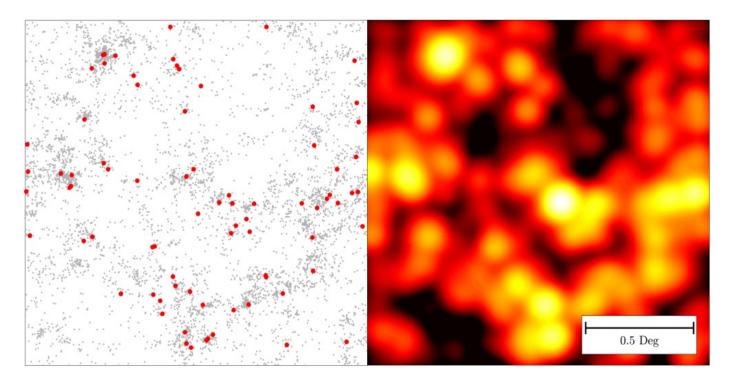
Searching for Decaying and Annihilating Dark Matter with Line Intensity Mapping

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What is Line Intensity Mapping (IM)?

Measures integrated emission from spectral lines in galaxies + diffuse IGM



Experiment	Target
CCAT	$\Big ext{[CII] (high } z) \Big $
CHIME	21-cm
COMAP	CO
STARFIRE	$ $ [CII] $(\log z)$
SPHEREx	$_{ m Hlpha}$

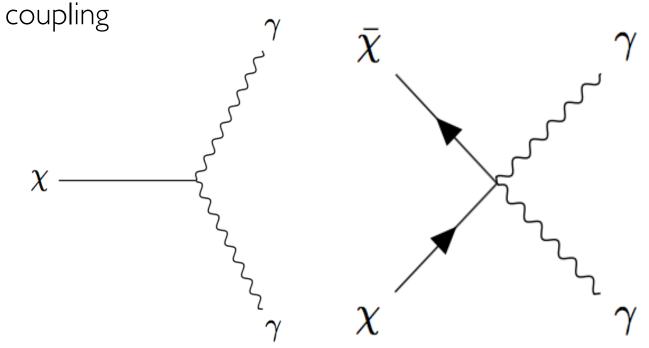
Image Source: Kovetz, et. al 1709.09066

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



What photons are we trying to observe?

Monoenergetic photons from a $DM(\chi)$ +photon(γ)



Experiment	Target
CCAT	[CII] (high z)
CHIME	21-cm
COMAP	CO
STARFIRE	[CII] (low z)
SPHEREx	$_{ m Hlpha}$

All DM Decay/Ann



What contaminants are there?

Extragalactic Background Light, Galactic Synchrotron Radiation ($\nu \leq 100~\text{GHz}$)

Imperfect detector Cosmic Background Specific Intensity + Instrumental Noise EBL+Sync 10^{-3} $T_B = 1000 \, \mathrm{K} \, (\nu / 100 \, \mathrm{MHz})^{-2.5}$ CCAT CHIME 10^{-5} COMAP STARFIRE 10^{-2} 10^{-7} ฟ_" [Wm⁻²sr⁻¹] 10^{-4} 10^{-9} 10^{-6} 10^{-11} $M_{\nu} \, [{\rm Wm}^{-2} {\rm sr}^{-1}]$ 10^{-13} 10^{-15} - 10^{-10} 10^{-12} 10-17 10⁵ 10⁶ 10⁷ 10⁸ 10² 10³ 10^{4} Frequency v [MHz] 10⁴ 10⁷ 10¹⁰ 10^{13} 10^{16} 10^{19} Frequency v [MHz]

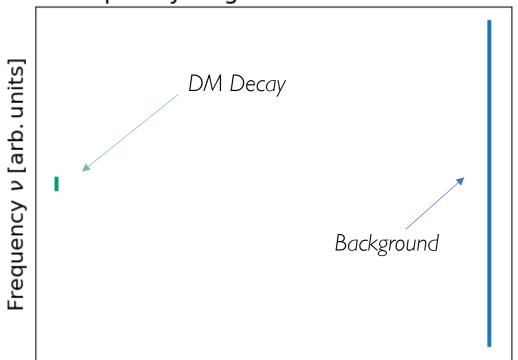


How to distinguish these photons?

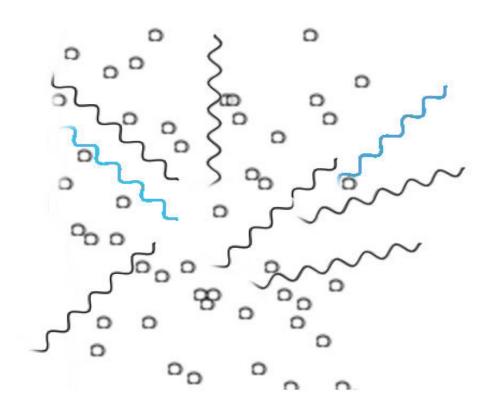
Cross correlating with a tracer (e.g. galaxies)

 $\left< ilde{\delta}_g(ec{k}) ilde{\delta}_{\gamma}^*(ec{k}')
ight>$





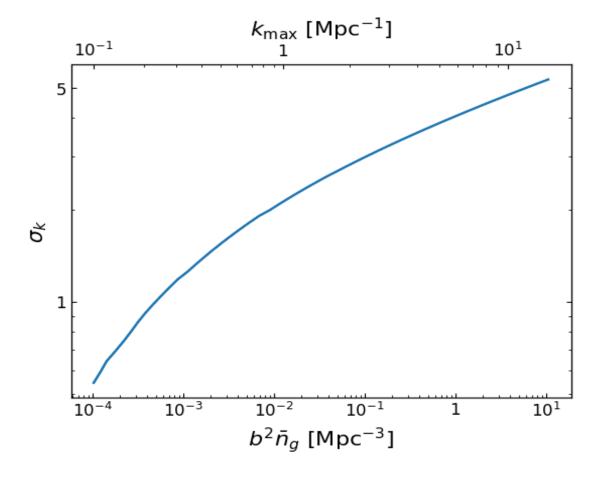
Angular Coordinates $\vec{ heta}$





How do I know I have detected DM?

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

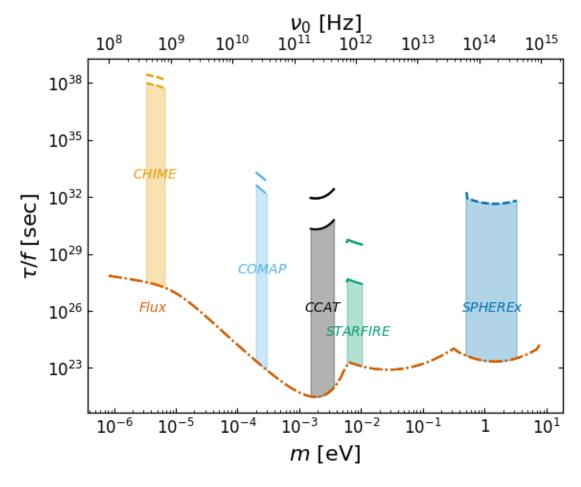




What constraints can I put if no detection?

Pretty good ones

$$au \simeq 7.5 imes 10^{32} rac{f \sigma_k (N_b/10^{20})^{1/2}}{(
u_0 I_{
u_0}^{\mathrm{CB}}/10^{-8} \, \mathrm{W \ m^{-2} \ sr^{-1}})} \sec a$$





Summary

• IM can detect DM decays and annihilation

Not cosmic-variance limited

Negligible background contributions

Noise doesn't ruin measurements

• 10⁹ constraining improvement

