

# Searching for Axion/Dark Photon Conversion Signals

Keston Smith, University of Alabama at Birmingham-SIST Intern

Raphael Cervantes - Fermilab, University of Washington

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## Cold Dark Matter in the Standard Model

- Dark matter is most notably observed through measurements of “invisible mass” in galactic rotation curves; other measurements also suggest its existence.
- A favorable representation for dark matter in the standard model could be a simple addition of a  $U(1)$  gauge symmetry.
- This extension could neatly represent the non-relativistic weakly interacting Cold Dark matter model.

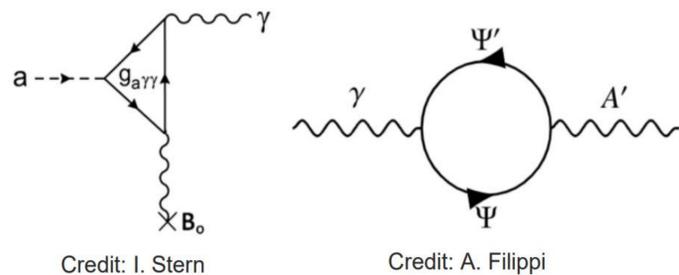


Figure 1: Feynman diagrams of SM photons with an axion and a dark photon from left to right.

- Axions and dark photons interact with the standard model photon through weak Primakoff scattering and kinetic mixing, respectively.
- It may be possible to detect the converted photon within the power spectrum of a tunable superconducting RF cavity.

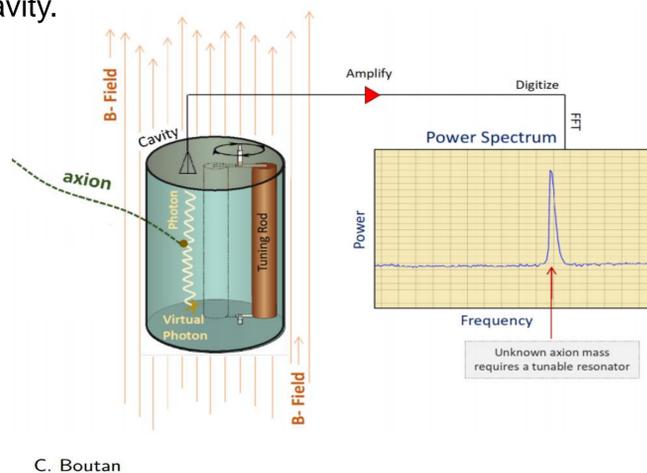


Figure 2: Schematic of a tunable cavity resonator, axions and dark photons are both measured using the same setup. A static external magnetic field is used to invoke interactions with axions in the local dark matter halo; local halo density in the lab frame is projected to be  $\rho_\Lambda = 0.45 \text{ GeV}/\text{cm}^3$ .

## Search for Narrow Conversion Signals

Simulate Raw Spectrum



Process Spectrum



Exclusion Limits

- Simulate an average spectrum of 1000 sub-spectra; power fluctuations in the analysis band can be described gaussian statistics by the Central Limit Theorem.
- The spectrum is standardized through the removal of electronic gain variation. This is done by dividing each spectrum by its baseline which effectively reduce the mean of the spectrum to one, each bin is then subtracted by one.
- Exclusion limits on dark matter search parameters are placed on frequency bins without dark photons and axion signals.

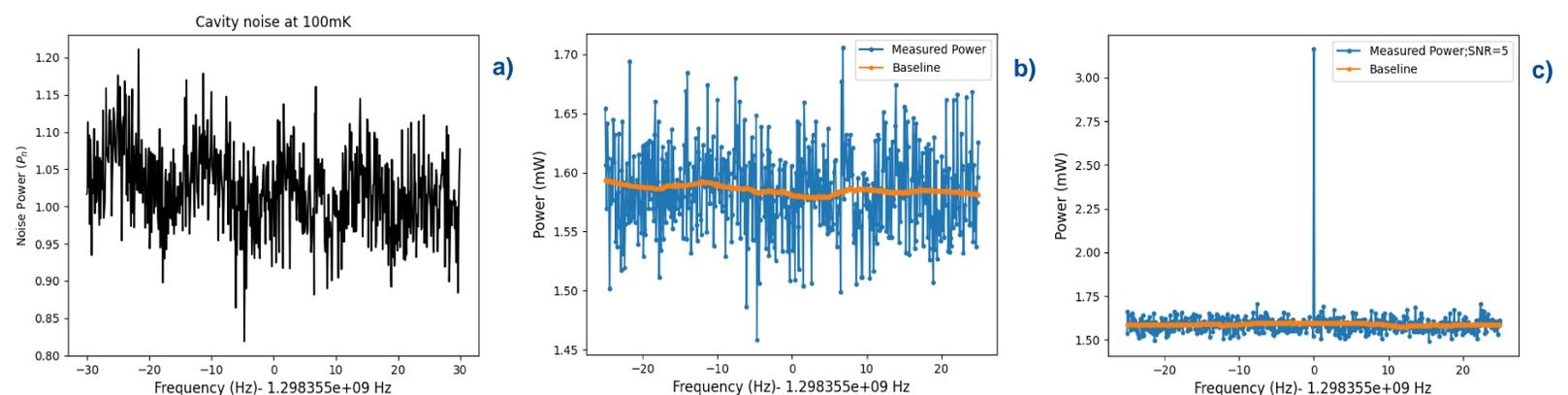


Figure 3: a) The simulated bins are samples drawn from a  $\chi^2$  distribution with 2 degrees of freedom. b) Measured power after variation removal and applying a second order Savitzky Golay (SG) filter. c) Measured power with an injected signal at the resonance frequency of the cavity.

## Simulated Spectra Analysis

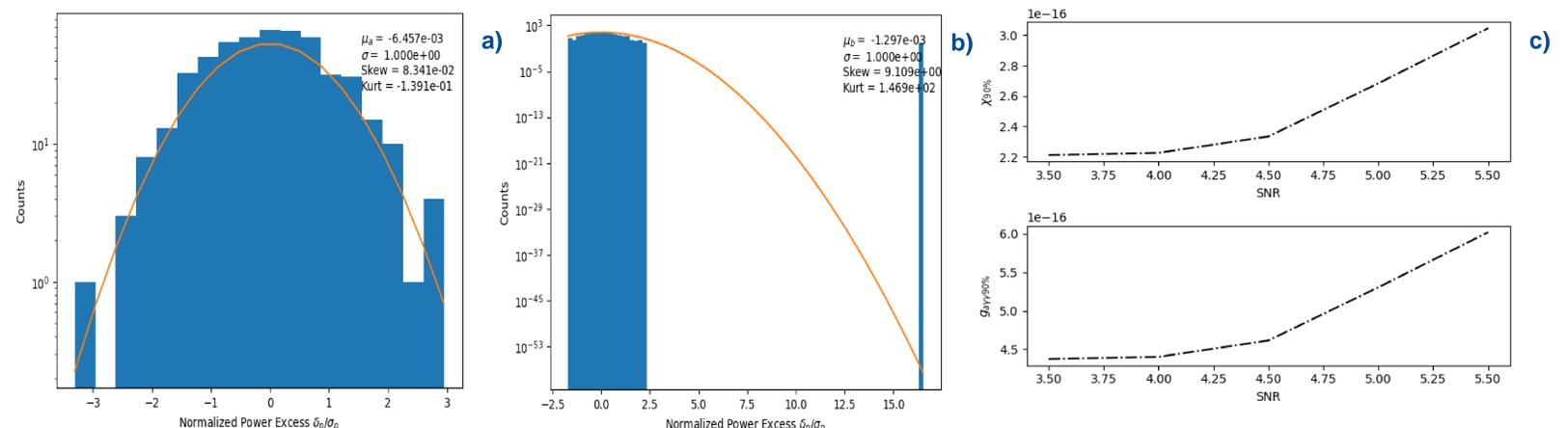


Figure 5: a) Power fluctuations are approximately  $\sim \mathcal{N}(0, 1)$  in the absence of a conversion signal. b) Now  $\mu_a < \mu_b$  as result of the injected signal. c) Search sensitivity is lost to the increase of the conversion signal strength.

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