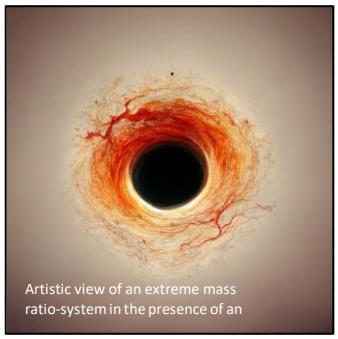
HIGHLIGHTS 2022

The DNRF Chair grant on **Black hole spectroscopy in the gravitational-wave era** started in October 2022 and it has been an exciting beginning of activities for the Strong group as a whole. The Strong group studies fundamental questions, which relate to gravity in mostly unexplored regimes: is gravity described by Einstein's theory? Do black holes exist? What happened at the beginning of the Universe? Can we use black holes as probes of other interactions? To realize the tremendous underlying discovery potential, we combine unique know-how in theory together with observations.


The Strong team in front NBI, Oct. 2022

We established the DNRF team in the Fall of 2022 with the hiring of two Postdocs, Drs. *Shilpa Kastha* and *David Perenniguez*, as well as two PhD students, *Jaime Redondo Yuste* and *Chun Lung Chan*, supervised by DNRF Chair Prof. Vitor Cardoso.

Work in Strong was recognized with a number of awards and honors. Prof. Cardoso was elected to the Lisbon Academy of Sciences, and was awarded an ERC Adv. Grant and a Villum Investigator Grant, whereas Assistant Prof. Jose Ezquiaga was awarded a Young Villum Investigator Grant and elected co-chair of the new LIGO-Virgo-KAGRA lensing group. Research in Strong is already receiving international attention. Highlights include a number of invitations to deliver colloquia and seminars worldwide (in the past few months, in Germany, Italy, Korea, Spain, The Netherlands, Portugal, UK). The Strong group published over 40 papers in leading international journal, including a number of articles in high-profile journals, e.g. Nature Astronomy, Physical Review Letters (PRL) and Physical Review D Letters.


Artistic view of an extreme mass ratio-system in the presence of an

We highlight a recent PRL work, since it is directly related to one of the priorities of the DNRF Chair. Next generation of gravitational-wave detectors will observe signals from small compact objects orbiting supermassive black holes inside galactic cores. Modeling such extreme-mass ratio systems is a daunting task on its own, made even more challenging by the recent black hole images of M87 and Sagittarius A*, which indicate highly complex descriptions of galactic centers. Accretion disks, dark matter halos, and tertiary companions are all expected to affect the binary evolution. But to understand the importance of astrophysical environments, or if they can undermine tests of General Relativity, one needs accurate gravitational-waveform models for the radiation emitted by these binaries. A comprehensive description of such binaries in non-vacuum environments was missing. In a PRL article, Prof. Cardoso and collaborators employed relativistic perturbation techniques to study black holes surrounded by generic matter distributions.

The team has bid for membership to the LISA consortium (the largest European Space Agency mission, composed of thousands of members, and of which Prof. Cardoso is a Board member), leading the NBI efforts in this direction. We are happy to announce that the group was formally accepted on January 9, 2023. We have also welcomed a number of international researchers both for seminars and collaboration visits, across all levels of seniority and in collaboration with other research groups at NBI. In terms of outreach, Prof. Cardoso led a podcast on science ((IN)PERTINENT, 12 episodes) organized by one of the largest philanthropic institutions in Portugal, co-starring the most popular comedian in the country (Joana Marques).