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Modeling the Richness of Ringdown: From Spheroidal Decomposition to Beyond the Fundamental and First Order Quasinormal Modes LIONEL LONDON, Georgia Inst of Tech, JAMES HEALY, Rochester Inst Tech, DEIRDRE SHOEMAKER, Georgia Inst of Tech, GATECH CRA TEAM — Numerical relativity waveforms are traditionally decomposed into the orthogonal spin -2 spherical multipoles. The ringdown of black holes, however, is more naturally described by the non-orthogonal spin -2 spheroidal multipoles. As a consequence, numerical relativity ringdown waveforms consist of a superposition of spheroidal modes. Upon implementing a method that identifies the spheroidal multipole content in numerical relativity waveforms, we find not only the fundamental QNM amplitudes, but also overtones, and long lived 2nd order QNMs in a series of unequal-mass systems. We use a Post-Newtonian inspired model to present new fitting formulas for the related QNM excitations. Finally, we discuss the relevance of our results to advanced gravitational wave detectors by considering the SNR of ringdown only temples in an example scenario.

Lionel London
Georgia Inst of Tech

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