Plenary Talk PV I Mon 9:00 Audimax

Measurement theory for quantum fields — •Christopher Fewster — Department of Mathematics, University of York, Heslington, York YO10 5DD. United Kingdom

Great emphasis is placed on the problem of measurement in quantum mechanics. However, a parallel discussion for quantum field theory (QFT) is much less well-developed, despite its foundational importance and the conceptual interest arising from the inclusion of relativity.

This talk will describe how the measurement chain can be described in QFT. Measurements of a quantum system are made by temporarily coupling it to a probe (itself a quantum system). Once the coupling is removed, the probe is measured and the results are interpreted as the measurement of a system observable. This arrangement is called a *measurement scheme* for the latter observable; although measurement schemes have been studied extensively in quantum mechanics, they have rarely been discussed in the context of quantum fields and still less on curved spacetimes.

I will describe how measurement schemes may be formulated for quantum fields on curved spacetime within the general setting of algebraic QFT. This allows the discussion of the localisation and properties of the system observable induced by a probe measurement,and the way in which a system state can be updated thereafter. The framework is local and fully covariant, allowing the consistent description of measurements made in spacelike separated regions. In particular, it sheds light on an old problem due to Sorkin concerning "impossible measurements" in which measurement apparently conflicts with causality.

Plenary Talk PV II Mon 9:45 Audimax

What's in a Shadow — •Heino Falcke — Radboud University, The Netherlands

The inside of black holes is shielded from observations by an event horizon, a virtual one-way membrane through which matter, light and information can enter but never leave. This loss of information, however, contradicts some basic tenets of quantum physics. Does such an event horizon really exist? What are its effects on the ambient light and surrounding matter? How does a black hole really look? Can one see it? Recently we have made the first image of a black hole and detected its dark shadow in the radio galaxy M87 with the global Event Horizon Telescope. Detailed supercomputer simulations faithfully reproduce these observations. Simulations and observations together provide strong support for the notion that we are literally looking into the abyss of the event horizon of a supermassive black hole. The talk will review the results of the Event Horizon Telescope, the nature and meaning of the black hole shadow, its scientific implications and future expansions of the array.

Plenary Talk PV III Tue 9:00 Audimax

ASDEX Upgrade tokamak: 30 years of science and technology development for a fusion power plant — •Arne Kallenbach — Max-Planck-Institut für Plasmaphysik, Garching

This year, 30 years of plasma operation at the ASDEX Upgrade tokamak in Garching have been completed. Over these three decades, the world map of fusion research facilities has undergone significant changes. ASDEX Upgrade has delivered numerous contributions towards the realization of nuclear fusion as clean and almost exhaustless energy source. Many elements of the experiment can be regarded as blueprint for a future reactor, like e.g. its tungsten plasma facing components and the use of impurity injection for gentle power exhaust. After a short introduction into the basics of nuclear fusion utilizing magnetic confinement and the actually favored reactor design, the talk will address important achievements and remaining obstacles and how they could be overcome. Examples are the rapidly growing understanding of plasma transport and stability, as well as solutions related to the occurrence of repetitive edge instabilities, plasma current disruptions and requirements of steady state operation. In addition to improved physical understanding, the increase of computational power and new numerical tools help in extrapolating the ASDEX Upgrade results to a reactor. Newly developed control techniques may even be directly applicable in any large device.

Plenary Talk PV IV Tue 9:45 Audimax

Superheavy Element Research at GSI — •Michael Block — GSI Helmholtzzentrum für Schwerionenforschung — Helmholtzinstitut Mainz — Universität Mainz

The investigation of superheavy elements (SHE) was one of the motivations for the foundation of the GSI Helmholtzzentrum in Darmstadt about fifty years ago. Around that time, shell-stabilized SHE were predicted to exist in the region Z = 114, N = 184 and to form a region of long-lived nuclei, the famous island of stability. In the following decades SHE up to element 118 were synthesized with the help of accelerators, among them six elements were discovered at GSI. Despite this progress several open questions remain, for example what the heaviest element that can exist will be. At the GSI in Darmstadt, we perform a comprehensive research program addressing all aspects of this multifaceted science field. Within the FAIR phase-0 program we performed several experiments investigating atomic, nuclear and chemical properties of SHE. Recent highlights comprise nuclear spectroscopy of Fl isotopes, laser spectroscopy of Fm and No isotopes, and high-precision mass measurements up to Db shedding light on the nuclear structure evolution of these exotic nuclei. In this contribution, I will present select results from the recent FAIR phase-0 campaigns and discuss future perspectives.

Evening Talk PV V Tue 19:00 ET

Galaxien und Schwarze Löcher — •Reinhard Genzel — Direktor, MPI für extraterrestrische Physik, Garching — Professor of the Graduate School, Physics and Astronomy, University of California, Berkeley, USA

Seit der Entdeckung der Quasare vor etwa 50 Jahren haben sich die Indizien gehäuft, dass in den Zentren von Milchstraßensystemen massive Schwarze Löcher sitzen, die durch Akkretion von Gas und Sternen effizient Gravitationsenergie in Strahlung umwandeln. Durch hochauflösende Messungen im Infrarot- und Radiobereich ist es jetzt im Zentrum unserer eigenen Milchstraße gelungen, einen überzeugenden Beweis für diese Hypothese zu liefern, und gleichzeitig neue und unerwartete Resultate über den dichten Sternhaufen in der unmittelbaren Umgebung des Schwarzen Lochs erbracht. Hierbei haben neue Entwicklungen in der Infrarotinstrumentierung und der adaptiven Optik und Interferometrie am neuen Großteleskop der ESO, dem VLT, eine wichtige Rolle gespielt. Gleichzeitig ist es klargeworden, dass die meisten Galaxien massive Schwarze Löcher beherbergen, und dass diese Schwarzen Löcher bereits etwa eine Milliarde Jahre nach dem Urknall entstanden sein müssen. Es werden diese neuen Messungen und ihre Konsequenzen für die Entstehung von Schwarzen Löchern im frühen Universum diskutiert.

Plenary Talk PV VI Wed 9:00 Audimax

Low pressure dusty plasmas for the synthesis of nanocrystals and quantum dots — •Uwe Kortshagen — University of Minnesota, Minneapolis, MN, USA

Chemically reactive nonthermal plasmas at low pressure are an interesting environment for the growth of nanocrystals. Molecular precursors are dissociated by electron impact reactions and the resulting molecular fragments and radicals, many of them charged, nucleate to form clusters and nanocrystals. Energetic surface reactions can heat these initial clusters to temperatures that exceed the gas temperature by hundreds of Kelvin. This enables plasmas to form crystalline nanoparticles even of materials with very high melting points. This presentation briefly discusses the physics of the plasma nanocrystal growth mechanisms and then highlights some examples of applications of plasma synthesized nanocrystals. Silicon quantum dots with the proper surface functionalization exhibit strong photoluminescence, different from bulk silicon material, and have shown promising properties for solar luminescent concentrators. The ability of plasmas to produce doped nanocrystals has recently enabled new insights into the electronic transport in nanocrystal films, including the first observation of the insulator-to-metal transition in plasma-produced nanogranular media. Plasma produced nanocrystals also have interesting properties for new photonic applications.

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Plenary Talk PV VII Thu 9:00 Audimax

Direct high-efficiency generation of the third harmonic wavelength in interference layer systems — •Marco Jupe[1], Detlev Ristau[2], and Wolfgang Rudolph[3] — [1]Laser Zentrum Hannover e.V., Hollerithallee 8 30419 Hannover, Germany — [2]Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [3]Dept. Physics and Astronomy, University of New Mexico, Albuquerque, NM 87131 USA

The direct generation of third harmonics delivers significant technical advantages for integration in optical systems. In particular, the

compact form of the one-step conversion process can prove to be a decisive advantage over the classical, two-step second-order conversion processes. In addition, centrosymmetric materials can be used for the third-order process, which significantly expands the material spectrum. A major technical challenge for the conversion is the strong dispersion of the refractive index and the associated phase mismatch, which cannot be compensated even by exploiting birefringence. Here, a concept based on interference filters to solve this problem was developed by UNM. The interference filters are designed to generated the THG in the high refractive index layer and compensated in the low refractive index layers. Additionally, exploiting resonant structures increases the conversion efficiency. In the presentation, theoretical and experimental results up to now are presented. For the designs, six different concepts have been developed and evaluated up to now. In application, the damage threshold of the materials currently limits the efficiency. Nevertheless, efficiencies of just under two percent have been shown.

Plenary Talk PV VIII Thu 9:45 Audimax

Geophysics in Elysium Planitia - First Year Results from the InSight Mars Mission — •Matthias Grott[1], Bruce Banerdt[2], Suzanne Smrekar[2], Tilman Spohn[1], Philippe Lognonne[3], Christopher Russel[4], Catherine Johnson[5], Don Banfield[6], Justin Maki[2], Matt Golombek[2], Domeniko Giradini[7], William Pike[8], Anna Mittelholz[5], Yanan Yu[4], and Attilio Rivoldini[9] — [1]German Aerospace Center, Berlin, Germany — [2]Jet Propulson Laboratory, Pasadena, USA — [3]IPGP, Paris, France — [4]UCLA, Los Angeles, USA — [5]University of British Columbia, Canada — [6]Cornell University, Ithaca, USA — [7]ETHZ, Zürich, Switzerland — [8]Imperial College, London, UK — [9]Royal Observatory, Brussels, Belgium

On November 26, 2018, NASA's InSight mission landed in Elysium Planitia, Mars, and installed the first geophysical station on the planet. InSight's primary payload consists of a seismometer, a heat flow probe, and a radio tracking experiment to determine the planet's rotational state. In addition, the lander is equipped with a robotic arm that has been used to deploy the seismometer and heat flow probe, two cameras, a radiometer, and an atmospheric and magnetic field package. InSight's primary objectives are to determine the interior structure, composition, and thermal state of Mars, as well as constrain present-day seismicity and impact cratering rates. While the heat flow probe was able to emplace sensors to a depth of 0.37 m only, the seismometer has been successfully installed. Here we will provide a mission overview and report on results obtained during the first year of operations on Mars.

Plenary Talk PV IX Fri 9:00 Audimax

Renaissance of nuclear physics at the LHC — •Laura Fabbietti for the ALICE-Collaboration — Technische Universität München, München, Germany

High energy LHC experiments provide a unique laboratory for nuclear and hadron physics studies that have a wide breadth of possible applications to astrophysics. This talk will report on recent and truly interdisciplinary studies carried out within the ALICE collaboration. On the one hand, we can address the formation process and properties of light anti-nuclei that constitute a pivotal ingredient in searches for dark matter in cosmic rays. On the other hand, we have carried out high precision studies of kaon-nucleon, hyperon-nucleon and hyperon-hyperon interactions and properties of (anti)hypernuclei that are fundamental to study the equation-of-state of neutron stars. As case in points we will highlight the recent measurement of the $^3\bar{H}e$ absorption cross section and its impact for the indirect search of dark matter and the unprecedented measurements of the p-Σ, p-ϕ p-Ξ, p-Ω and p-Λ interactions and the consequences for the equation of state of hyperon stars. The perspectives for the upcoming Run 3 and Run 4 campaigns at the LHC will also be discussed.

Plenary Talk PV X Fri 9:45 Audimax

How does the heat get to the ice? - Comprehensive year-round observations of ocean-ice-atmosphere interactions in the high Arctic Ocean — •Christian Haas[1,2] and MOSAiC Team[1] — [1]Alfred Wegener Institute, Bremerhaven, Germany — [2]Institute of Environmental Physics, University of Bremen, Germany

Arctic sea ice retreats rapidly with profound consequences for climate and the ecosystem, however the underlying processes and their interactions are still poorly understood quantitatively, and regional and climate model projections are uncertain. In 2019/20 the international Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) set out to improve process understanding and model parameterizations by collecting the most comprehensive, year-long observations ever of the atmosphere, ice, ocean, and ecosystem and their interactions in the high Arctic Ocean. The German research icebreaker Polarstern was used as a drifting base camp to support the work in, under, and above the ice. Here we briefly summarize the events of the expedition and its most important results. These show the importance of heat fluxes in the atmospheric and oceanic boundary layers for the growth and melt of sea ice, and of the wind and current driven redistribution of snow and ice for the sea ice mass balance. Attempts to budget energy and matter fluxes and their impact on sea ice growth and melt show the challenges related to inconsistent satellite data products and to distributed measurements of parameters subject to variability on different temporal and spatial scales.