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Quasinormal modes of Kerr black holes in the eikonal limit HUAN YANG, DAVID NICHOLS, FAN ZHANG, AARON ZIMMERMAN, California Institute of Technology, ZHONGYANG ZHANG, The University of Mississippi, YANBEI CHEN, California Institute of Technology — Quasinormal-mode frequencies of Kerr black holes with l=|m| and l=0 relate simply to equatorial and polar unstable spherical photon orbits (orbits restricted on spherical shells), respectively, in the eikonal limit (l >>1). The real part of a mode's frequency corresponds to the photon's orbital frequency, and the imaginary part of the mode's frequency relates to the Lyapunov exponent of the photon's orbit. Although a similar correspondence between non-polar and non-equatorial photon orbits and quasinormal modes with large l and |m|!=l or 0 has been predicted before, an explicit calculation comparing null geodesics to these more general modes (in the eikonal limit) has not been performed. In this article, we use a WKB analysis to reveal the connection between general spherical photon orbits and the least damped quasinormal modes in the eikonal limit. With our result, we find that for any black-hole spin parameter, there are pairs of quasinormal modes that have different l,m but the same real-part of their frequencies; furthermore, for values of black-hole spin parameter with this mode degeneracy, the corresponding spherical photon orbits are closed. In addition to revealing more about the structure of the quasinormal-mode spectrum of Kerr black holes, this relationship between closed orbits and degenerate modes bears an interesting similarity with the onnection between degeneracy in the spectrum of the hydrogen atom in quantum mechanics and closed orbits of a classical particle in a Coulomb potential.

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