

The DNRF Chair grant on **Black hole spectroscopy in the gravitational-wave era** started in October 2022 and it is now a reputed group in Europe producing some of the most exciting research in strong gravity. 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?

In 2023, in accordance with the main goal of the DNRF Chair, we re-designed black hole spectroscopy, with three seminal results, now being explored by the community: i. We showed that black hole ringdown carries imprints of the nonlinearities of Einstein's equations; ii. The black hole spectrum is *unstable* when external effects are included and iii. Evidence for overtones in gravitational-wave data will likely need to wait for future gravitational wave detectors, e.g. LISA in 2034. These results are re-shaping the field and community, and even though published only last year, all Strong articles on this matter are top cited works already. In 2023, we established the Hyperboloidal Research Network, an effort to strengthen a multidisciplinary community, launched with the 'Infinity on a Gridshell' workshop at NBI, running monthly web seminars and developing open-source codes. The Strong group published over 60 papers in leading international journals, including a number of articles in high-profile journals, e.g. Nature Astronomy, Physical Review Letters and Physical Review D Letters.

Strong organized 3 high-profile international events: i. The **26th Capra Meeting**, where the DNRF Chair grant financed 10 'student traveling grants' for PhD/Master students from underrepresented regions. We also hosted invited speaker Prof. Abhay Ashtekar, Penn State, for an NBI colloquium; ii. The **LISA working Group meeting on Fundamental Physics** was hosted at NBI, and both of these events cemented Denmark as a hub for strong field gravity and brought together hundreds of key players in the community;



iii. the **Kavli-Villum School** in Corfu, organized jointly between Strong and Cambridge, where the next generation of leaders were trained. We also organized the Strong PhD Day 2023.

The professional highlights of 2023 were the start of the Villum Young Investigator Grant awarded to Jose Ezquiaga and the formation of the LIGO group, making NBI the first Danish institution to join this international collaboration. Work in Strong was recognized with a number of awards and honors. Prof. Cardoso was appointed IST Distinguished Professor, an honor given yearly to one or two faculty members, and was nominated by the Portuguese government as member of the Science Council of FCT (main funding body for science).

The team grew from 15 members to 26 during 2023, and Strong members, including PhD students, were invited as plenary or Colloquium speakers in over 30 events worldwide. We now have a steady stream of requests to host researchers with their own fellowships (we highlight a two-year Swiss National Fellowship, two Marie Curie and two CNPq grants, all joining in 2024). In addition to the enormous advances in spectroscopy, we initiated two new research lines: one on magnetism, offering a fresh perspective to explore fundamental physics from black holes; the second on the generic tidal response of black holes. Finally, we continue our pioneering work on exploring black holes as detectors for ultralight particles, yielding significant observational implications for both the Event Horizon Telescope and high-energy neutrino observations.