

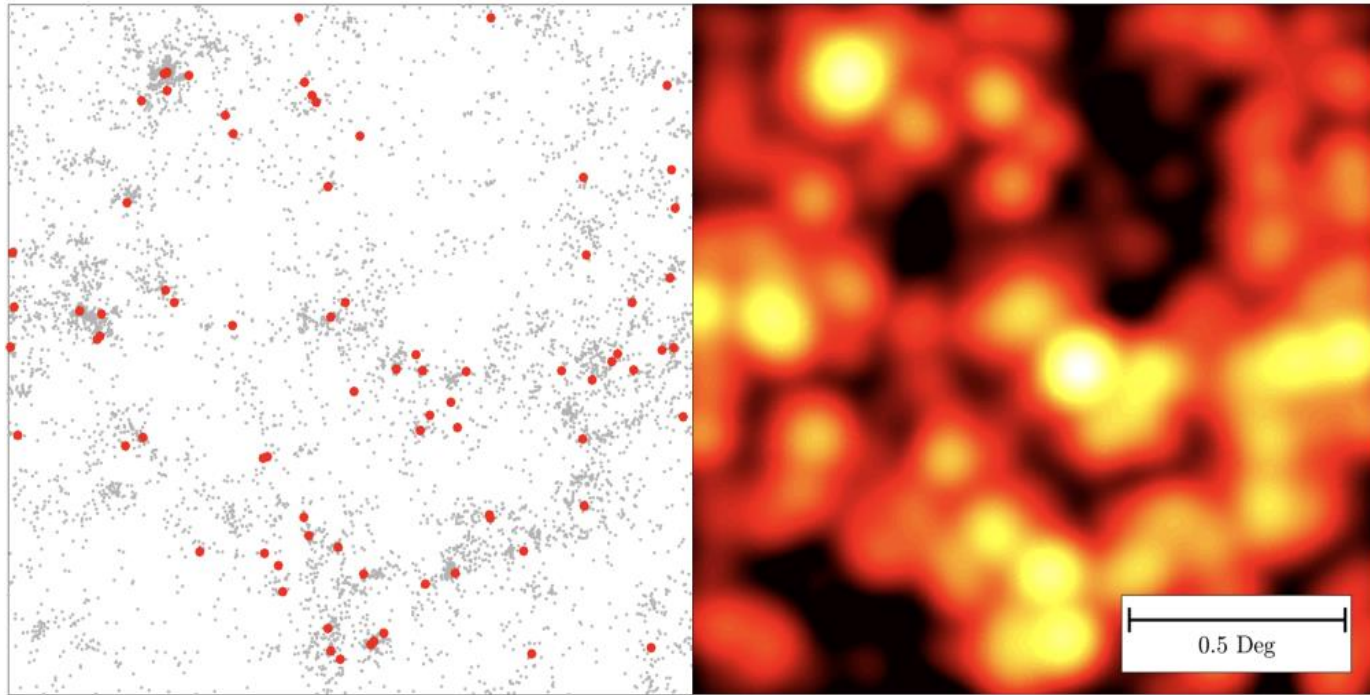
# Searching for Decaying and Annihilating Dark Matter with Line Intensity Mapping

Cyril Creque-Sarbinowski, JHU

IDM 2018

# What is Line Intensity Mapping (IM)?

Measures integrated emission from spectral lines in galaxies + diffuse IGM



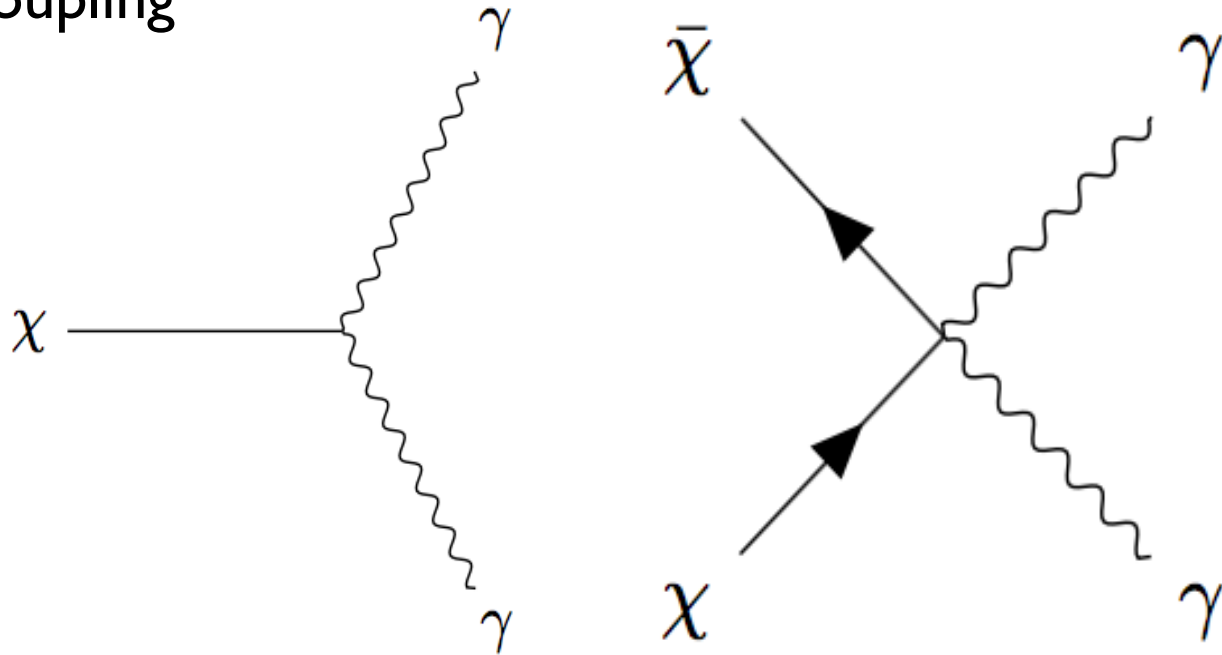
| Experiment          | Target            |
|---------------------|-------------------|
| CCAT                | [CII] (high $z$ ) |
| CHIME               | 21-cm             |
| COMAP               | CO                |
| STARFIRE            | [CII] (low $z$ )  |
| SPHERE <sub>x</sub> | H $\alpha$  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

Image Source: Kovetz,  
et. al 1709.09066

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

# What photons are we trying to observe?

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



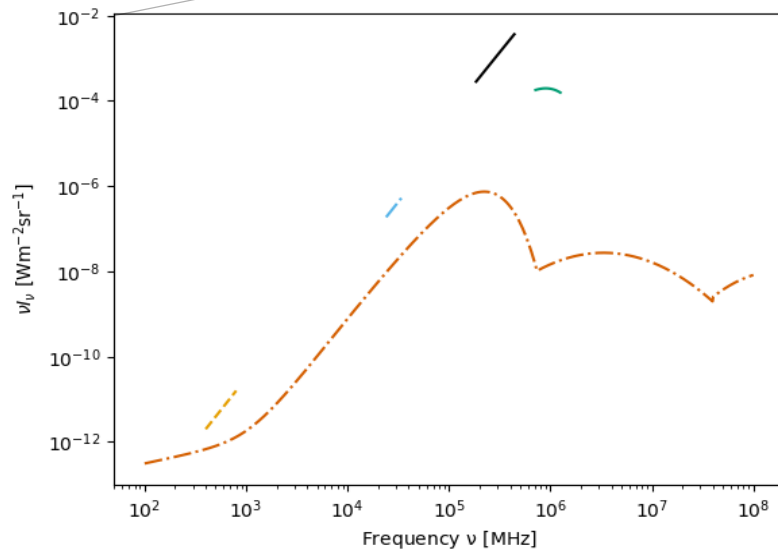
| Experiment          | Target            |
|---------------------|-------------------|
| CCAT                | [CII] (high $z$ ) |
| CHIME               | 21-cm             |
| COMAP               | CO                |
| STARFIRE            | [CII] (low $z$ )  |
| SPHERE <sub>x</sub> | H $\alpha$  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

# What contaminants are there?

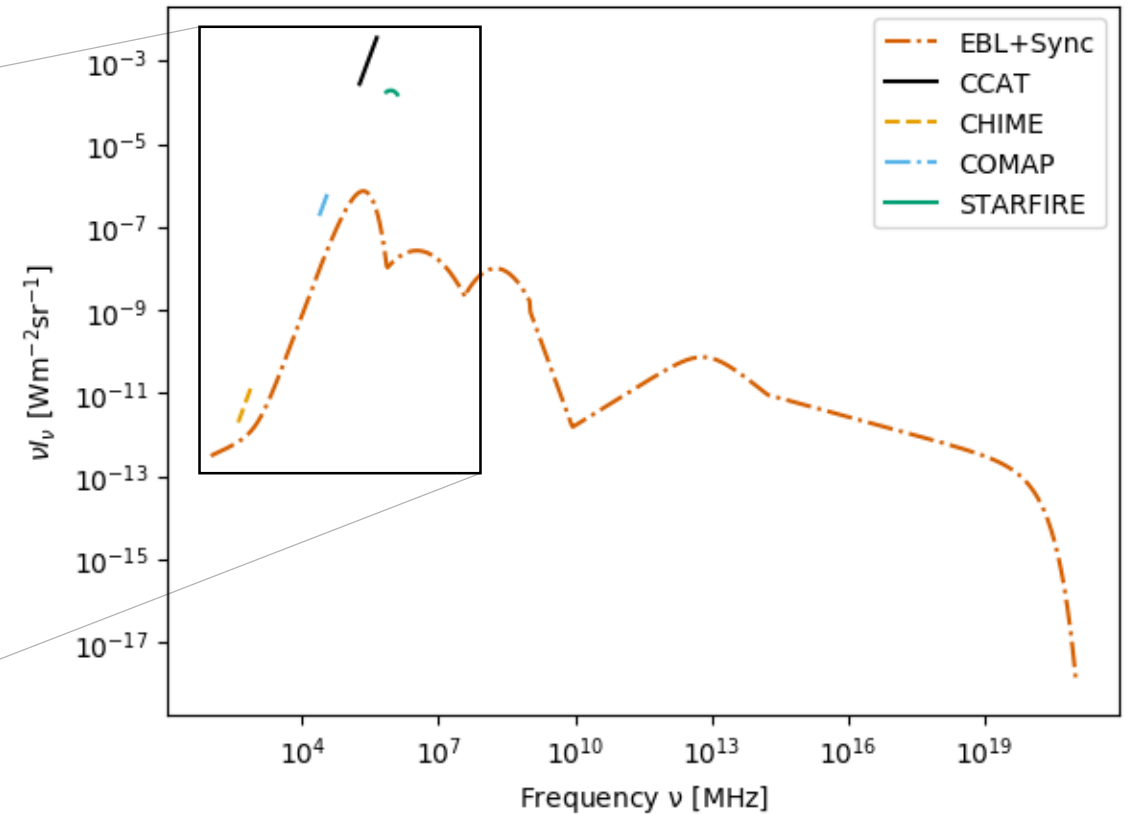
Extragalactic Background Light, Galactic Synchrotron Radiation ( $\nu \leq 100$  GHz)

Imperfect detector

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



Cosmic Background Specific Intensity + Instrumental Noise

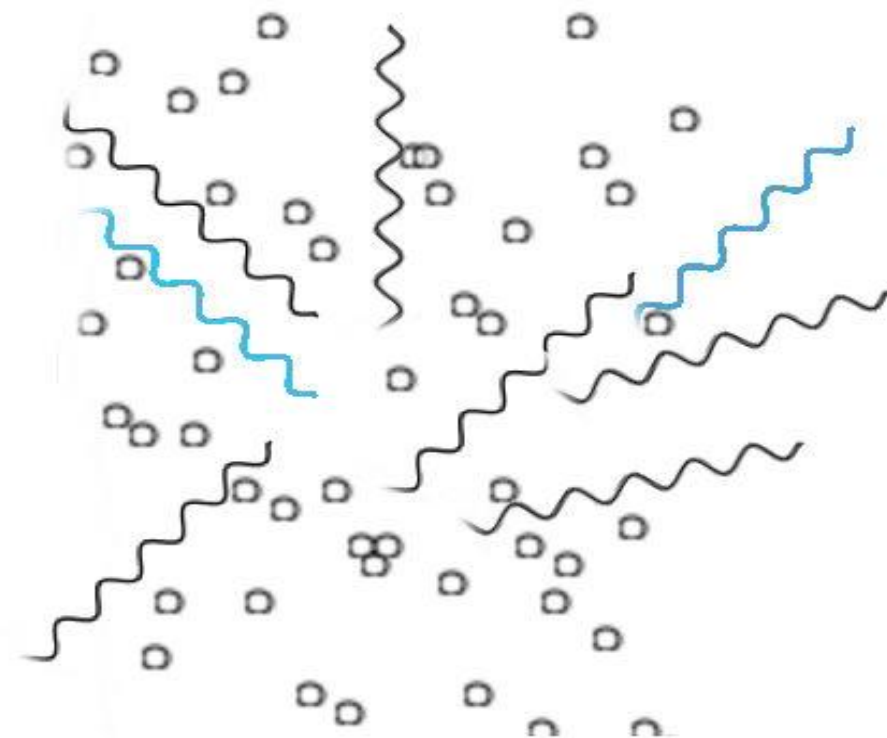
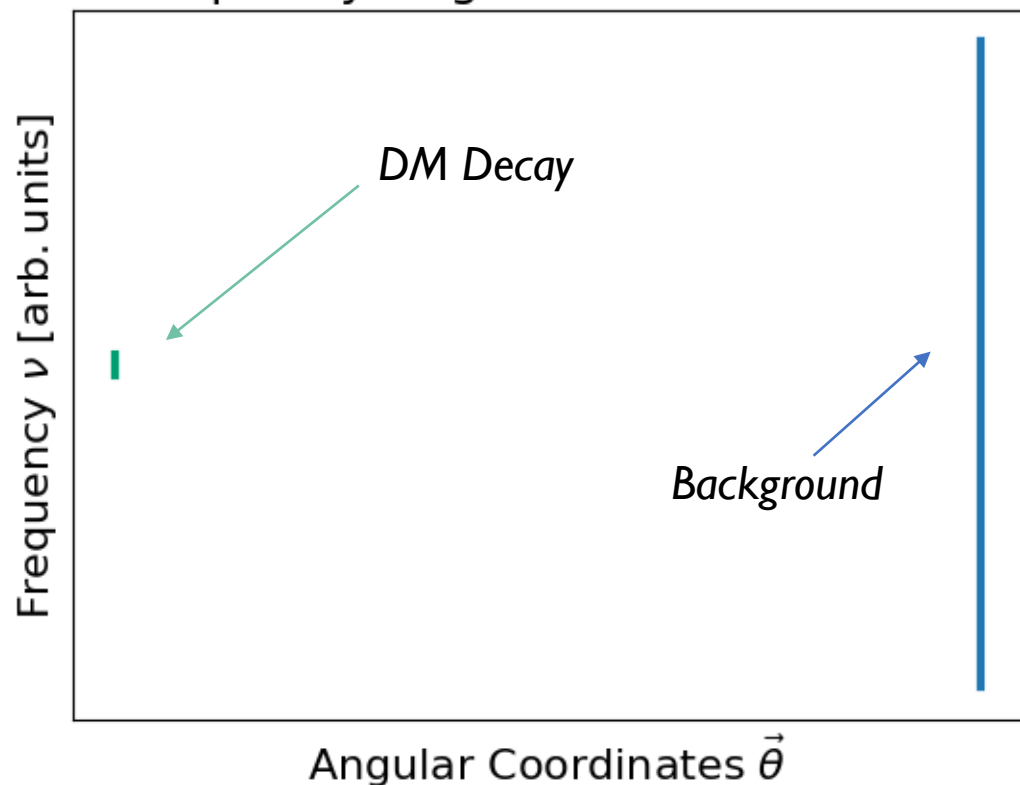


# How to distinguish these photons?

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

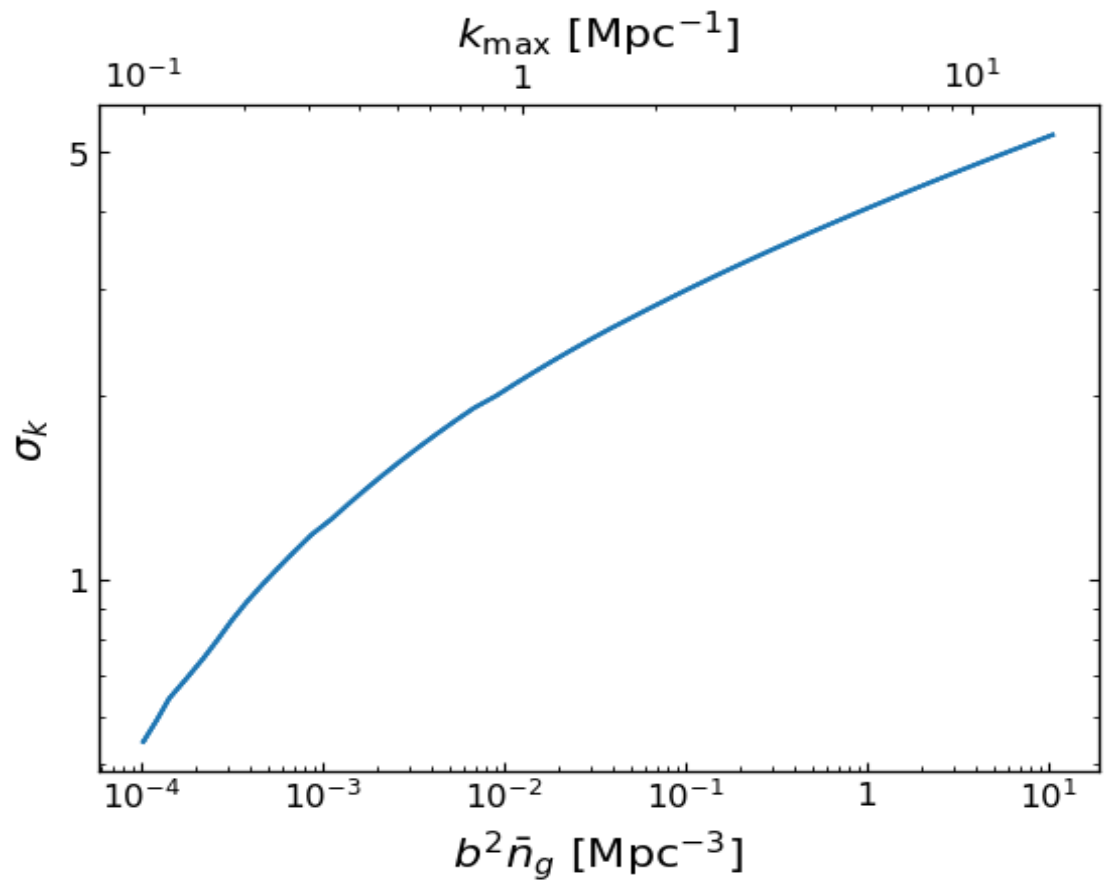
$$\langle \tilde{\delta}_g(\vec{k}) \tilde{\delta}_\gamma^*(\vec{k}') \rangle$$

IM Frequency-Angular Photon Distribution



# How do I know I have detected DM?

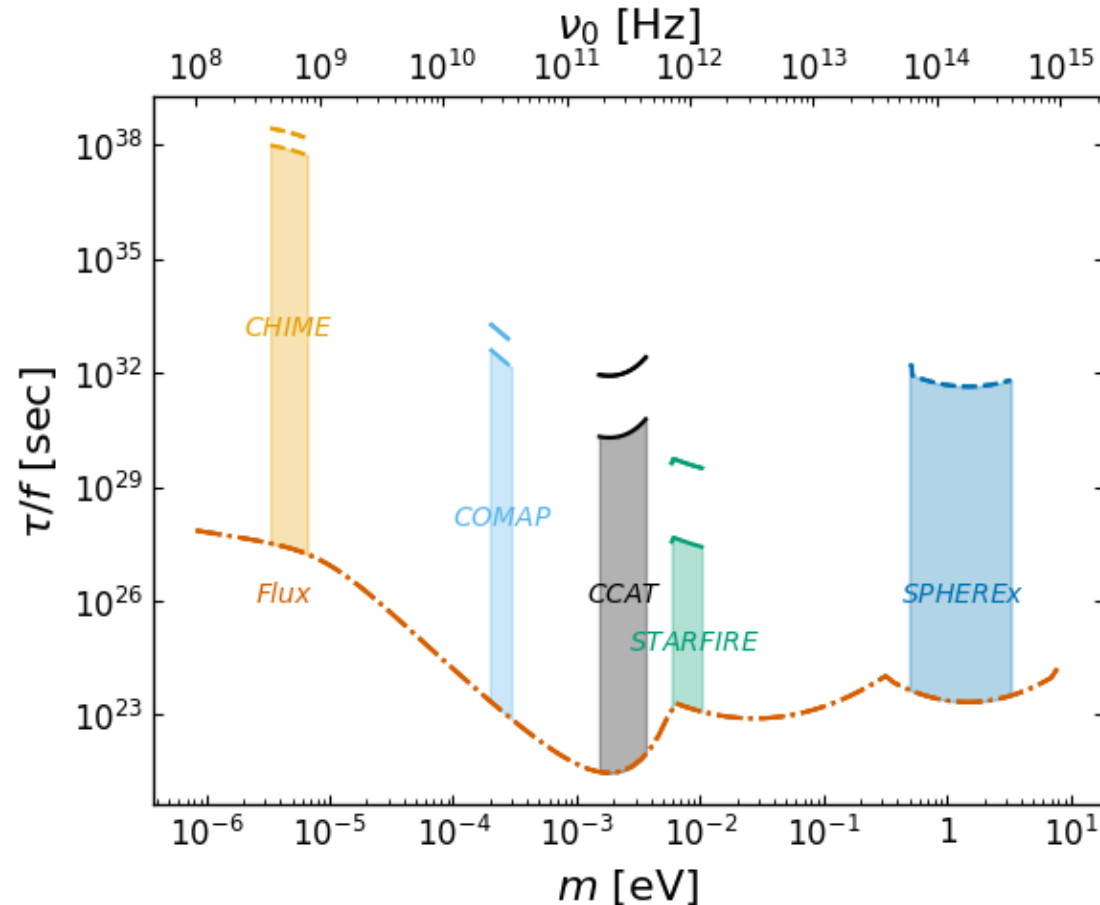
Count enough photons  $\xi \gtrsim \xi_{\min} \simeq 2(N_b \sigma_k^2 / 2)^{-1/2} \sqrt{1 + (N_n / N_b)}$



# 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
- $10^9$  constraining improvement
- Not cosmic-variance limited
- Noise doesn't ruin measurements