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Cooperative light scattering from helical-phase-imprinted atomic rings[1] HSIANG-HUA JEN, Institute of Physics, Academia Sinica, M. S. CHANG, Y. C. CHEN, IAMS, Academia Sinica — We theoretically investigate the light scattering of the super- and subradiant states which can be prepared by the excitation of a single photon which carries an orbital angular momentum (OAM). With this helical phase imprinted on the stacked ring of atomic arrays, the subradiant modes show directional side scattering in the far-field, allowing for light collimation and quantum storage of light with OAM. For the excitations with linear polarizations, we find a discrete C_4 rotational symmetry in scattering for the number of atoms $N = 4n$ with integers n, while for circular polarizations with arbitrary N, the azimuthal and C_N symmetries emerge for the super- and subradiant modes respectively. When the radial and azimuthal polarizations are considered, a mode shift can happen in the scattering pattern. The forward scattering of the superradiant modes can be enhanced as we stack up the rings along the excitation direction, and for the subradiant modes, we find the narrowing effects on the scattering in the azimuthal and the polar angles when more concentric rings are added in the radial direction. By designing the atoms spatially, helical-phase-imprinted subradiant states can tailor the radiation properties, which is potentially useful in quantum information manipulations.

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