

# Searching for Decaying and Annihilating Dark Matter with Line Intensity Mapping

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IDM 2018

# What is Line Intensity Mapping (IM)?

Measures integrated emission from spectral lines in galaxies + diffuse IGM

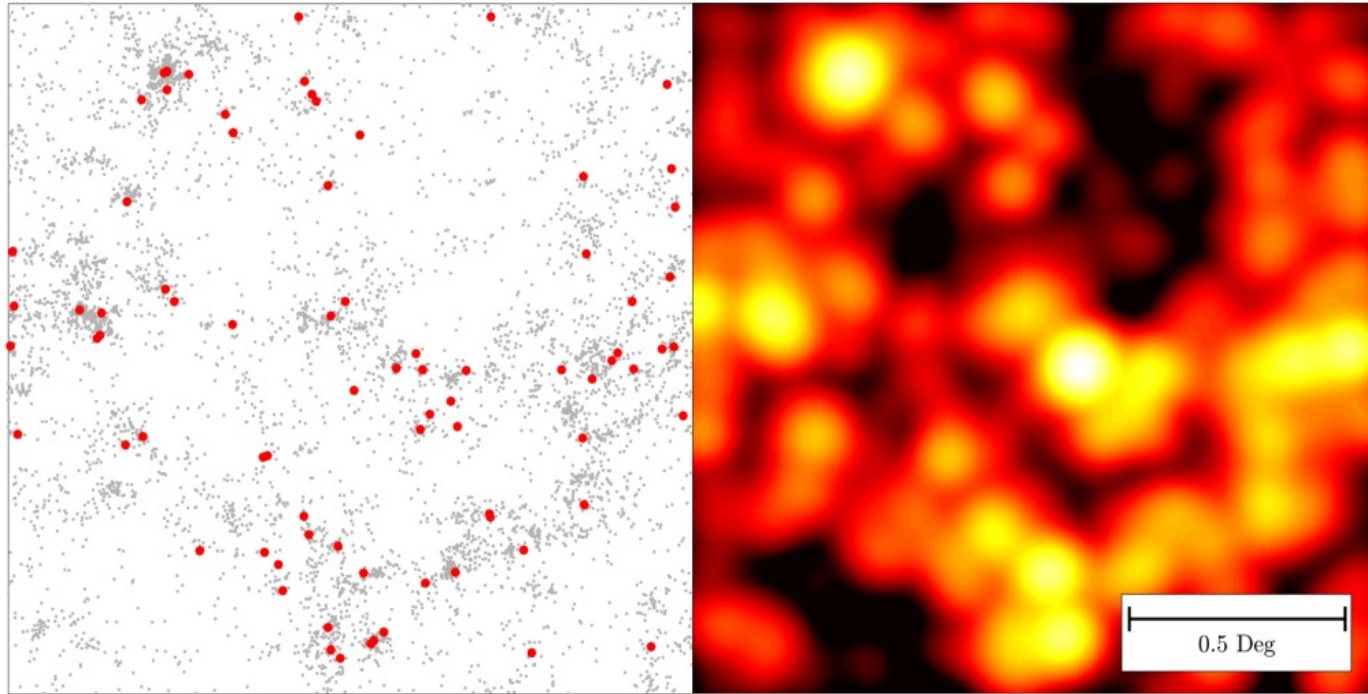


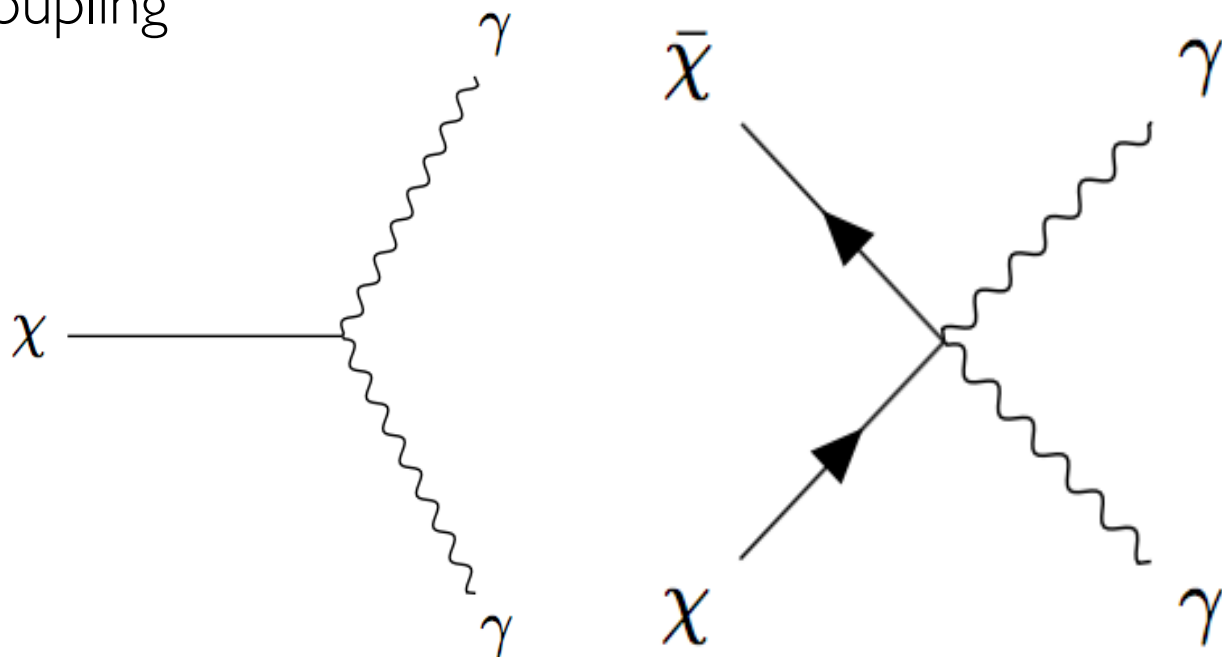
Image Source: Kovetz, et.  
al 1709.09066

$$\nu_{\text{obs}} = \nu_{\text{rest}} / (1 + z)$$

Experiment	Target
CCAT	[CII] (high $z$ )
CHIME	21-cm
COMAP	CO
STARFIRE	[CII] (low $z$ )
SPHERE <sub>x</sub>	H $\alpha$

# What photons are we trying to observe?

Monoenergetic photons from a  $\text{DM}(\chi) + \text{photon}(\gamma)$  coupling



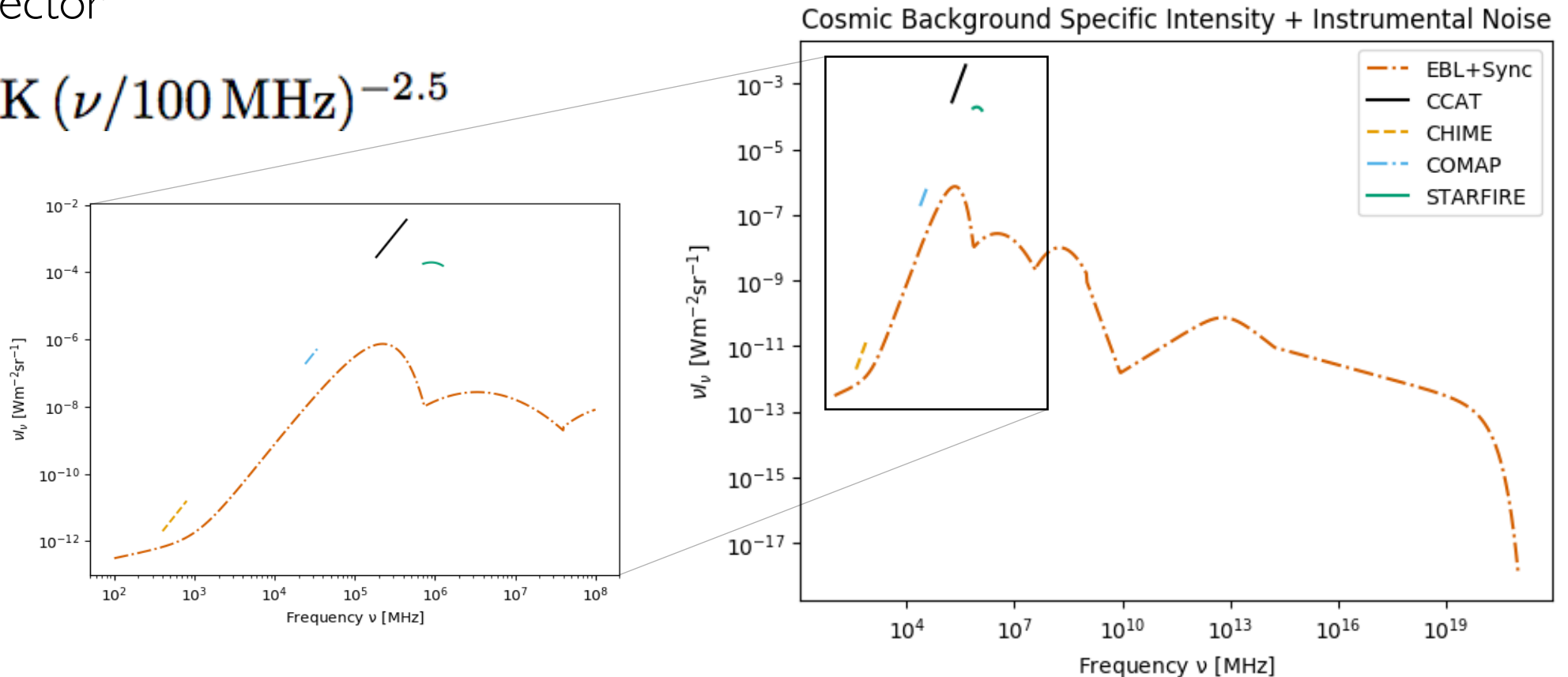
Experiment	Target
CCAT CHIME COMAP STARFIRE SPHERE <sub>x</sub>	[CII] (high $z$ ) 21-cm CO [CII] (low $z$ ) $\text{H}\alpha$
All	DM Decay/Ann

# What contaminants are there?

Extragalactic Background Light, Galactic Synchrotron Radiation ( $\nu \leq 100$  GHz)

Imperfect detector

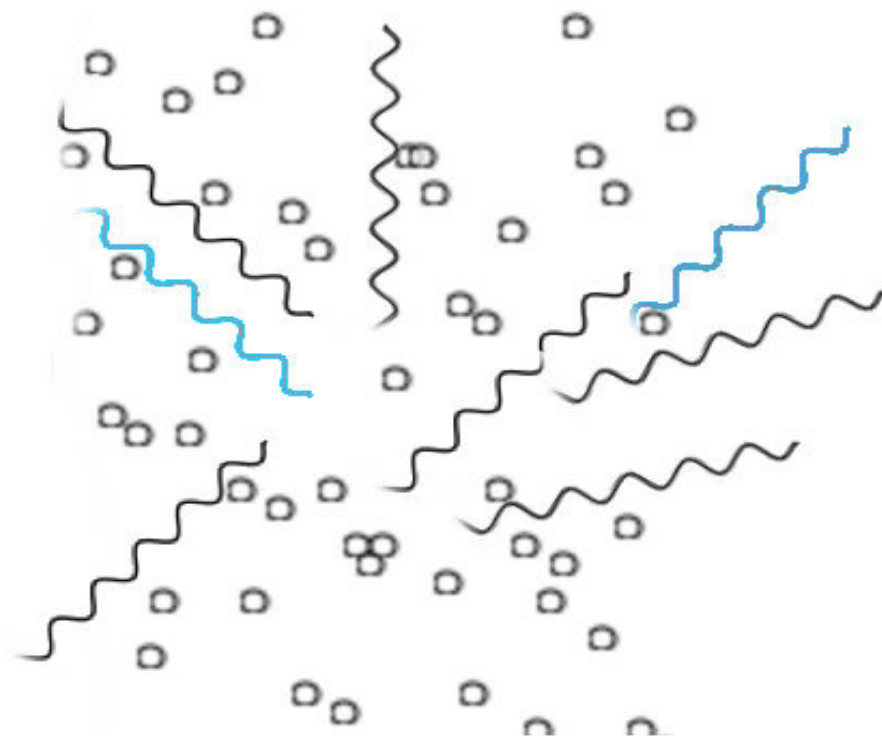
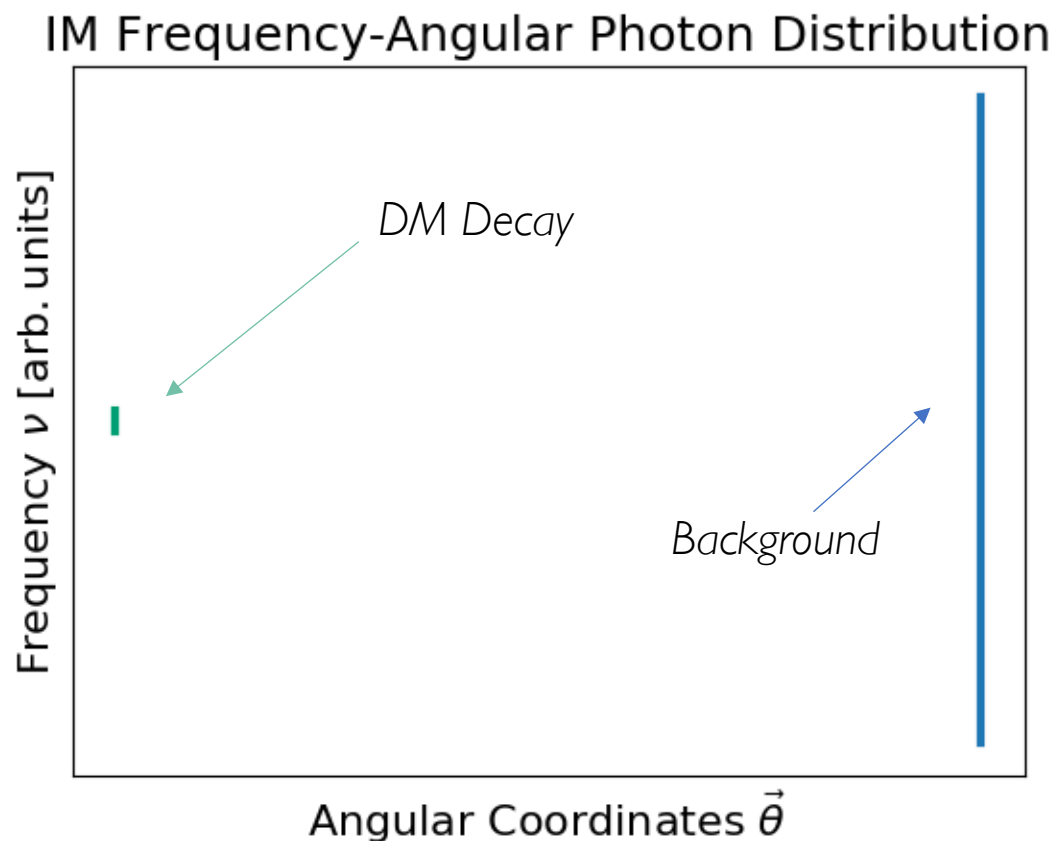
$$T_B = 1000 \text{ K } (\nu/100 \text{ MHz})^{-2.5}$$



# How to distinguish these photons?

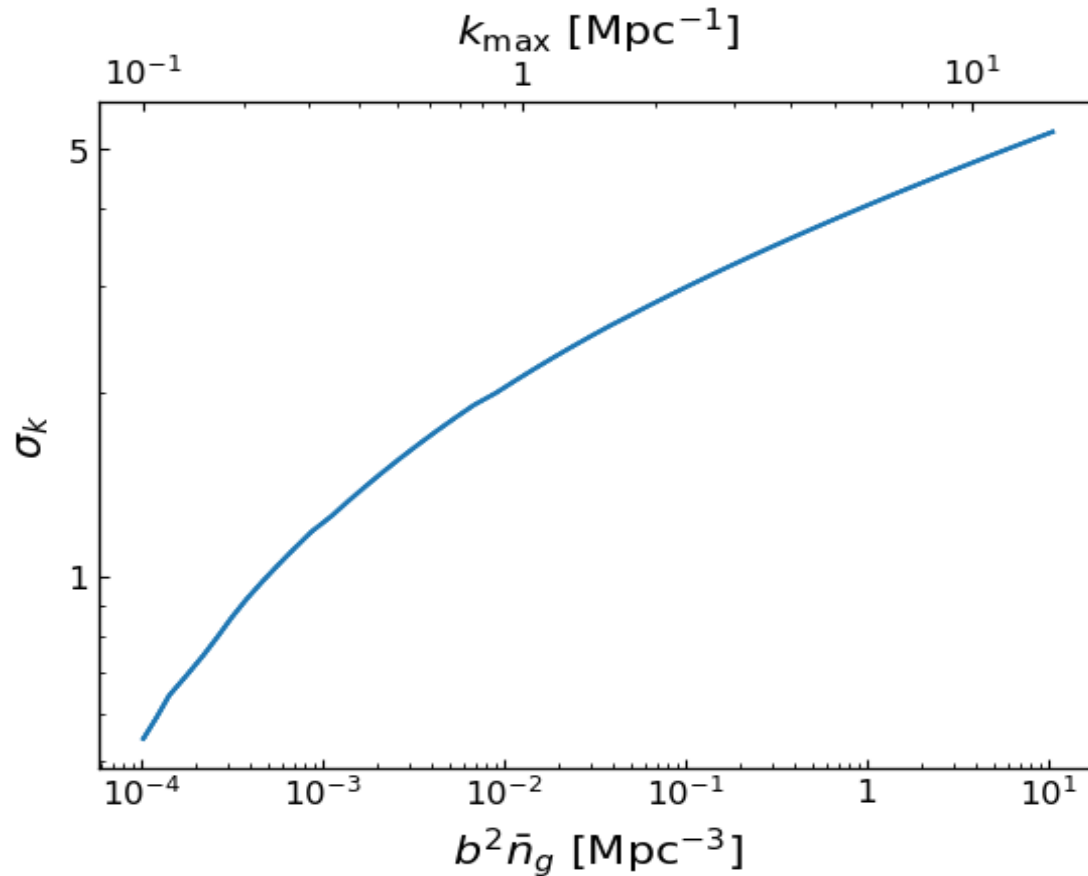
Cross correlating with a tracer (e.g. galaxies)

$$\langle \tilde{\delta}_g(\vec{k}) \tilde{\delta}_\gamma^*(\vec{k}') \rangle$$



# How do I know I have detected DM?

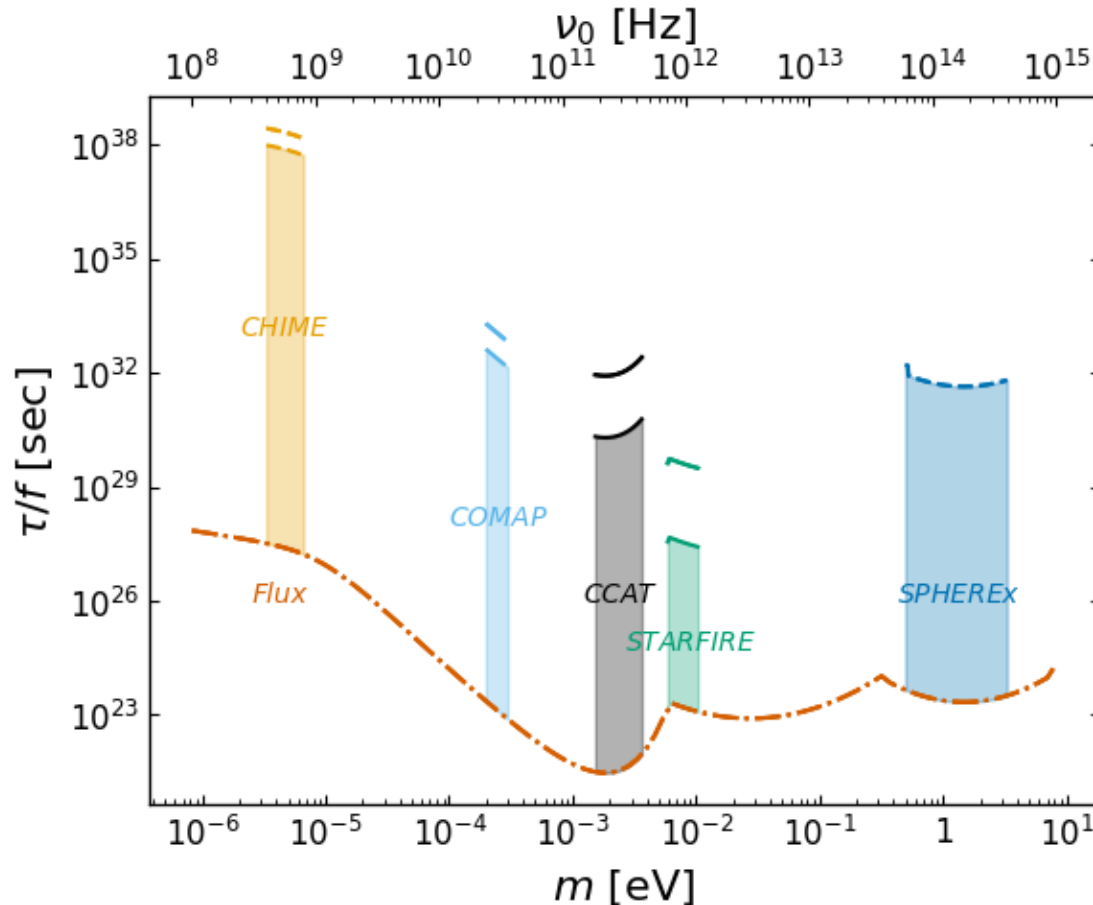
Count enough photons  $\xi \gtrsim \xi_{\min} \simeq 2(N_b \sigma_k^2/2)^{-1/2} \sqrt{1 + (N_n/N_b)}$



# What constraints can I put if no detection?

Pretty good ones

$$\tau \simeq 7.5 \times 10^{32} \frac{f \sigma_k (N_b / 10^{20})^{1/2}}{(\nu_0 I_{\nu_0}^{\text{CB}} / 10^{-8} \text{ W m}^{-2} \text{ sr}^{-1})} \text{ sec.}$$



# Summary

- IM can detect DM decays and annihilation
- Negligible background contributions
- Not cosmic-variance limited
- Noise doesn't ruin measurements
- $10^9$  constraining improvement