with the support of Fondazione CRT

DOMOSCHOOL
International Alpine School of Mathematics and Physics

15 – 19 JULY 2019 - Domodossola -Italy

EINSTEIN EQUATIONS: PHYSICAL AND MATHEMATICAL ASPECTS OF GENERAL RELATIVITY

SHORT TALKS

Vittorio De Falco

Centre for Computational Physics and Data Processing Faculty of Philosophy & Science
Silesian University in Opava

New trends in the general relativistic Poynting-Robertson effect modelling

Abstract

In the radiation processes occurring in high-energy astrophysics around compact ob- jects, it is important to study how the gravitational pull interacts with the radiation field on the surrounding matter. If we consider a small-sized test particle, there is the appearance of the Poynting-Robertson (PR) effect, which is a general relativis- tic viscous phenomenon. I present the actual improvements brought to the general relativistic PR effect model from the results proposed by Bini and collaborators in the two-dimensional (2D) case done in 2009–2011. I show the extension of the 2D model in the three-dimensional (3D) space in the Kerr metric, for a radiation field emitted radially at infinity and from a rigidly rotating spherical source. It is built, as the previous 2D model, upon the ”relativity of observer splitting formalism”, powerful technique in General Relativity (GR). It admits the existence of a critical hypersurface, region where the gravitational and radiation forces balance and the matter tends to end its motion. I explain how to prove with an innovative technique the stability of these critical hypersurfaces. I show also some numerical simulations of selected test particle orbits.

I present how to study the general relativistic PR effect under the Lagrangian for- malism, very peculiar for a viscous system in GR, due to the high-non-linearities of the background metric. I describe how through an innovative mathematical method, termed ”energy formalism”, it is possible to determine the analytical form of the radiation potential and to solve other issues in metric theories of gravity.

I conclude with the discussion about future projects and possible astrophysical applications of the general relativistic PR effect model in high-energy astrophysics.