SEMPARIS – Séminaires en région parisienne

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Cours

Vendredi 5 Octobre 2018, 10 :00
IPHT, Salle Claude Itzykson, Bât. 774(https ://courses.ipht.cnrs.fr/ ?q=en/node/220)
Domaines : astro-ph—gr-qc

Titre : *From Classical Gravity to Quantum Amplitudes (1/4)*

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Résumé : *The recent observation of gravitational wave signals from inspiralling and coalescing binary black holes has been significantly helped, from the theoretical side, by the availability of analytical results on the motion and gravitational radiation of binary systems.*

The course will deal with the Effective One-Body (EOB) theory of the motion and radiation of binary systems, and explain the links between this formalism and various classical and quantum approaches to gravitationally interacting two-body systems, from traditional post-Newtonian computations of the effective two-body action to quantum gravitational scattering amplitudes.

The following analytical techniques will be reviewed ab initio :
1 - Matched Asymptotic Expansions approach to the motion of black holes and neutron stars ;
2 - post-Newtonian theory of the motion of point particles ;
3 - Multipolar post-Minkowskian theory of the gravitational radiation of general sources ;
4 - Effective One-Body (EOB) theory of the motion and radiation of binary systems.

The EOB formalism was initially based on a resummation of post-Newtonian-expanded results. The post-Newtonian approach assumes small gravitational potentials and small velocities, and loses its validity during the last orbits before the merger of black holes. The resummed EOB approach was able to extend the validity of the post-Newtonian description of the motion and radiation of binary black holes to the strong-field, high-velocity regime reached during the last orbits, and the merger. EOB theory initially used a dictionary to translate post-Newtonian-expanded results on (slow-motion) bound states

of gravitationally interacting binary systems into the (resummed) Hamiltonian of a particle moving in an effective external gravitational field.

The second part of the course will present the recent extension of EOB theory to the description of (classical) scattering states within the post-Minkowskian approach which does not assume that velocities are small. This led to new insights in the high-energy limit of gravitational scattering and opened the way to transcribe quantum gravitational scattering amplitudes into their EOB Hamiltonian description. For instance, some two-loop ultra high-energy quantum scattering results of Amati, Ciafaloni and Veneziano could be transcribed into an improved knowledge of the high-energy limit of the classical gravitational interaction of two black holes. This leads also to interesting predictions about a linear-Regge-trajectory behavior of high-angular-momenta, high-energy circular orbits.
