Hearing the Nature of Compact Objects

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With the detection of gravitational waves, a new era of astrophysics and fundamental physics is at dawn. Current and future gravitational wave detectors will measure the characteristic oscillation spectra of compact objects like neutron stars or black holes. These measurements can be used to study extreme astrophysics, the nature of compact objects and test general relativity as theory of gravity.

In this talk I present the so-called inverse spectrum problem, where one tries to reconstruct information of the source from a known spectrum. Studying axial perturbations of compact object space-times is a natural theoretical starting point. In this case the perturbation equations are tractable with semi-analytic methods. For spherically symmetric and non-rotating objects, the perturbation equations reduce to the one-dimensional wave equation with a potential term being characteristic for the underlying type of object. It is shown how generalized Bohr-Sommerfeld rules can be derived and used to reconstruct the perturbation potentials of different type of compact objects. However, as it is known from Mark Kac's famous question: "Can one hear the shape of a drum?" [1], uniqueness often plays a crucial role for inverse problems. It will be discussed as well and shown what type of physical assumptions allow for unique solutions.

Some of the methods and results being presented in this talk have been published over the last year [2–5].

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