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Phase Synchronization between Superradiant Lasers JOSHUA WEINER, KEVIN COX, JUSTIN BOHNET, MATTHEW NORCIA, JAMES THOMPSON, JILA and University of Colorado at Boulder — Bad-cavity (or superradiant) lasers using highly forbidden atomic transitions are expected to achieve coherence lengths on the order of the earth-sun distance, with the potential to improve optical atomic clocks, long-baseline interferometry, and other precision measurements. Cold-atom Raman lasers operating deep in the superradiant regime have been demonstrated, where the effective atomic linewidth is much narrower than the cavity linewidth. We explore the interactions of two independently driven superradiant Raman lasers emitting into a single mode of an optical cavity. In particular, we present experimental studies of the time dynamics of phase synchronization of the two collective atomic dipoles after an external phase perturbation has been applied. Also, the two lasers are shown to undergo a transition from lasing at distinct frequencies to lasing at a common frequency as the relative detuning between their natural emission frequencies is decreased. This work with a model Raman system will inform strategies for mitigating phase noise in future superradiant lasers that will use highly forbidden optical transitions.

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