Spontaneous six-wave mixing in cold ^{87}Rb ensemble

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Distributed quantum networks relying on atomic ensembles as quantum nodes require narrow-band photons at atomic transitions to implement important protocols, like DLCZ [1].

Our group recently demonstrated the generation of narrow-band, time-correlated four-photon state at the $D1$ (anti-Stokes) and $D2$ (signal) transitions of rubidium-87 [2], utilizing the double Λ scheme that couples the $5S_{1/2}$ with the $5P_{3/2}$ and the $5P_{1/2}$ levels, as shown in Fig. 1. Additionally, the generation of time-correlated photon pairs at 776 nm (idler) and 780 nm (signal) has been experimentally observed using the diamond scheme that couples the $5S_{1/2}$ to $5D_{5/2}$ via the $5P_{3/2}$ level (Fig. 1) [3].

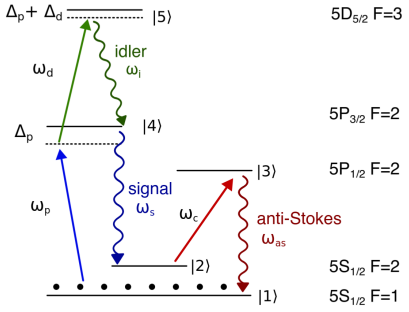

FIG. 1. Our scheme for spontaneous six-wave mixing in ^{87}Rb [3].

Theoretical analysis and preliminary results show the feasibility of generating time-correlated photon triplet by incorporating the diamond scheme within the double Λ scheme as show in Fig. 1. We aim to characterize the time correlation between all pairs among the generated triplets and explore entanglement properties among them.

[1] L. M. Duan *et al.*, *Nature* **414**, 413 (2001)
[2] Y. Li *et al.*, *arXiv* **2601.05558** (2026)
[3] Y. Li, *"Correlated Photon Pairs and Multiphoton States from a Cold Atomic Ensemble"*, Ph.D. thesis, National University of Singapore (2025).

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