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Getting to know the elegance of Laguerre-Gauss beams

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Laguerre–Gaussian (LG) modes are solutions of the paraxial Helmholtz equation in cylindrical coordinates and are associated with light fields carrying orbital angular momentum (OAM). It is customary to modulate such beams using phase-only vortex profiles, e.g. when increasing (laddering up) or decreasing (laddering down) the OAM content of some given LG mode. However, the resulting beams have been shown to be hypergeometric-Gaussian modes, due to the changing radial amplitudes on propagation. In this work, we show that these beams in fact have the angular spectrum of a set of modes known as elegant Laguerre–Gaussian (eLG) modes, which map back to LG-type modes more intuitively than hypergeometric-Gaussian modes. Accordingly, the fields obtain new OAM and radial quantum numbers that depend on the initial OAM and additional OAM gained during modulation. Identifying the true modal structure of OAM-modulated beams as elegant Laguerre–Gaussian modes improves our understanding of beam evolution and supports more precise control in applications like optical communication, beam shaping, and quantum information processing.

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