Title: On the stability of black hole quasi-normal modes: a pseudospectrum approach

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Abstract: Black hole (BH) quasi-normal modes (QNM) encode the resonant response of black holes under linear perturbations, their associated complex frequencies providing an invariant probe into the background spacetime geometry. In the late nineties, Nollert and Price found evidence of a BH QNM instability phenomenon, according to which perturbed QNMs of Schwarzschild spacetime migrate to new perturbed QNM branches of different qualitative behaviour and asymptotics. Here we revisit this BH QNM instability issue by adopting a pseudospectrum approach. Specifically, rather than starting from the formulation of QNMs in scattering resonance theory, we cast the QNM problem as an eigenvalue problem for a non-selfadjoint operator by adopting a hyperboloidal formulation of spacetime. Non-selfadjoint (more generally non-normal) operators suffer potentially of spectral instabilities, the notion of pseudospectrum providing a tool suitable for their study. We explore this problem in a numerical methodology based on pseudospectral methods. As a result, we find evidence that perturbed Nollert & Price BH QNM branches track the pseudospectrum contour lines, therefore probing the analytic structure of the resolvent. Specifically, we find strong support to claim: i) the stability of the slowest decaying (fundamental) mode, and ii) the high-frequency instability of all QNM 'overtones'. But numerical evidence is not a proof. The goal of this talk is to boost the interaction among physicists, geometers and analysts to fully assess this BH QNM instability problem.