Title:
Quasi-Normal Modes, Non-Selfadjoint Operators and Pseudospectrum: an interdisciplinary approach

Keywords: (Min. 5 words)
Quasi-normal modes, non-selfadjoint operators, pseudospectrum, non-normal dynamics, hyperboloidal approach, spectral instability, transients, pseudo-resonances, black hole spectroscopy

Background: (approx. 100-150 words)
Quasi-normal modes, namely the complex frequencies encoding the linear response of resonators under tiny perturbations, have acquired major importance in recent years in different settings of physics, ranging from astrophysical and theoretical problems in gravitational physics to the study of scattering properties of optical nanoresonators. Beyond physics, the subject makes direct contact with the study of the spectral and dynamical properties of non-selfadjoint operators, a very active area of current research in applied and fundamental mathematics with direct applications in physics, from hydrodynamics and turbulence to non-Hermitian quantum mechanics. In spite of these converging and complementary interests and working knowledge, research interchanges among the involved subcommunities seem quite scarce. In this setting, the central notion of Pseudospectrum provides a systematic framework furnishing a common arena to this interdisciplinary field of research, namely a crossroad in the physics and mathematics of open non-conservative systems.

Goal: (approx. 100-200 words)
The general goal is to bring to the front line of physics research the qualitative and quantitative features that are specific to systems whose dynamics is governed by non-selfadjoint operators. This generic goal is concretely articulated around the Pseudospectrum notion, a key concept in the spectral theory of non-selfadjoint (more generally, non-normal) operators. In this context, the main focus will be placed on the study of the structural stability of the spectrum of non-selfadjoint operators, with the calculation of quasi-normal modes in a variety of physical scenarios providing a particularly timely problem. Indeed, the recent introduction of the Pseudospectrum in the gravitation physics, namely in the study of the spectral instability of quasi-normal modes of black holes, has raised a number of problems that remain open and are urgent in the context of astrophysical compact objects as sources of gravitational waves. Crucially, this problem transcends the gravitational context making contact with other disciplines, such as optics. Complementary to this main spectral instabillity focus, and taking the Pseudospectrum as a bridge to the broader setting of non-modal analysis largely developed in fluid and turbulence physics), attention will be placed to dynamical transients and pseudo-resonances. The ultimate goal is the threading of an interdisciplinary research community framed around the application of non-selfadjoint operator concepts and tools in physics.

Scope and information for authors: (approx. 100-150 words)
Contributions to this Research Topic are expected to address a problem directly related or motivated by the physics and/or mathematics of non-selfadjoint operators. Among the possible topics to be covered we can mention: formulations of the quasi-normal mode problem as a non-selfadjoint problem with particular attention to hyperboloidal methods, spectral instability of quasi-normal modes and other non-selfadjoint spectral problems, application of the Pseudospectrum notion in physical settings (gravitational, optics, fluids, quantum mechanics...) or in applied mathematics in either spectral or dynamical settings, resonant (quasi-normal mode) expansions of scattered fields and implications from spectral instability, inverse problems in the data analysis of exponentially damped oscillating signals. This list is not exhaustive, but only indicative and open to consideration of affine subjects. Contributions can be in the form of an original research article but, given the need of building a common research framework, contribution in the fom of “reviews”, “general short commentaries” and “perspectives” are particularly welcome.