Multi-Mode Frequency Filtered Photon Correlations of a Driven Three-Level Ladder Atom

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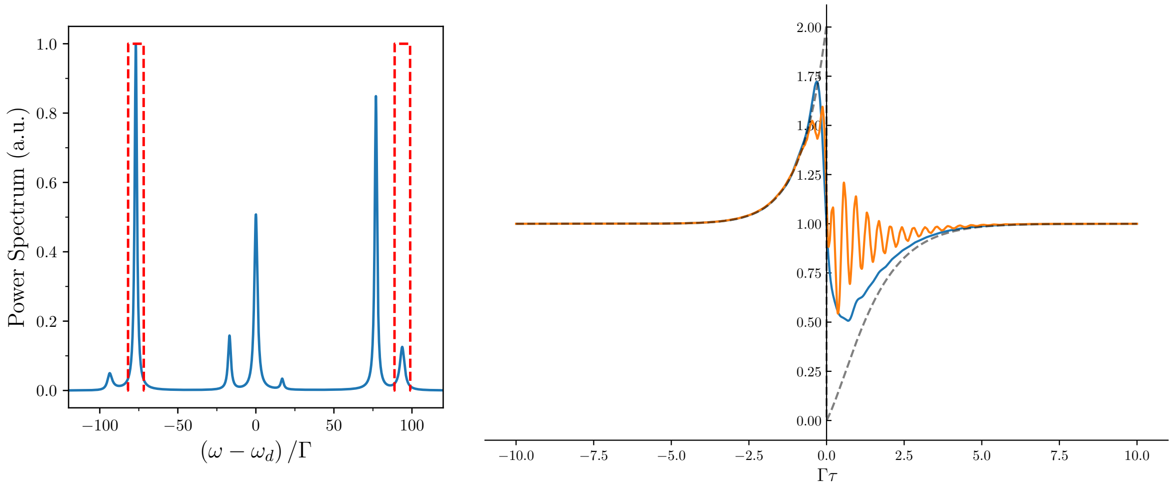
Resonance fluorescence and photon correlations are areas that have long been studied, and are integral to the field of quantum optics. Recently frequency filtered photon correlations and the method of frequency filtering have had a surge of interest [1–4]. In this work we develop a novel method of calculating frequency filtered photon correlations by coupling the atomic fluorescence – in this case, from a three-level ladder type atom [5, 6] – into an array of single-mode cavity filters. This coupling, modelled with an open cascaded systems approach [7, 8] is entirely unidirectional, allowing us to derive a closed set of coupled moment equations for the filter source operators. This provides an extremely efficient method for calculating frequency filtered second-order correlation functions.

The multi-mode array filter has an approximate box-shaped frequency response, giving a much sharper frequency cut-off compared to a standard single-mode cavity Lorentzian filter. We can then increase the bandwidth – increasing the temporal response – while still maintaining good frequency isolation. In Fig. 1 we show photon cross-correlations for the two isolated peaks in Fig. 1(a). In Fig. 1(b) we see a much smoother correlation function for the multi-mode array filter (blue) than in the Lorentzian filter (orange) due to the sharp frequency cut-off, while still closely following the "ideal" correlation functions derived in the secular approximation (dashed).



(a) **(b)**

Figure 1: Power spectrum of the three-level atom (a) and frequency filtered cross-correlations (b) for the highlighted peaks. We compare the frequency filtered correlations of the multi-mode array filter (blue) and a single-mode cavity filter (orange) with results derived from the dressed state picture in the ideal secular approximation (dashed).

References

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