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Nondiffracting accelerating wave packets beyond the paraxial limit PENG ZHANG, University of California, Berkeley, YI HU, Institut National de la Recherche Scientifique, Canada, TONGCANG LI, University of California, Berkeley, DRAKE CANNAN, San Francisco State University, XIAOBO YIN, University of California, Berkeley, ROBERTO MORANDOTTI, Institut National de la Recherche Scientifique, Canada, ZHIGANG CHEN, San Francisco State University, XIANG ZHANG, University of California, Berkeley — Self-accelerating Airy wave packets have stimulated rapidly growing research interest in the past five years. However, optical Airy beams are inherently subjected to the paraxial limit. Here, we demonstrate both theoretically and experimentally linear and nonlinear self-accelerating beams propagating along circular trajectories beyond the paraxial approximation. Such nonparaxial accelerating beams are exact solutions of the Helmholtz equation. Furthermore, we introduce and demonstrate nonparaxial Mathieu and Weber accelerating beams, generalizing the concept of all previously found accelerating wave packets. We show that such beams bend into large angles along elliptical or parabolic trajectories but still retain nondiffracting and self-healing capabilities. The circular nonparaxial accelerating beams can be considered as a special case of the Mathieu accelerating beams, while an Airy beam is only a special case of the Weber beams at the paraxial limit. Not only do generalized nonparaxial accelerating wave packets open up many possibilities of beam engineering for applications, but the fundamental concept developed here can be applied to other linear wave systems in nature, ranging from electromagnetic and elastic waves to matter waves.

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