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Abstract for an Invited Paper
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New Tools for Precision Measurement and Quantum Science with Narrow Linewidth Optical Transitions

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I will present a set of tools that rely on narrow linewidth optical transitions to extend the capabilities of precision measurement and quantum science. The focus of this work has been the development of an experimental system in which large ensembles of strontium atoms are coupled to an optical cavity by narrow-linewidth optical transitions. This has enabled the first explorations of optical superradiance on such transitions, with the goal of creating a highly precise active optical frequency reference. Key results include first characterizations of superradiance from narrow (7.5 kHz) and ultranarrow (1 mHz) linewidth optical transitions, observations of interesting spin-exchange dynamics in the lasing system, and an assessment of the frequency stability of the superradiant light. Aside from superradiance, other projects from my thesis work include a demonstration of nondestructive atom counting using a narrow-linewidth transition, a fundamentally new form of laser cooling applicable to narrow-linewidth transitions, and extensions to proposed methods for using atoms to detect gravitational waves.