Symposium Neutron stars (SYNS)

jointly organised by
the Gravitation and Relativity Division (GR) and
the Hadronic and Nuclear Physics Division (HK)

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Neutron stars belong to the most extreme objects in our universe, whose properties stretch our imagination to its limits. Here are two examples: 1) On such a star, the weight of a teaspoon full of its average matter is comparable to that of a mass of our entire Moon placed on the surface of the Earth. 2) Strengths of magnetic fields exceed the critical one, at which the energy difference of a spin-up and spin-down electron is at the pair-production threshold. Clearly, the understanding of such objects poses an outstanding challenge to modern physics, involving an unusually rich and complex combination of our most fundamental theories. Our symposium aims to shed some light from various angles on the current status of this rapidly evolving and most fascinating field.

Overview of Invited Talks and Sessions

(Lecture hall Audimax)

Invited Talks

SYNS 1.1	Thu	14:00–14:40	Audimax	**Binary neutron stars: from gravitational to particle physics** — •Luciano Rezzolla
SYNS 1.2	Thu	14:40–15:20	Audimax	**Probing subatomic physics with gravitational waves** — •Tanja Hinderer
SYNS 1.3	Thu	15:20–16:00	Audimax	**A NICER view of neutron stars** — •Anna Watts

Sessions

SYNS 1.1–1.3	Thu	14:00–16:00	Audimax	**Symposium on Neutron Stars**

SYNS 1: Symposium on Neutron Stars

Time: Thursday 14:00–16:00 Location: Audimax

Invited Talk SYNS 1.1 Thu 14:00 Audimax

Binary neutron stars: from gravitational to particle physics — •Luciano Rezzolla — Institute for Theoretical Physics, Frankfurt, Germany

I will argue that if black holes represent one the most fascinating implications of Einstein's theory of gravity, neutron stars in binary system are arguably its richest laboratory, where gravity blends with astrophysics and particle physics. I will discuss the rapid recent progress made in modelling these systems and show how the gravitational signal can provide tight constraints on the equation of state for matter at nuclear densities, as well as on one of the most important consequences of general relativity for compact stars: the existence of a maximum mass. Finally, I will discuss how the merger may lead to a phase transition from hadronic to quark matter. Such a process would lead to a signature in the post-merger gravitational-wave signal and open an observational window on the production of quark matter in the present Universe.

Invited Talk SYNS 1.2 Thu 14:40 Audimax

Probing subatomic physics with gravitational waves — •Tanja Hinderer — Institute for Theoretical Physics, Utrecht University, NL

The gravitational waves from merging binary systems carry unique information about the internal structure of compact objects. For neutron stars – objects comprising matter compressed by strong gravity to supra-nuclear densities where novel phases emerge – this opens unique opportunities for advancing our understanding of matter and fundamental interactions in largely unexplored regimes. Measuring this information in the data analysis relies on accurate models of the interplay of matter with strong-field, dynamical gravity. I will discuss the imprints of neutron star matter on the gravitational wave signals during the binary inspiral epoch, and the need for modeling these effects with a tapestry of approximation schemes for the interplay of dynamical gravity and matter. I will also highlight what we can learn from binaries involving a neutron star and a black hole and summarize the new insights we have gained from recent gravitational-wave measurements of such systems as well as from double neutron star events. I will conclude with an outlook onto the remaining challenges and exciting prospects for the next years, as gravitational-wave science continues to move towards an era of precision physics.

Invited Talk SYNS 1.3 Thu 15:20 Audimax

A NICER view of neutron stars — •Anna Watts — University of Amsterdam

NICER, the Neutron Star Interior Composition Explorer, is an X-ray telescope on the International Space Station. Its mission is to study the nature of the densest matter in the Universe, found in the cores of neutron stars. NICER uses Pulse Profile Modeling, a technique that exploits relativistic effects on X-rays emitted from the hot magnetic polar caps of millisecond pulsars, to make simultaneous measurements of neutron star masses and radii. These depend directly on the dense matter Equation of State. Pulse Profile Modeling also lets us map the hot emitting regions, which form as magnetospheric particles slam into the stellar surface at the magnetic polar caps. I will present NICER's latest results - including a measurement of the radius for the highest mass pulsar known - and discuss the implications for our understanding of ultradense matter, pulsar emission, and neutron star magnetic fields.