Update on the 3.5 keV Candidate Dark Matter Decay Signal

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With
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WIMPS VS SUPERWIMPS

WIMPS

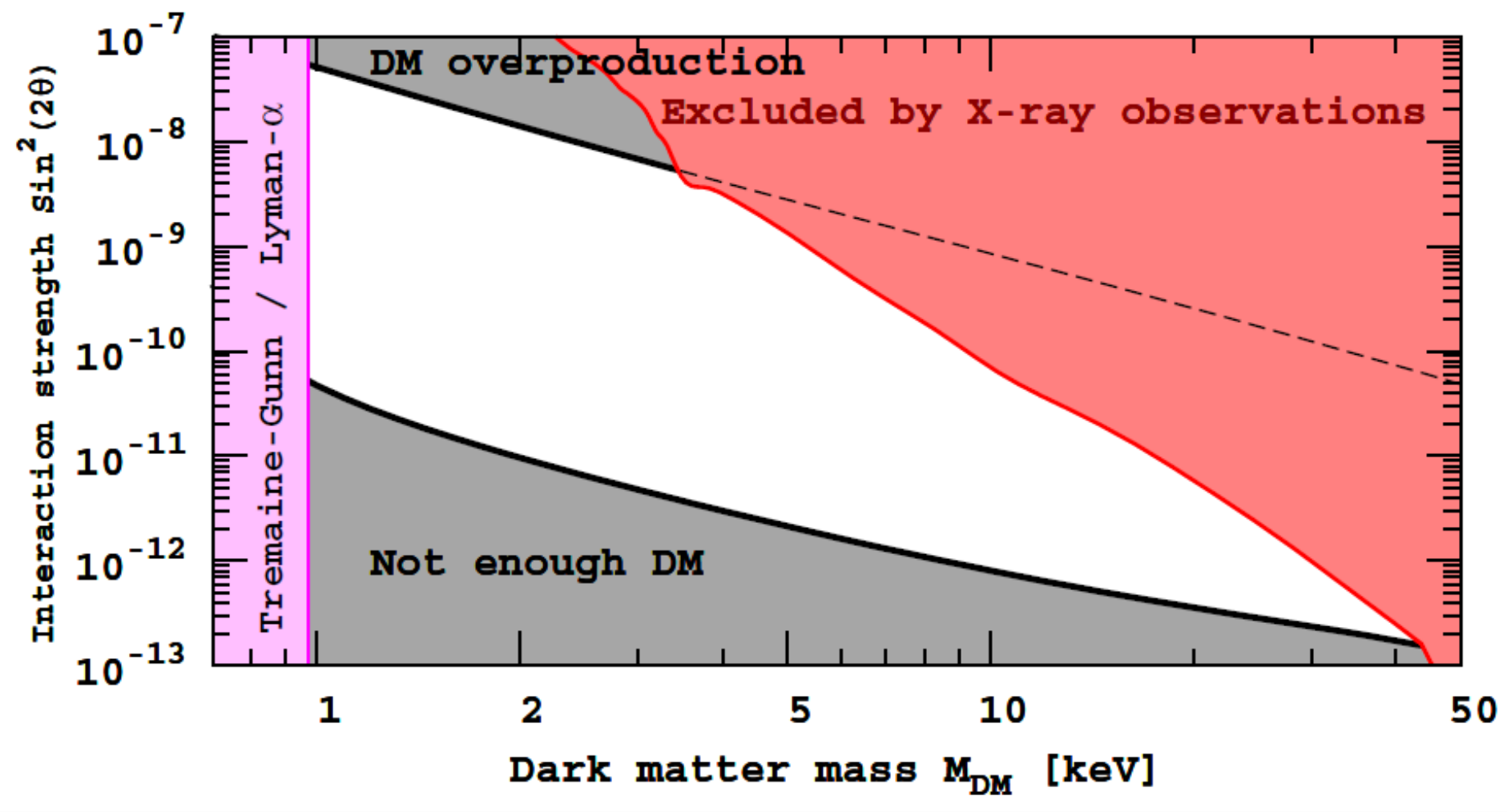
- Interaction strength at weak scale
- Correct Ω_{DM} for masses Gev – TeV
- Would have short lifetime
- Made stable with new physics

SUPERWIMPS

- Interaction strength weaker-than-weak
- Correct Ω_{DM} for masses of order keV
- Lifetime longer than age of universe
- Allowed to be decaying DM

SUPERWIMPS IN X-RAYS

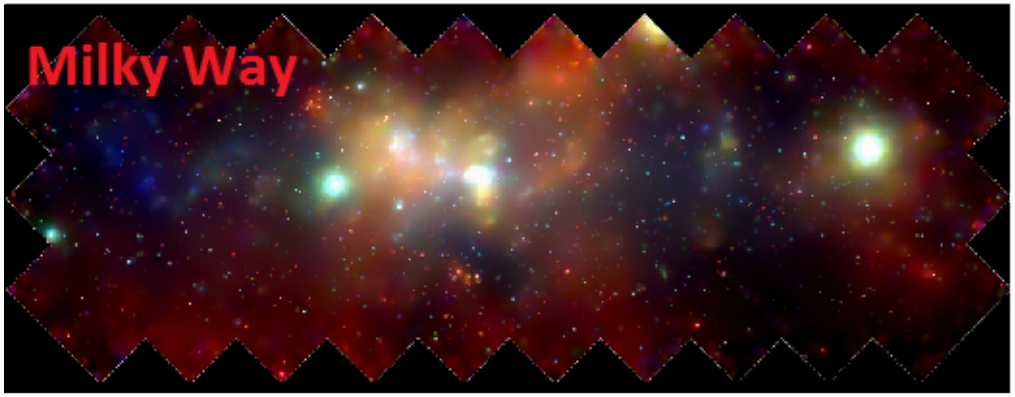
Decaying DM should decay into monochromatic X-rays

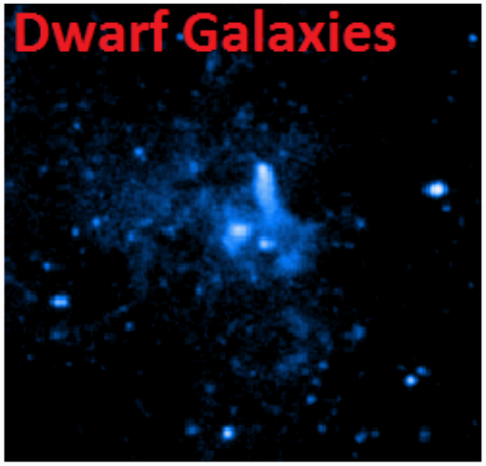


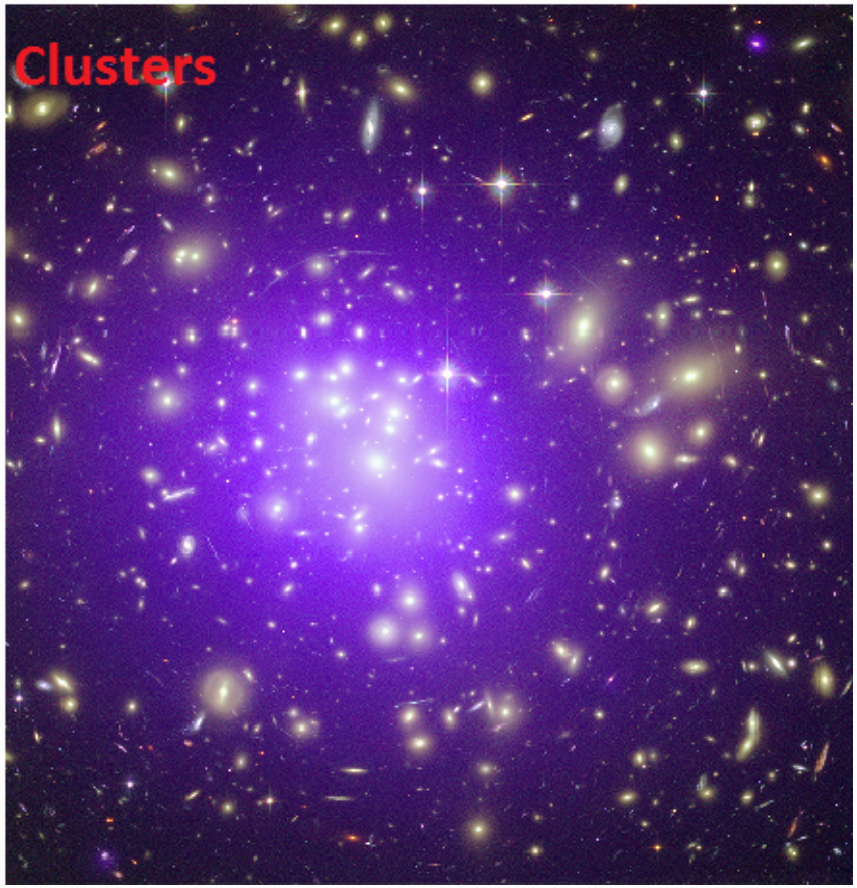
TARGET SOURCES

Good targets are dark matter dominated. Specifically, sources with high expected decay signal strength

$$\text{signal} \propto \text{DM mass in FoV} / \text{distance}^2$$

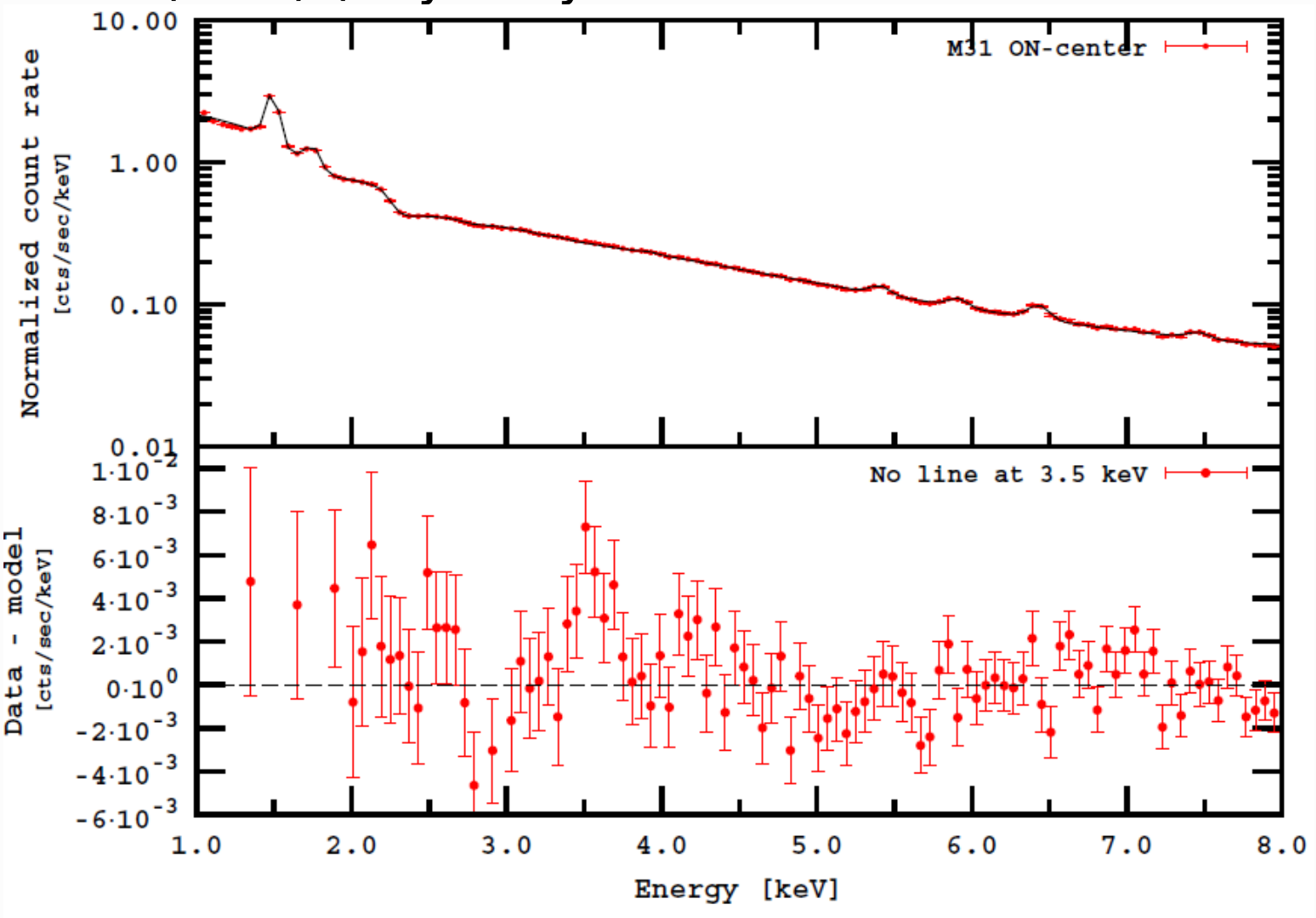






DETECTION AT $E \sim 3.5$ KEV

Andromeda (M31) (Boyarsky et al. 2014a [1402.4119])



Detections of the Unidentified 3.5 keV Line

Boyarsky et al. 2014a,b [1402.4119, 1408.4388]

M31 galaxy	XMM-Newton, center & outskirts	***4.4σ***
Perseus cluster	XMM-Newton, outskirts only	
Blank sky	XMM-Newton	***No detection***

Bulbul et al. 2014 [1402.2301]

73 clusters	XMM-Newton (MOS & PN), centers only, up to $z = 0.4$	***5σ*** & ***4σ***
Perseus cluster	Chandra, center only	***3.5σ***

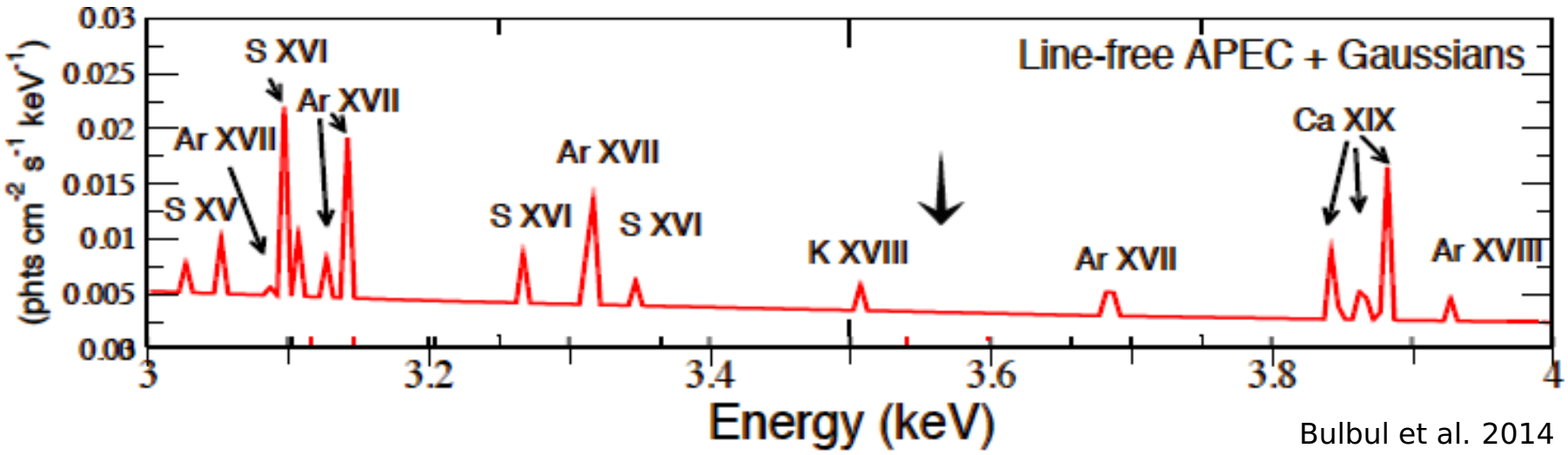
Instrumental Origin?

Instrumental origin unlikely

- Detected in 4 different detectors
- Line redshifts correctly with sources
- Not detected in blank sky dataset

Atomic Line?

Unlikely: can not explain consistently all observations



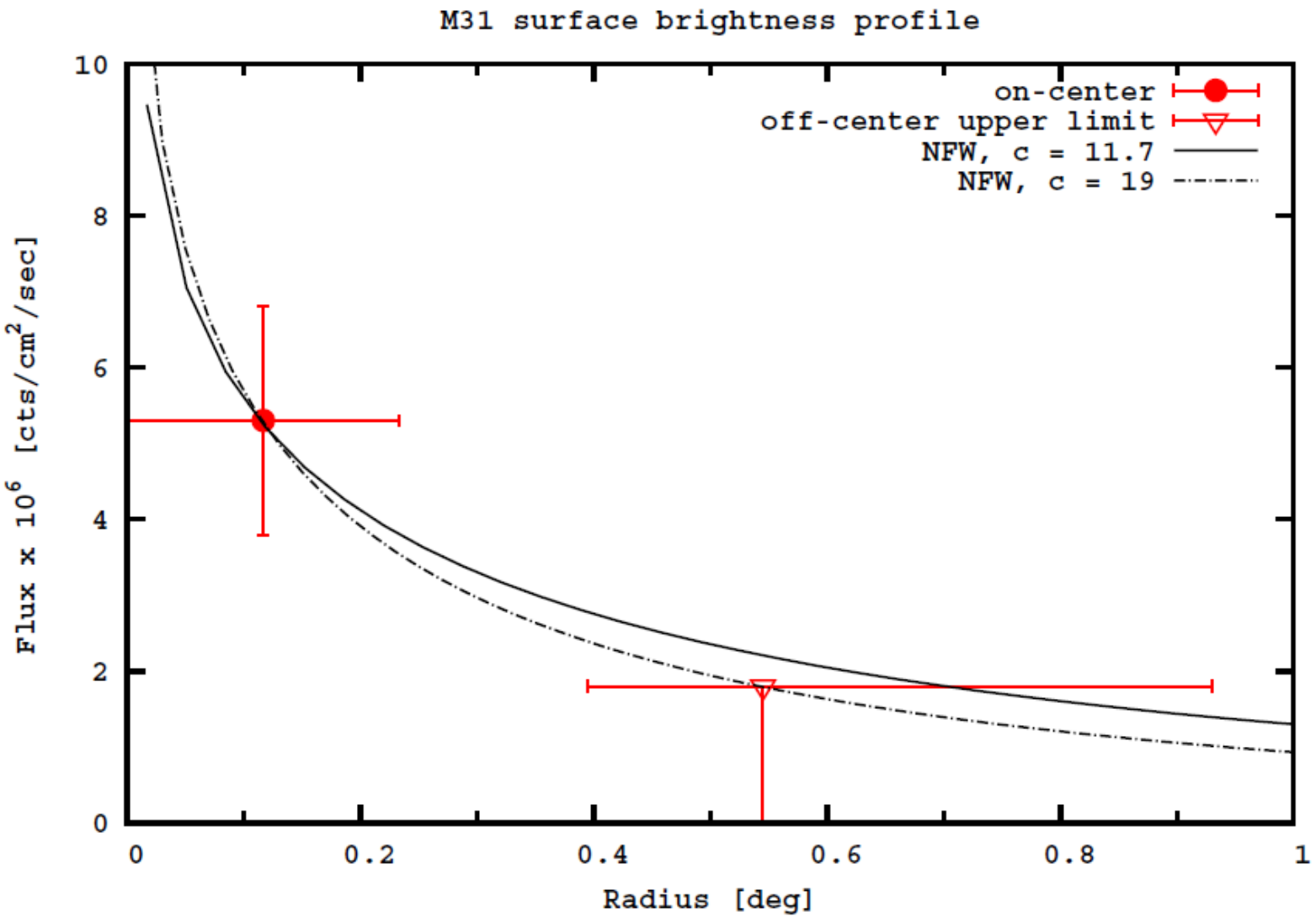
Bulbul et al. 2014

M31 line is stronger than other atomic emission

CLUSTERS need anomalous line ratios of a factor $\sim 20 - 30$

Dark Matter Decay?

The line flux should be proportional to mass / distance^2



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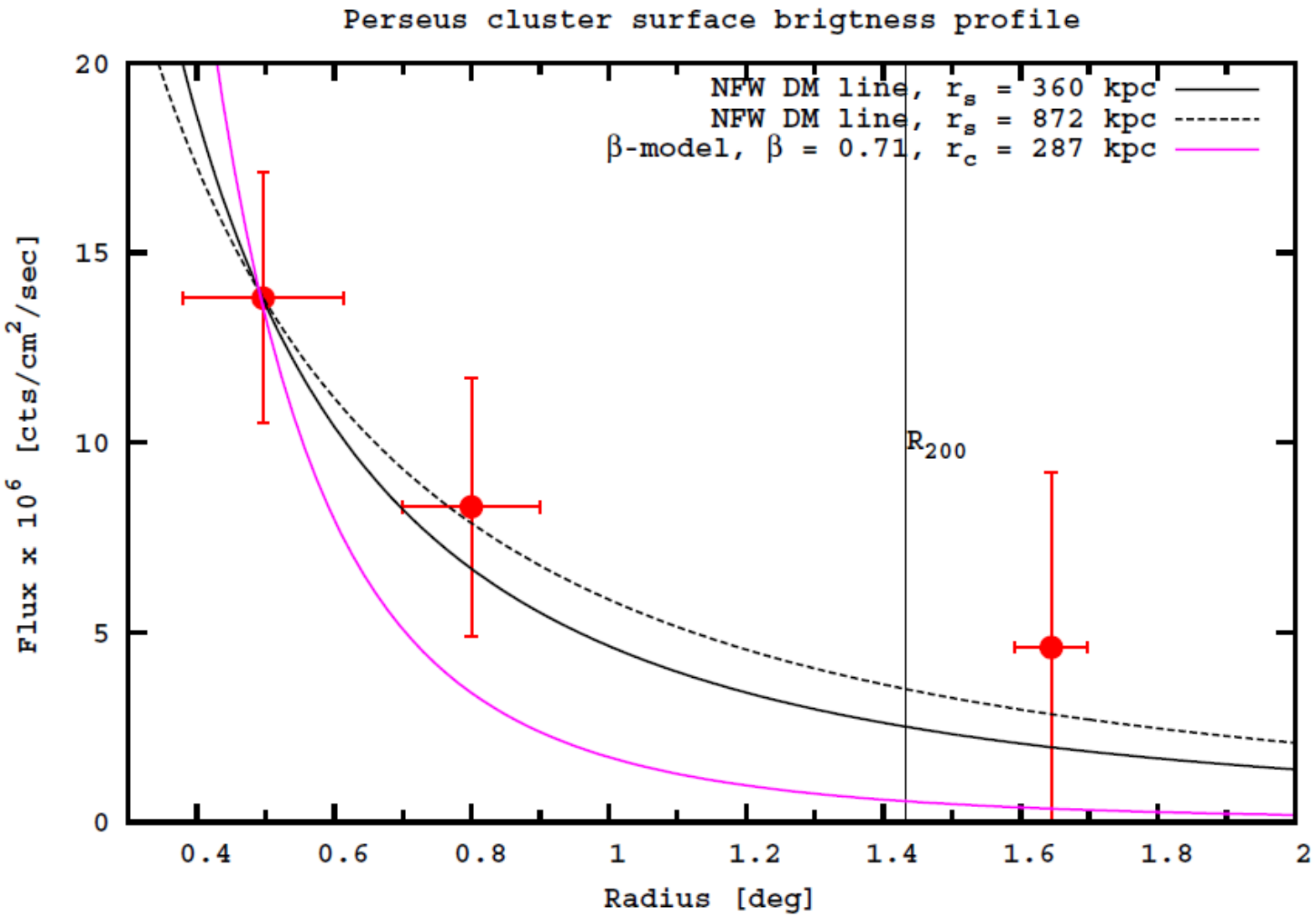

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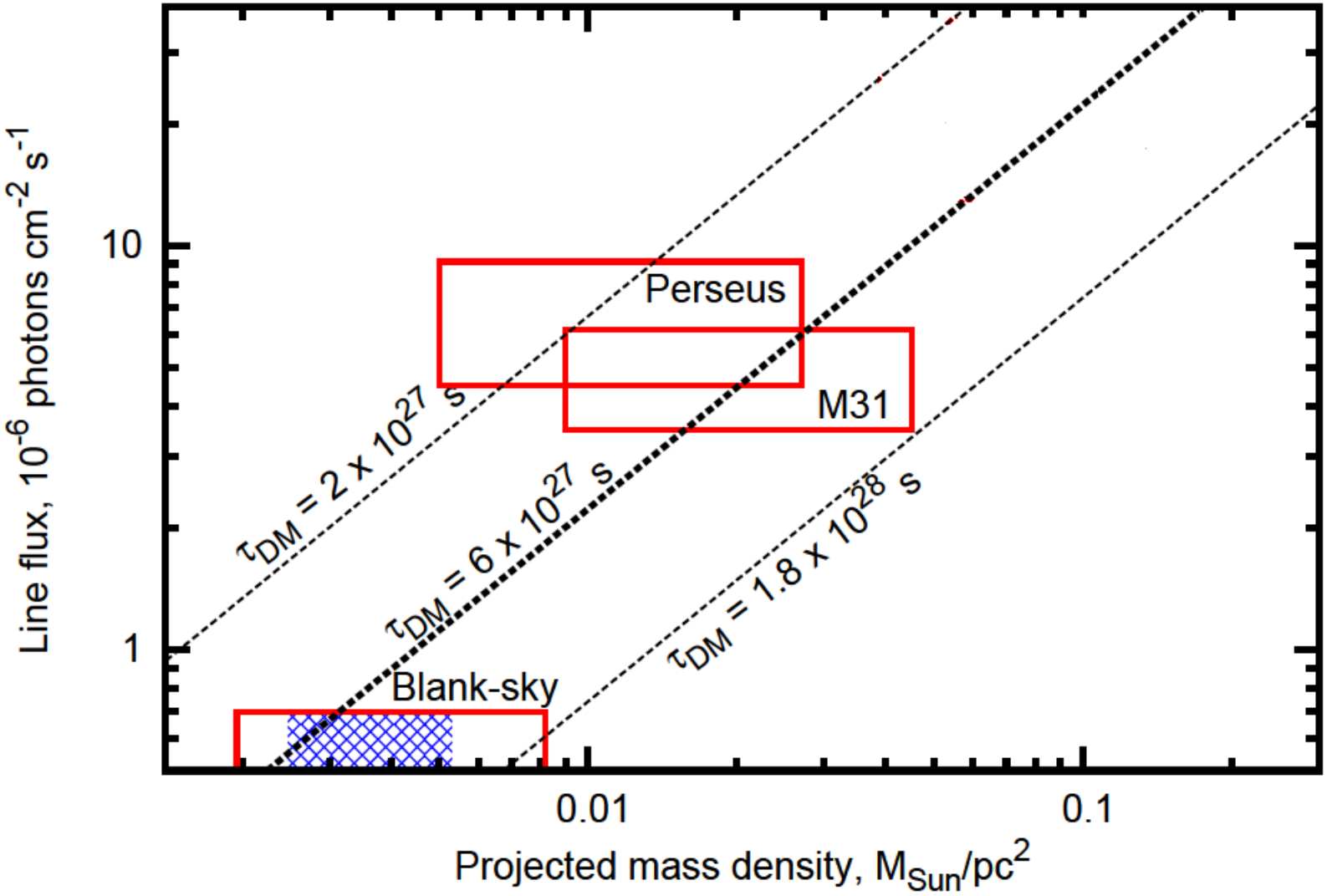
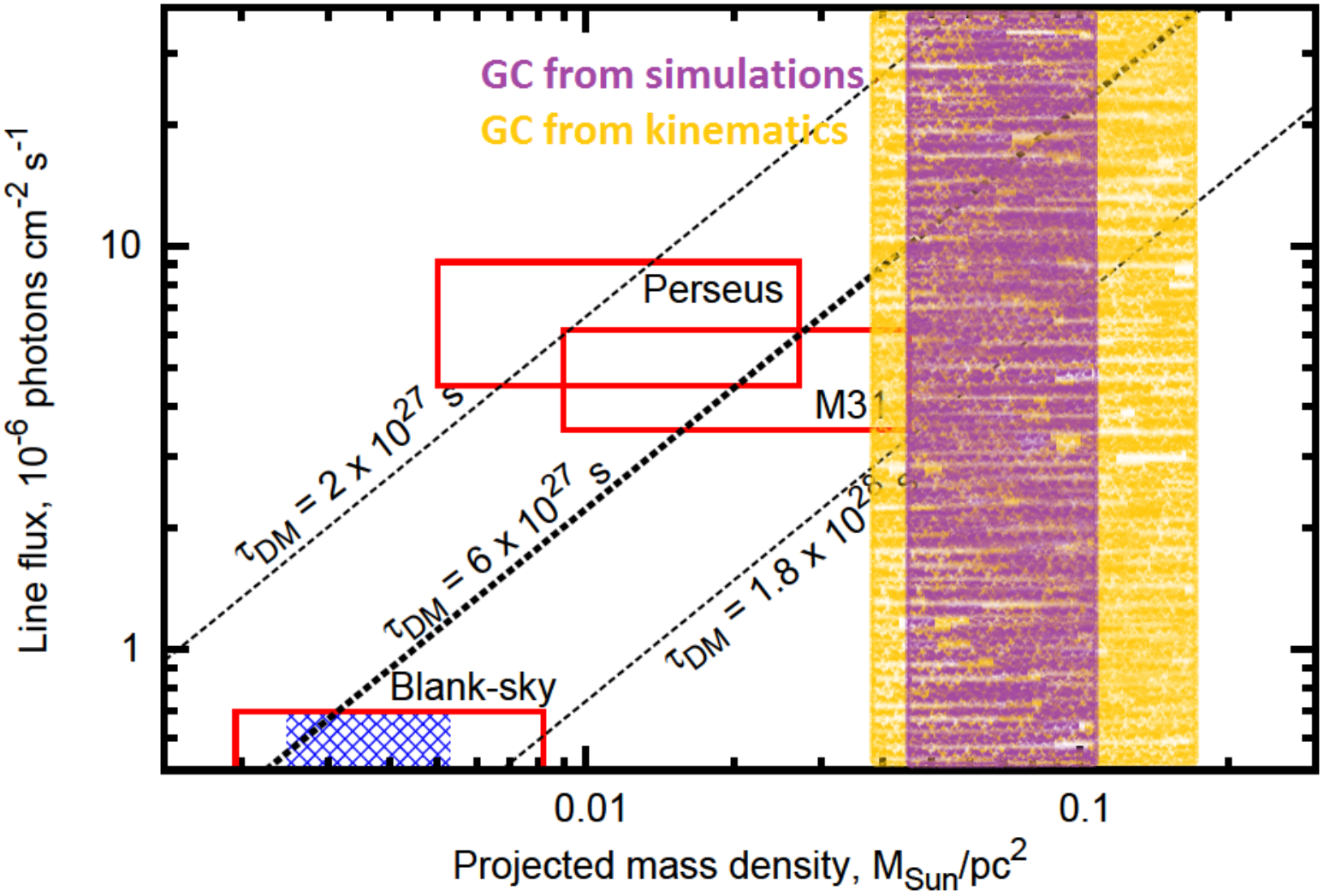


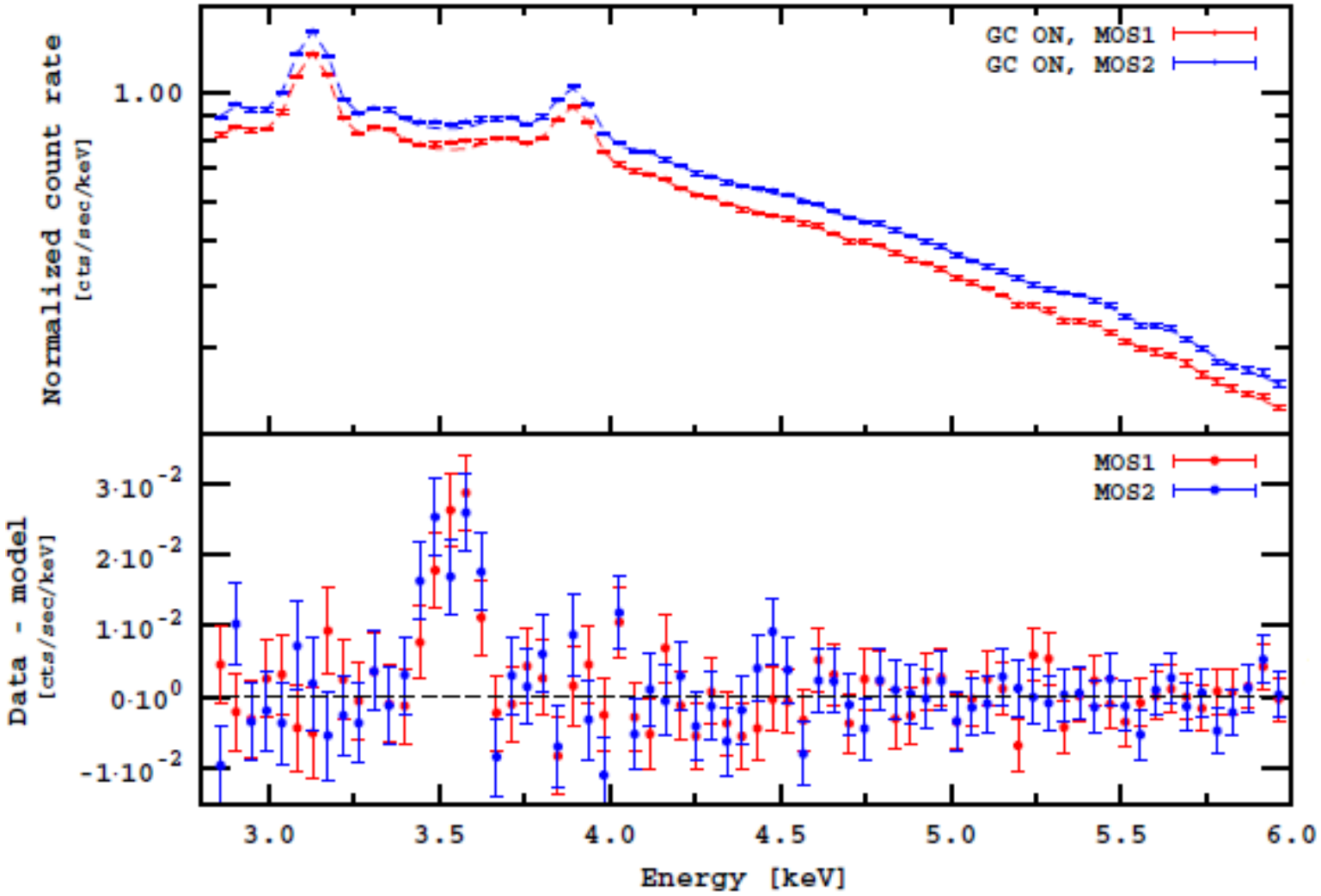
Galactic Center

Expect large signal from GC → “easy” cross-check



Galactic Center

Boyarsky et al. 2014b [1408.4388]



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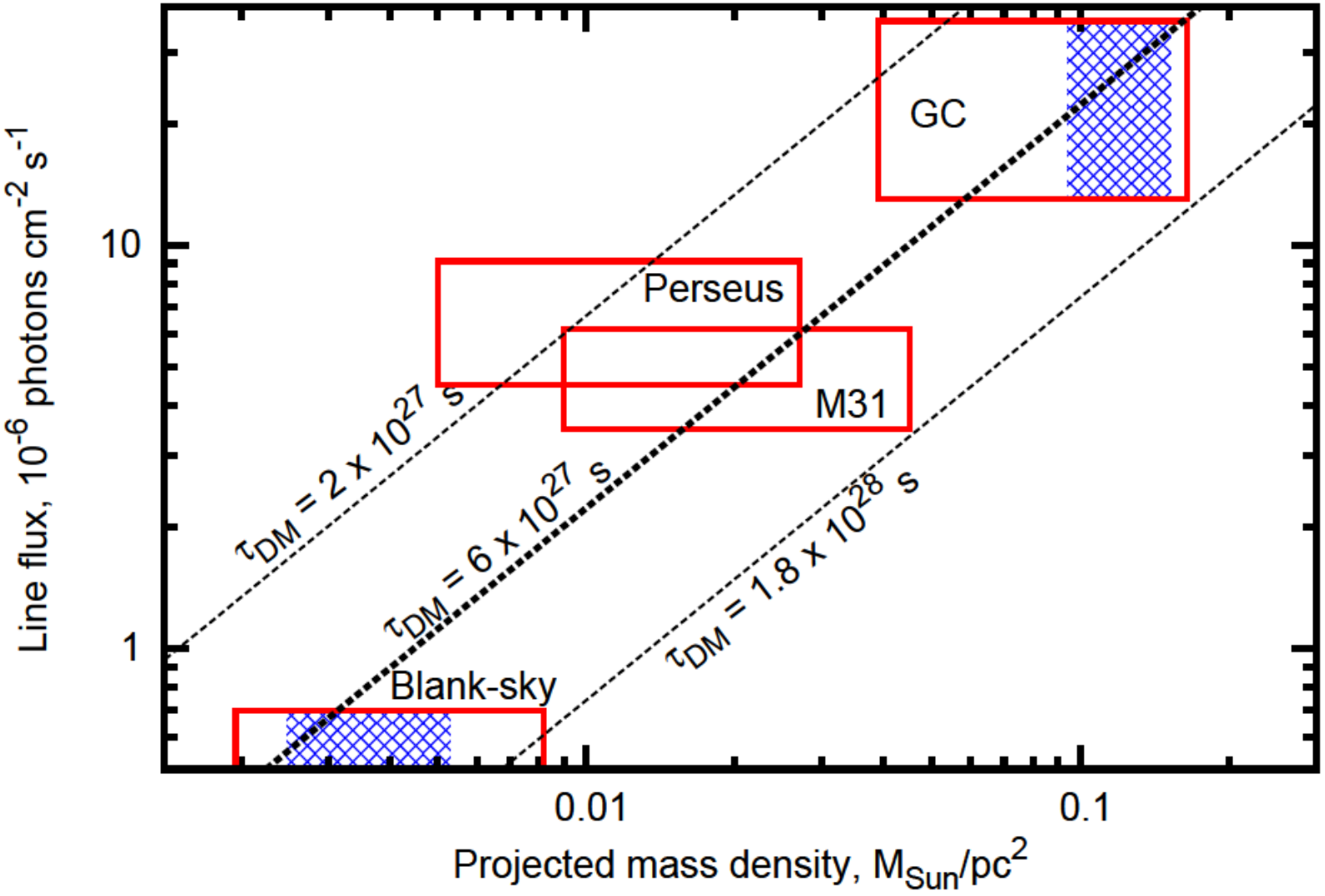
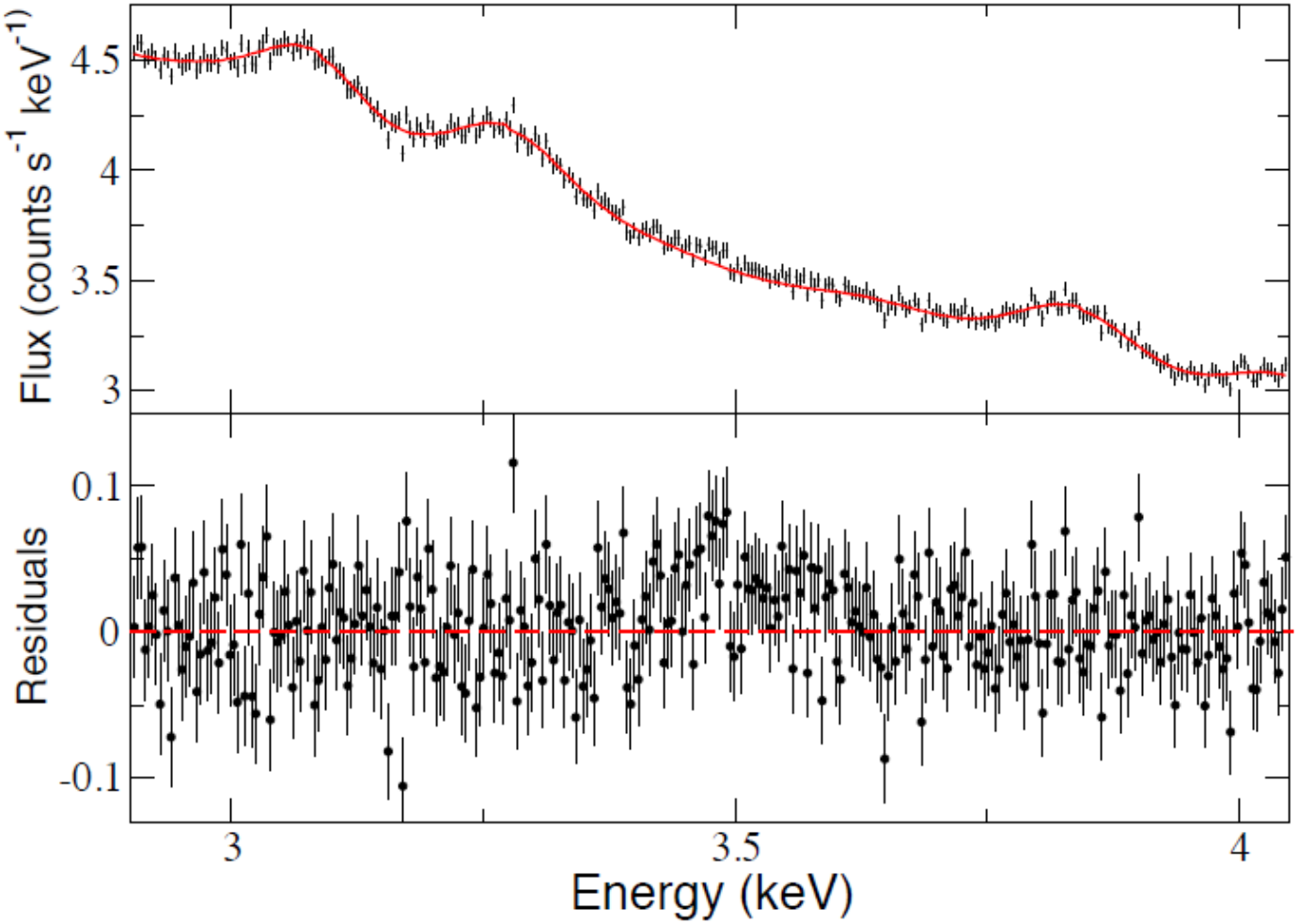


More Perseus

Preliminary 1 Ms with *Suzaku*, 3σ detection in the center



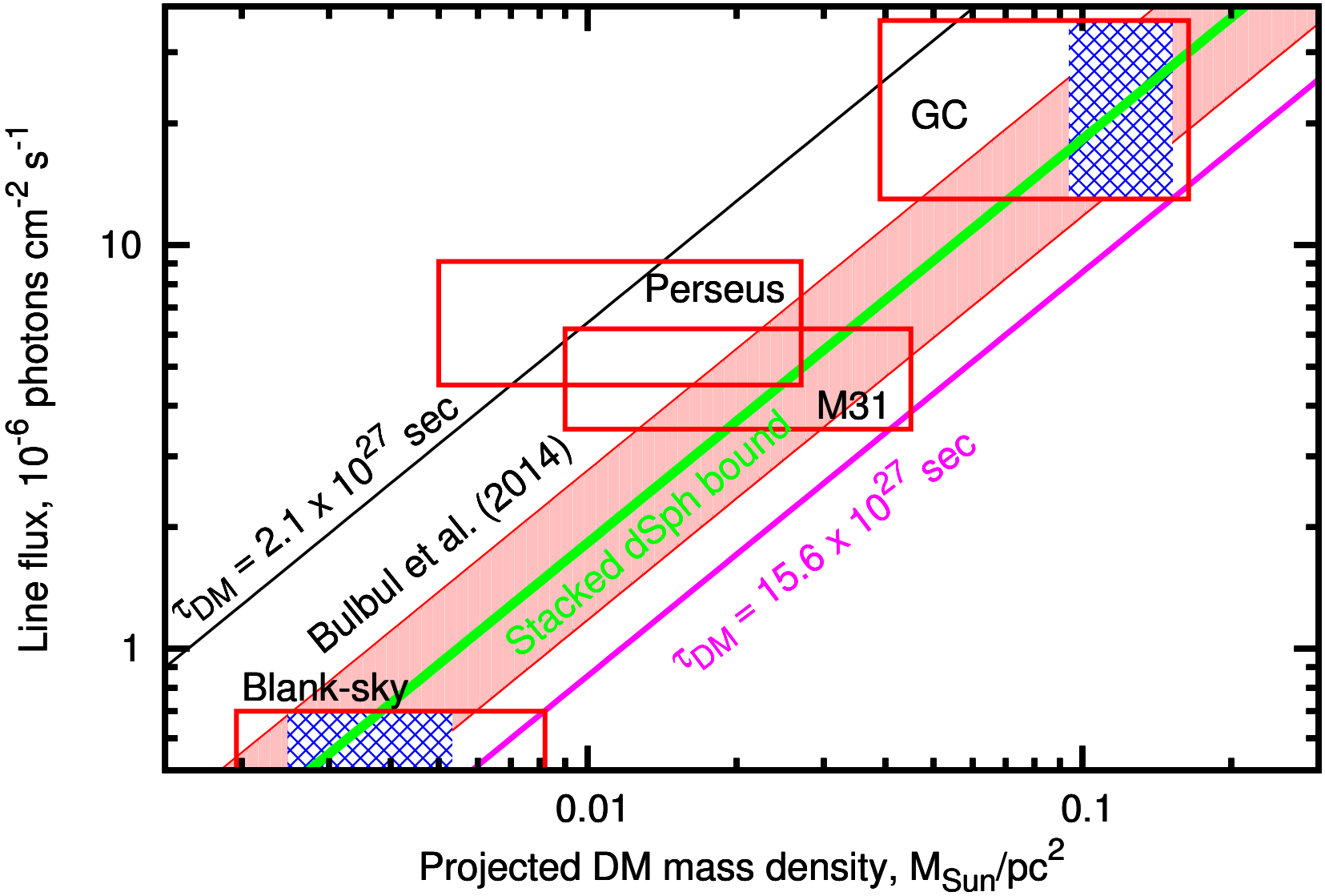
Franse, Bulbul et al. (in prep)

Next: Lots of Draco

We have been ***awarded 1.4 Ms*** of XMM observations of the Draco dwarf galaxy this year

- Nearby, dark matter dominated object
- Highest expected signal of all dwarf galaxies (Geringer-Sameth+ 2014, Lovell+ 2014)
- Very gas-poor (***do not expect any atomic lines***)
- We will be able to **confirm or deny the DM origin** of the 3.5 keV line somewhere **in 2016**.

Draco dSph Observation Projections



Parameter Space