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Stable Bessel Vortex Beams Sustained By Multiphoton Absorption In Self-focusing Kerr Media

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Bessel vortex beams (BVBs) are vorticity-carrying nonlinear Bessel modes, propagation-invariant solutions of the nonlinear Schrödinger equation with Kerr and multiphoton absorption (MPA) nonlinearities. As for the fundamental nonlinear Bessel beam case, their stationarity is supported by a power reservoir mechanism, which arises from its weak localization. In this work it is demonstrated how the MPA effect provides BVBs of simple and multiple topological charges with complete stability against both azimuthal breakup and collapse. A linearized stability analysis for small perturbations is used to vaticinate the stabilizing properties, and direct numerical simulations to verify the results. Furthermore, it is described how the model here proposed allows a common explanation to the three dynamical regimes previously observed in axicon-generated vortex beams propagating in nonlinear media: tubular, rotatory or specklelike filament regimes.

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