

Frequency Multi-mode State Generation Via Four-Wave Mixing in Hot Alkali Atoms

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Optical parametric processes, such as those occurring in optical parametric oscillators and amplifiers, are key tools for generating non-classical states of light in the continuous variable (CV) domain [1]. Atomic systems further offer promising platforms for quantum memories in quantum information processing [2].

In this work, we report experimental results (as in figure 1) and a microscopic theoretical description of a rubidium-85 vapor-based optical parametric amplifier operating with two frequency-detuned collinear pumps. This configuration enables the generation of probe and conjugate beams containing multiple frequency modes. Our results represent a step toward the realization of entangled cluster states in ⁸⁵Rb D1 line wavelength, a crucial resource for universal CV quantum computation [3].

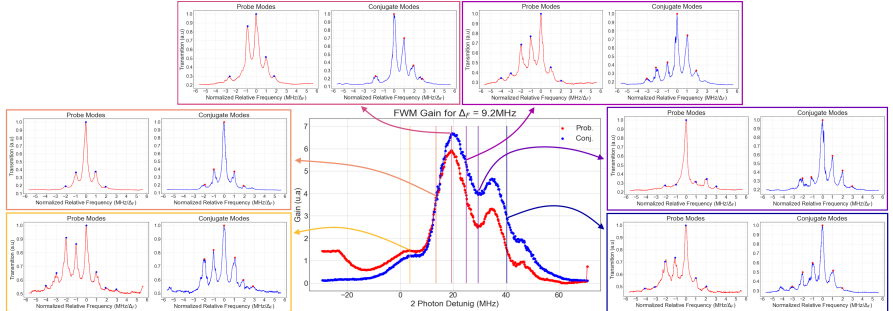


FIG. 1. Probe (red) and conjugate (blue) gain curves vs. two-photon detuning (δ) for a difference of $\Delta_F = 9.2$ MHz in the pumps frequency. Surrounding panels show the corresponding frequency mode distribution for specific δ .

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[2] R. Zhao *et al.*, *Nature Physics* **5** pages100–104 (2009)

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