Courses

B. Dittrich

Quantum Gravity and Quantum Space-Time

J. Niemeyer

Cosmological signatures of axion-like particle dark matter

The three lectures will be on i) basics and early evolution, iii) signatures from the power spectrum, and iii) gravitational heating and boson stars.

A. Luna

Amplitudes, double copy and GW

M. Szczepanczyk

Hunting for the discoveries with GW

The newly-born Multi-messenger Gravitational-Wave Astrophysics is the new venue for discovery; it is one of the most exciting areas in Science. This new window probes phenomena previously not accessible with time-domain astronomy. Out of nearly a hundred gravitational-wave detections, the first binary black hole merger and an intermediate-mass black hole are the exceptional observations that challenged our understanding of the Universe. Along with detecting compact binary mergers, we also await discoveries of gravitational-wave bursts from exploding stars or cosmic strings. Future discoveries of special gravitational-wave sources should play a key role in this endeavor of exploring the Universe. Daily detections in the fourth observing run of LIGO, Virgo, and KAGRA are exciting opportunities. I will describe searches that have already made discoveries, such as real-time observation of the first binary black hole merger, and explain why they are successful in this discovery challenge. Finally, I will present the latest news from the observing run that will already few months into the observations.

Plenaries

H. Olivares

Simulating the multi-scale environment of supermassive black holes

The recent observations of supermassive black holes (SMBHs) Sgr A* and M87* performed by the Event Horizon Telescope (EHT) allow us to study strong gravity systems in a completely new way. The interpretation of these observations has gained considerable insight from comparisons with libraries of numerical simulations. In this talk, we will briefly review the process of simulation-based modeling used within the EHT, including its limitations and future directions in modeling techniques that have been proposed to overcome them. Finally, we will focus our attention on the important role of the large-scale environment surrounding these objects and present a simulation setup that aims to incrementally incorporate information from the large scales in event-horizon scale simulations.https://arxiv.org/abs/2301.12020

A. González-Morales

An overview of DESI Lyman alpha forest data and science.

The Lyman alpha forest measured from the spectra of high-redshift quasars observed with DESI will provide a wealth of information for cosmology. It will allow us to unveil the expansion history with great precision by measuring the BAO scale at redshift above 2, through the measurement of the forest absorptions auto-correlation and cross-correlations with quasars. Also it will provide information on scales of about tens of Mpc, allowing to set strong constraints to massive neutrinos and dark matter with small scale suppression, such as warm and scalar field dark matter. In this talk I will give an overview of the Lyman alpha DESI early data analysis and main results as well as prospects for the first year analysis.

A. L. García

Relativistic gases: transport properties in flat and curved space-times.

The transport equations describing relativistic systems are established, together with the corresponding dissipative force–flux relations, within the formalism of kinetic theory to first order in the gradients. Both the flat and curved space-time cases are addressed including the effects of relativistic molecular velocities. In particular, the constitutive equations for the heat flux and viscous tensor are obtained for appropriate collisional models and the temperature dependence of the corresponding transport coefficients is analyzed. The general behaviour of the macroscopic equations is discussed in the particular case of a self-gravitating gas in the static background case.

C. Herdeiro

On the fate of the light ring instability

In this contribution, we provide a concise description of our code CAFE, specifically tailored for the study of Fuzzy Dark Matter dynamics. Throughout our research, we have pursued various incremental steps, each contributing to a certain understanding of the subject. Our endeavors include: constructing simple stationary solutions with spherical symmetry, exclusively composed of FDM, that show core-tail structures; developing stationary solutions that encompass both FDM and an ideal gas, broadening the scope of our investigations; constructing halos based on a multimode expansion of the wave function; exploring the evolution of systems governed by the GPP system, which include binary and multi-mergers, multimode halos, as well as the evolution of merger trees; introducing the coupling with an ideal gas, thereby enabling the exploration of mergers resulting in the formation of disks; conducting a detailed study of the influence of domain topology on various dynamical processes at local scales, revealing valuable insights into their behavior; investigating the core-halo scaling relation and its dependency on boundary conditions, further enriching our comprehension of FDM dynamics. These incremental steps have advanced our understanding of Fuzzy Dark Matter dynamics and hold the potential to contribute positively to the community.

M. Zanolin

Multimessenger astronomy for core colapse supernovae

In this talk I will give an overview of recent trends in combining Gravitational waves, neutrino and EM observations to detect GWs from CCSNe and performastrophysical parameter estimation on the progenitor.

T. Matos

On the physics of the Gravitational Wave Background

It is a matter of fact that the universe lives on a Gravitational Wave Background (GWB). This GWB is extra energy that is not contained in Einstein's equations. In RMF67 (2021) 040703, a new model was developed to explain the accelerating expansion of the universe where a GWB was incorporated into Einstein's equations by extending them as $R_{\mu\nu}-\frac{1}{2} Rg_{\mu\nu}+\frac{2\pi^2}{{\lambda}^2}g_{\mu\nu}=\kappa ^2 T_{\mu\nu}$, where ${\lambda}$ is the Compton wavelength of the graviton. In this talk we explain the important points of this new paradigm. Due to GWB, quantum particles cannot follow geodesic, but rather stochastic trajectories. In this talk, we start by adding a stochastic term to the trajectories of quantum particles and derive the corresponding field equations for a quantum particle. We arrive at the Klein-Gordon equation in curved spacetime and from it we obtain a generalized Schr\"odinger equation. This leads to the following relevant result: the Schr\"odinger equation can be a direct consequence of the fact that the universe lives in a GWB. At the end, we briefly talk about the cosmology derived from this paradigm.