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Quantum synchronization and the no-photon laser[1]

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This talk will present a new approach to lasers that is based on the quantum synchronization of many atoms. Such lasers are predicted to produce light of unprecedented spectral purity and coherence, some two orders of magnitude better than any system available today. The idea is based on superradiant emission, where an ensemble of atoms with an extremely narrow atomic transition can phase-lock and form a macroscopic dipole that radiates light collectively. This is quite unlike a typical laser where atoms essentially act independently. The resulting light source is expected to have a spectral linewidth of just a few millihertz and could lead to more accurate and stable atomic clocks. Atomic clocks based on optical transitions have improved tremendously in recent years, giving clocks that tick 10^{15} times per second, and can have a fractional stability exceeding one part in 10^{16}. This new sharper light source aims to push the frontier even further, so that fundamental tests of physics, such as the time variation of constants and tests of gravity, might even be possible.

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