Microwave cavity search for paraphotons

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Abstract. Two methods to experimentally search for the hidden sector photon, the paraphoton, with microwave cavities are explored and preliminary results given. The first approach mimics the light-shining-through-wall experiment where the oscillation of a photon into a paraphoton allows it to bypass a normally impenetrable wall and then oscillate back into a photon for detection [1]. Here instead of a laser, and Fabry-Pérot cavities [3], high Q microwave cavities are used [2]. An emitter cavity, hooked up to a signal generator, is placed on one side of a shielded wall whist a detector cavity, attached to a detector, is placed on the other. In the event of appropriate photon-paraphoton-photon oscillation microwaves will appear in the detector cavity. Our first prototype experiment uses copper cavities in a vacuum at room temperature and excited in the TE011 mode near 9.6 GHz with $Q \sim 10^4$. This set up is sensitive to the kinetic mixing parameter to the order of $\chi \sim 10^{-8}$[2].

The second approach aims to detect paraphotons by crossing an energy threshold for their production. A single microwave cavity is set up and the resonant frequency is made to slowly change. As the frequency of the photons resonating within the cavity change their energy may cross the threshold required for paraphoton production. If this threshold crossing occurs within our variable frequency range then we expect to see a sudden change in the amount of energy being detected in the cavity. Our preliminary experiments use highly stable cryogenic sapphire oscillators with frequency near 11.2 GHz and varied by temperature change. Because we are only concerned with the emittance of paraphotons in this method detection will be dependent on χ^2, instead of χ^4 as in light-shining-through-wall experiments where the paraphoton needs to reconvert back into a photon for detection. Over very small regions of paraphoton mass this is potentially sensitive to $\chi \sim 10^{-12}$.

Keywords: Hidden sector, Paraphoton, Microwave cavity
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