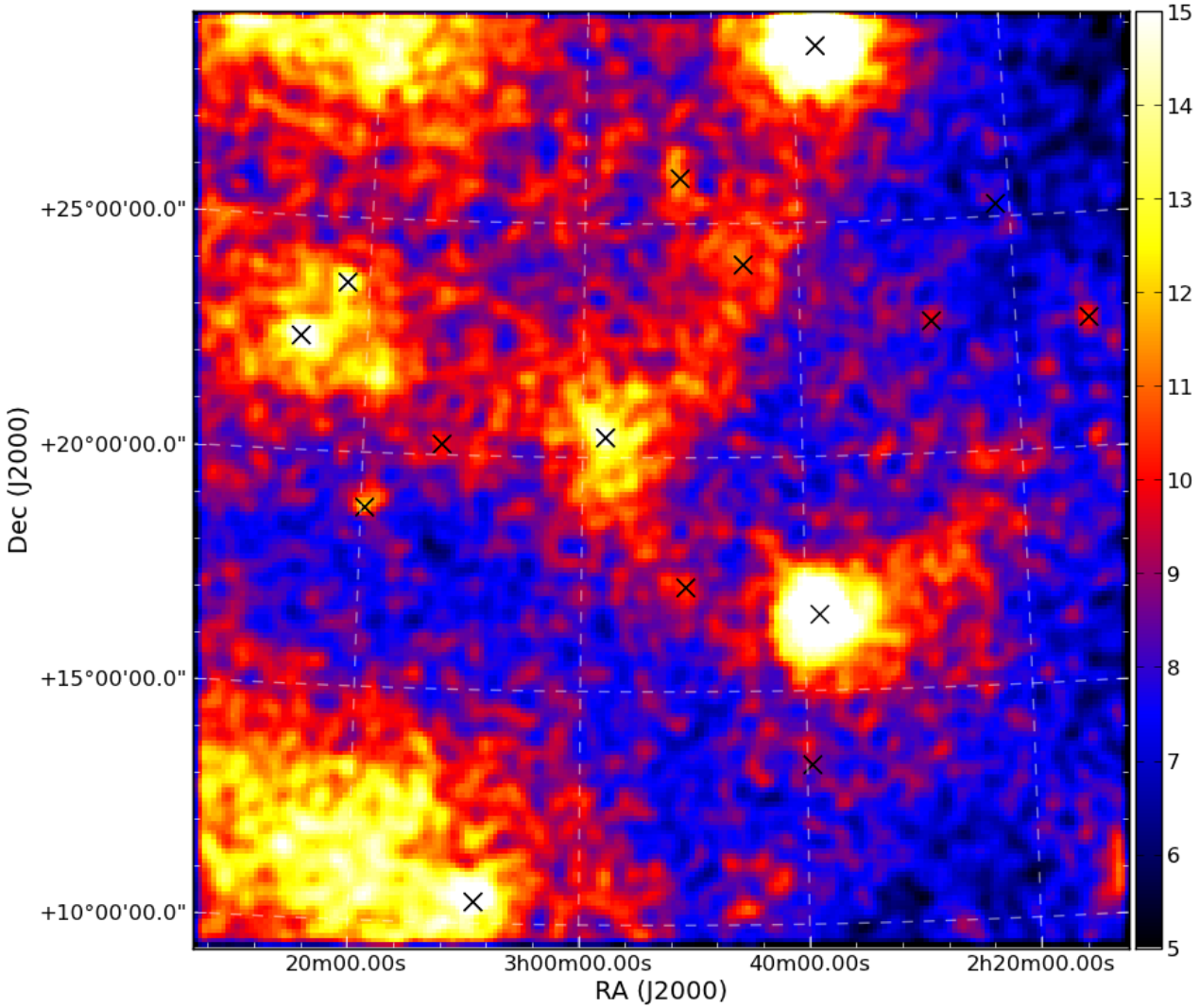


A point source proves to be a problem

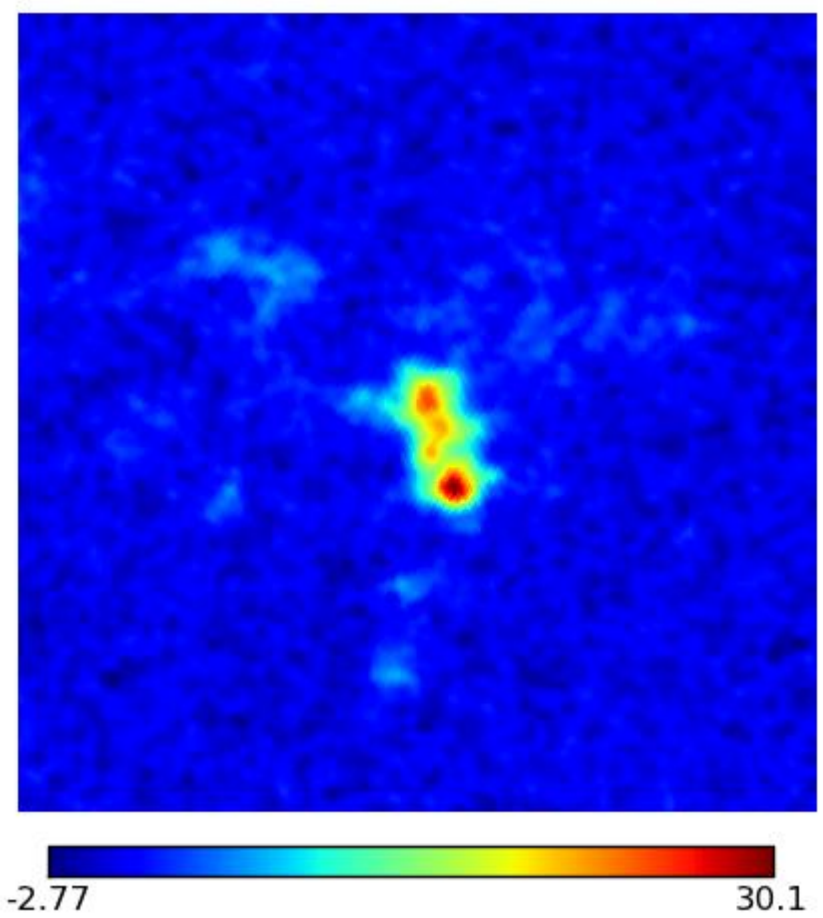


2FGL J0257.9+2025c is coincident with MBM 12 – *confusion*!

We can CO data from Planck!

In MBM 12 itself, we can check Planck against Moriarty-Schieven (1997)

10ºx10º Planck



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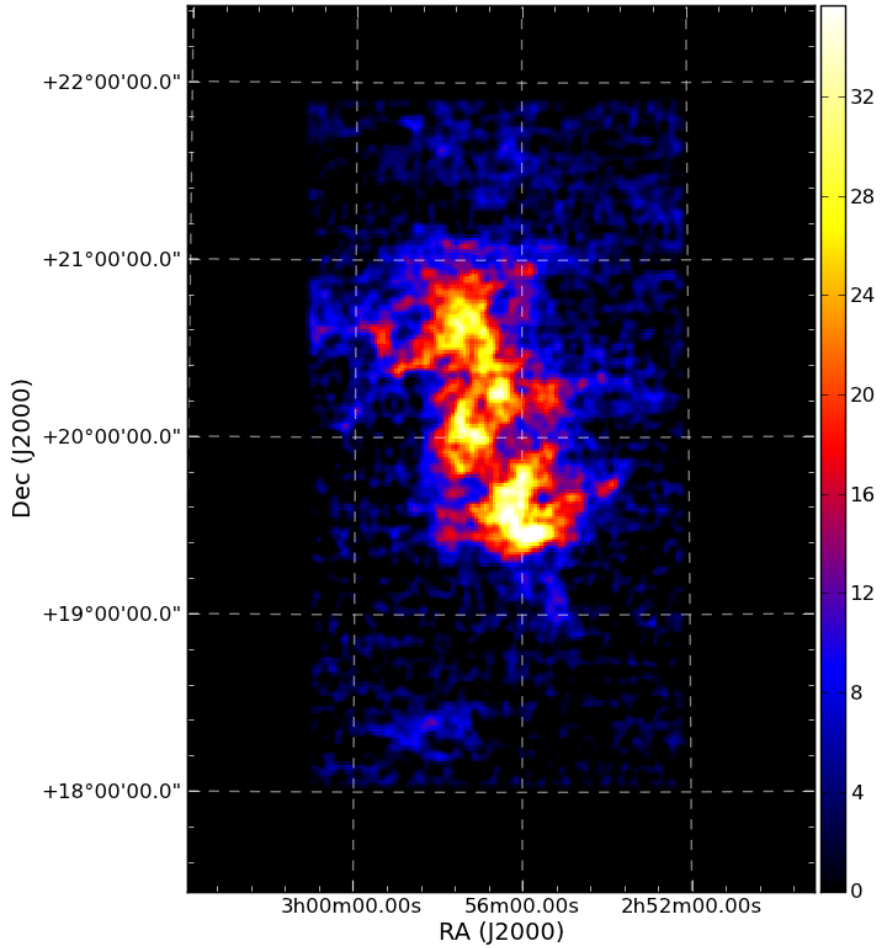
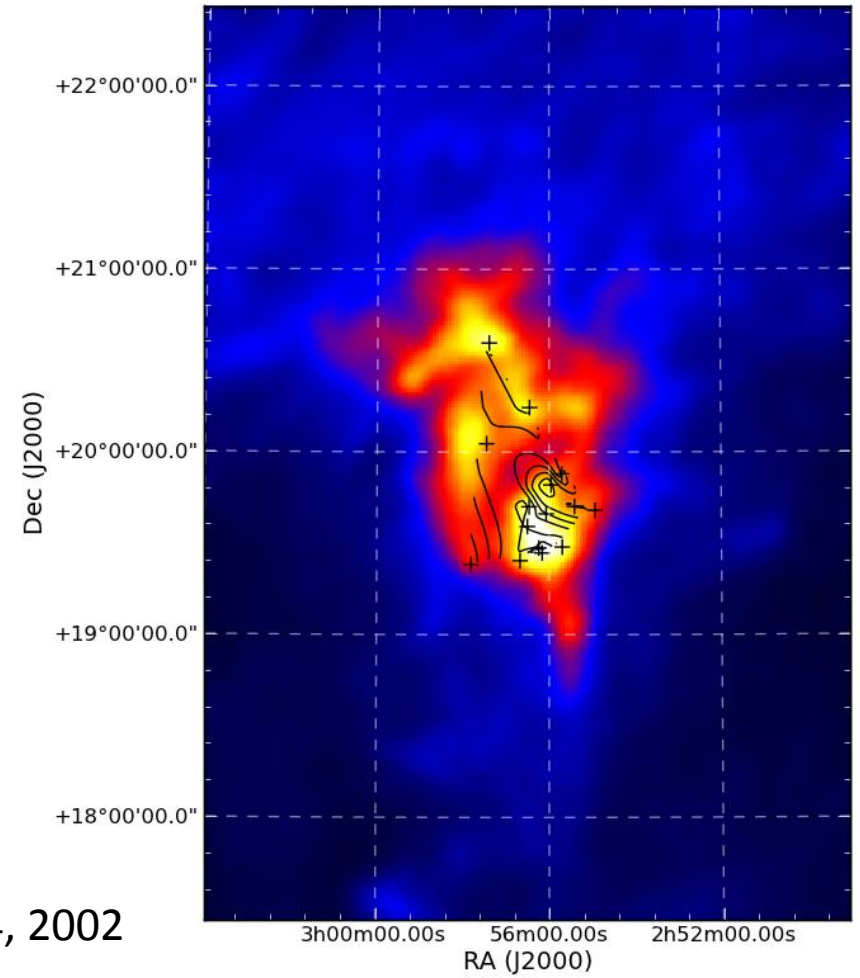


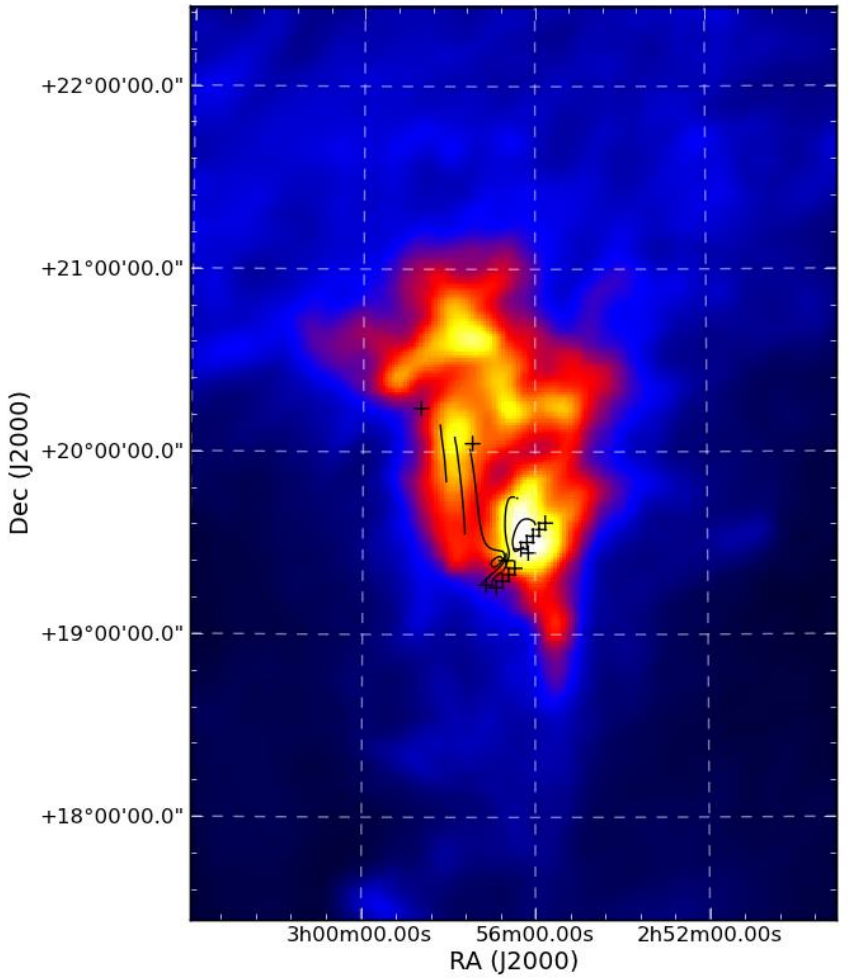
Can PDR gas trace the dark gas?

We would like to compare CI (609 μm) and CII (158 μm) to the dark gas distribution.

Neutral Carbon, CI



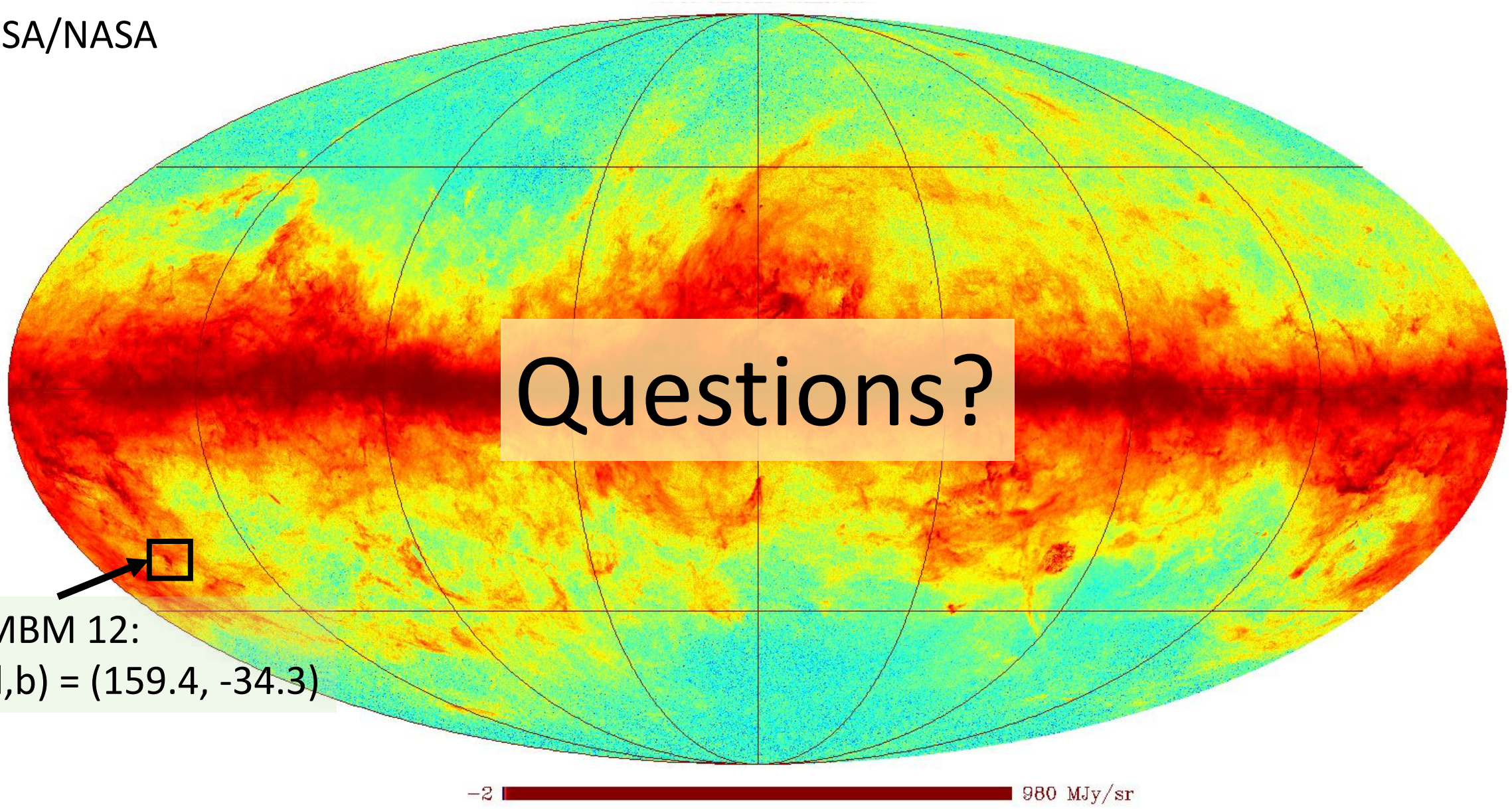
Ionized Carbon, CII



Ingalls 1994, 2002

Planck Thermal Dust Emission

ESA/NASA



References

- Ackermann, M and the *Fermi* collaboration, 2012, ApJ, 755, 22.
- Kalberla, P. M. W., et al. 2005, A&A, 440, 772.
- Ingalls, J. G., Bania, T. M., & Jackson, J. M. 1994, ApJ, 431, L139.
- Ingalls, J. G., Reach, W. T., & Bania, T. M. 2002, ApJ, 579, 289.
- Moriarty-Schieven, G. H., Andersson, B.-G., & Wannier, P. G. 1997, ApJ, 475, 642.
- Nolan, P. L. and the *Fermi* collaboration, 2012, ApJS, 199, 31.
- *Planck* collaboration, arXiv:1303.5073.
- Schlegel, D. J., Finkbeiner, D. P., & Davis, M. 1998, 500, 525.
- Tielens, A. G. G. M. & Hollenbach, D. 1985, ApJ, 291, 722.