Cavity Sub- to Superradiance Transition with Application to Ramsey Spectroscopy

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Large atomic ensembles coupled to a single optical resonator mode can be steered to strongly enhanced or suppressed collective emission via phase controlled excitation. Employing the Tavis-Cummings model using a second order cumulant expansion approach [1] we predicted that a homogeneously excited ensemble equally distributed between odd and even sites along the cavity mode is extremely subradiant as long as the average excitation remains below 50%, but shows pulsed emission for inversion [2]. The combination of these two properties enables the implementation of an efficient cavity-enhanced Ramsey probing featuring a fast readout and minimal heating with particular advantages for atomic clock transitions. We experimentally confirm the predicted excitation threshold for superradiant emission on a narrow optical transition and apply it in a Ramsey sequence [3]. The minimal heating of the atoms allows for multiple interrogations within one experimental cycle.

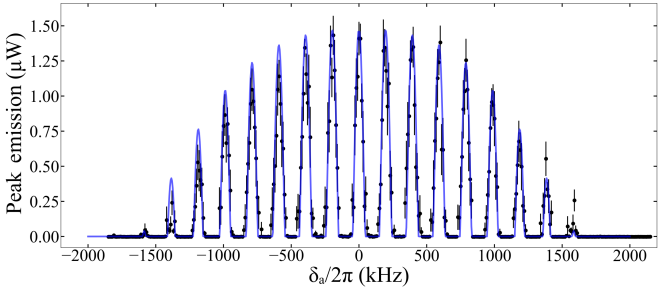

Fig. 1: Cavity Ramsey signal with characteristic flat zero-photon regions.

References

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