Bessel beams of laser-driven two-level atoms

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We study Bessel beams of two-level atoms that are driven by a linearly polarized laser field. Starting from the Schrödinger equation, we determine the states of two-level atoms in a plane-wave field respecting propagation directions both of the atom and the field. For such laser-driven two-level atoms, we construct Bessel beams beyond the typical paraxial approximation. We show that the probability density of these atom beams obtains a non-trivial, Bessel-type behavior and can be tuned under the special choice of the atom and laser parameters, such as nuclear charge, atom velocity, laser frequency, and propagation geometry of the atom and laser beams. Moreover, we temporally and spatially characterize the beam of hydrogen and neutral alkali-metal atoms, such as lithium, sodium and potassium, when (resonantly) driven on the 1s↔2p, 2s↔2p, 3s↔3p and 4s↔4p atomic transitions, respectively. We also show the effect of possible enhancement of the second maximum in the profile of these laser-driven atom beams. The proposed spatiotemporal Bessel states are able to describe, in principle, *twisted* states of any two-level system which is driven by the radiation field and have potential applications in atomic, nuclear processes and quantum communication.