

# Superradiant transfer of orbital angular momentum to a Bose-Einstein condensate in a ring trap

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Orbital angular momentum (OAM) can be superradiantly transferred from a laser beam to ultracold atoms in a ring trap [1]. The spontaneous formation of the azimuthal bunching of ultracold atoms in the ring trap is at the core of the process. The process is similar to the quantum regime of collective atomic recoil lasing [2] and to the superradiant Rayleigh scattering [3], but with transfer of orbital angular momentum in units of  $\hbar$  instead of linear momentum in units of  $\hbar k$ . Differently from these linear configurations, the many harmonics of the potential here allow one to promote the atoms to one or more higher OAM states. This mechanism is particularly promising for the creation of states of matter with tailored OAM. Tuning the ring parameters and winding number of the pump light allows control of the emission to generate light with OAM different from that of the pump, as the atomic ring imprints its contribution on the scattered light.

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[2] R. Bonifacio and L. D. S. Souza, NIMA 341, 360 (1994).

[3] S. Inouye, et al., Science 285, 571 (1999).