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R. Konoplya: First few overtones probe the event horizon geometry

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It is broadly believed that quasinormal modes (QNMs) cannot tell the black-hole near-horizon geometry, because usually the low-lying modes are determined by the scattering of perturbations around the peak of the effective potential. Using the general parametrization of the black-hole spacetimes respecting the generic post-Newtonian asymptotic, we will show that tiny modifications of the Schwarzschild/Kerr geometry in a small region near the event horizon lead to almost the same Schwarzschild/Kerr fundamental mode, but totally different first few overtones. Having in mind that the first several overtones affect the quasinormal (QN) ringing at its early and intermediate stage [M. Giesler, M. Isi, M. Scheel, and S. Teukolsky, Phys. Rev. X 9, 041060 (2019)], we argue that the near-horizon geometry could in principle be studied via the first few overtones of the QN spectrum, which is important because corrections to the Einstein theory must modify precisely the near-horizon geometry, keeping the known weak field regime. We discuss the connection of this observation with the so called "overtones'instability"recently studied in [J. Jaramillo et. al. Phys. Rev. Lett. 128, 211102 (2022)].

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