LECTURE: Gravitational Collapse

Abstract: In this lecture I will give a review of the gravitational collapse mechanism in relativistic hydrodynamics assuming spherical symmetry, presenting the set of non linear Einstein/fluid equations that need to be solved, focusing on perfect fluids. The equation of state plays an important role to determine the outcome of the collapse. I will then discuss the concept of space time foliation presenting the set of equations in two specific cases: the Misner-Sharp comoving observer (cosmic time) and the Misner-Hernandez null observer (observer time). The observer time foliation is particularly relevant for studying black hole formation, following the complete evolution of the black hole exterior. I will conclude introducing the concept of dynamical horizons for black holes in spherical symmetry, generalizing the well known Schwarzschild condition $R = 2M$ for the event horizon.

SEMINAR: Primordial Black Hole Formation

Abstract: Black holes can form in the early Universe from the collapse of cosmological perturbations after cosmological horizon crossing. In calculations of spherically symmetric collapse, starting with a non linear curvature perturbation in the super horizon regime, the non linear evolution is simulated using a Lagrangian relativistic hydrodynamical code. If the perturbation is larger than a threshold depending on the equation of state and on the specific shape of the perturbation, a black hole within an evacuated region is formed as an effect of the pressure gradients giving rise to a very strong relativistic wind. The mass spectrum of these objects is following the typical scaling law of critical collapse, described by a self similar solution. I will discuss in particular the dependence of PBH formation on the initial shape of the curvature profile showing the relation between the threshold amplitude and the steepness of the perturbation. Primordial black holes formed in the early Universe are possible candidates for the dark matter component of the Universe as well as for the seeds of supermassive black holes that we observe today in the centres of galaxies.