Plenarvortrag PV I Mo 11:45 S1/01 A1

Neutrinos - a window to new physics — •Christian Weinheimer — University of Münster, Institut für Kernphysik, Germany

With the discovery of neutrino oscillations (Nobel Prize in Physics 2015) with atmospheric and solar neutrinos as well as its confirmation by reactor and accelerator neutrinos, it became evident that neutrinos feature very interesting properties, like neutrino mixing or non-zero masses. The origin of the neutrino masses probably lies beyond the usual Yukawa-coupling to the Higgs boson and might be connected to physics beyond the Standard Model at much higher scales. In such models neutrinos are their own antiparticles giving rise to neutrinoless double beta decays. The neutrino mixing angles, the possible leptonic CP violating phase as well as the sizes and the hierarchy of neutrino masses have very important consequences. In addition to the 3 known neutrinos even additional sterile neutrinos might exist.

Neutrino masses and mixing are equally important for astrophysics and cosmology: The sizes of the neutrinos masses define their role in the evolution of the universe or neutrino oscillations help cooling in supernova explosions. Finally neutrinos are very interesting messengers to understand astrophysical processes from nuclear fusion in our sun up to ultrahigh energetic processes in the universe.

After a brief recap of the discovery of neutrino oscillations an overview on these questions will be given concentrating on topics related to nuclear and hadron physics like the search for neutrinoless double beta decay, neutrino oscillation experiments with solar and reactor neutrinos as well as the direct search for the neutrino mass scale.

Plenarvortrag PV II Mi 9:00 S1/01 A1

Nuclear Structure Studies using Coulomb Excitation at REX-ISOLDE (CERN) — •Nigel Warr for the Miniball-Collaboration — Institut für Kernphysik, Universität zu Köln

Coulomb excitation (Coulex) was one of the main tools for studying nuclei in the early days of nuclear physics, as it can be performed at relatively low beam energies. With improvements to accelerators, this technique became somewhat neglected and nuclear physicists shifted their focus to high spin. In the last 15 years, however, the advent of post-accelerated radioactive beams from ISOL facilities like REX-ISOLDE (CERN) has renewed interest in Coulex. As these beams generally have low energies, techniques like Coulex have come back into fashion, with the important difference, that it is now the Coulex of the exotic beam rather than a stable target, which is of interest. The nuclei of interest have a significant velocity, making a Doppler-shift correction essential. The Miniball array pioneered such γ-ray spectroscopy with radioactive beams at REX-ISOLDE and was the first of the new generation of segmented-detector arrays, which have lead the way forward towards tracking detectors like AGATA. This lead, as a direct consequence, to an increased interest in Coulex, whether it be for the island of inversion around ^{32}Mg or for the octupole deformation of ^{224}Ra. Examples will be presented from over a decade of Coulex studies with Miniball at REX-ISOLDE as well as the prospects for Coulex with the upgrade of this facility: HIE-ISOLDE, which came online this autumn, with energies of up to 4 MeV/nucleon.

Plenarvortrag PV III Mi 9:45 S1/01 A1

Production of fragile objects in high energy collisions at the LHC — •Benjamin Dönigus for the ALICE-Collaboration — Institut für Kernphysik, Goethe Universität Frankfurt

The high collision energies reached at the Large Hadron Collider (LHC) at CERN in proton-proton, proton-lead and, in particular, lead-lead collisions, lead to significant production rates of fragile objects, i.e. objects whose binding energies are small compared to the mean kinetic energy of the particles produced in the system. Such objects are, for instance, light (anti-)nuclei and (anti-)hypernuclei.

The most extreme example here is the hypertriton, a bound state of a proton, a neutron and a Λ, where the separation energy of the Λ is only around 130 keV. These states, from the anti-deuteron up to the anti-alpha nuclei, are nevertheless created and observed in heavy-ion collisions. Their production yields can even be well described in a statistical-thermal model approach with only three parameters, namely chemical freeze-out temperature $T_{\rm ch}$, volume V and baryo-chemical potential $\mu_{\rm B}$. The latter is close to zero at LHC, which means the ratio of anti-baryons to baryons is close to unity and in continuation also anti-nuclei and nuclei are produced in equal amounts. $T_{\rm ch}$ at the LHC is extracted to be 156 MeV, which is a factor 1000 above the binding energy of the Λ to the deuteron, inside the hypertriton.

In addition, the thermal model can be used to make predictions for the production of other fragile objects, such as hyperon-nucleon or hyperon-hyperon bound states. The data collected at LHC can be used to test the existence of these bound states.

Plenarvortrag PV IV Do 9:00 S1/01 A1

Status and Future of Neutrino Physics with Scintillator-Based Detectors — •Livia Ludhova — Forschungszentrum Jülich, Wilhelm-Johnen-Straße, 52428 Jülich and RWTH Aachen, Otto-Blumenthal-Straße, 52074 Aachen

The liquid-scintillator detection technique has gained a fundamental role in neutrino physics. High light yield, and thus a possibility of low-energy threshold and a good energy resolution, are fundamental in a wide variety of applications. With its use in the detection of reactor antineutrinos, KamLAND provided one of the first observations of neutrino oscillations. When combined with extreme radio-purity, as achieved by Borexino, solar-neutrino spectroscopy below 1 MeV became a reality. Geo-neutrinos, messengers about the radioactive decays inside the Earth, have been detected as well in liquid scintillator detectors. The recent discovery of non-zero θ13 mixing angle by Daya Day was based on the same detection technique. Liquid scintillators, when doped with special isotopes, are entering in the field of neutrinoless double-beta decay search, as KamLAND using 136Xe. There are several future projects based on liquid-scintillator detectors in different stages of their proposal and/or construction. SNO+, opting for 130Te-loaded scintillator, should come on scene in a near future. The first detector exceeding the existing 1-kton scale, is the JUNO 20 kton detector, which is planning to start taking data in 2020. The talk will review the status and prospects of the neutrino physics based on the liquid-scintillator detection technique.

Plenarvortrag PV V Do 9:45 S1/01 A1

From COSY to HESR and EDM-at-COSY — •Mei Bai — Forschungszentrum, Juelich, Germany

The COoler SYnchrotron (COSY) at Juelich is a low to medium energy accelerator of polarized and unpolarized protons and deuterons[1]. Equipped with both electron cooling as well as stochastic cooling, COSY was the working horse for hadron physics with internal target as well as extracted beam for external targets during the past two decades[2], and yielded many important physics results including the observation and confirmation of a di-baryon state[3]. Lately, COSY has transformed itself into an ideal test facility for various developments of accelerator and detector technology, including the High Energy Storage Ring (HESR) and the PANDA detector at Facility of anti-proton and Ion (FAIR). As one of the few polarized light ion accelerators in the world, COSY is an ideal facility for the R&D efforts towards a dedicated storage ring for direct charged particle's electric dipole moment (EDM) search, which can provide a direct understanding of the asymmetry between matter and antimatter in our universe[4]. This presentation reports the current status of COSY and its plans for HESR and storage ring based EDM search developments including a very first experiment to search the deuteron's EDM in COSY.

[1] R. Maier, Nucl. Inst. Meth. A390, 1 (1997) [2] K.-Th. Brinkmann, Physics Program at COSY, Proceedings of 11th International Conference on Meson-Nucleon Physics and the Structure of the Nucleon, 2007 [3] P. Adlarson et al, PRL 112, 202301 (2014) [4] http://collaborations.fz-juelich.de/ikp/jedi/about/introduction.shtml

Abendvortrag PV VI Do 20:00 S1/01 A1

Fusion von Wasserstoff – Energie der Zukunft oder ewiger Traum? — •Thomas Klinger — Max-Planck-Institut für Plasmaphysik, Garching

Bereits seit einem halben Jahrhundert beschäftigt sich die Forschung mit der Frage, ob die Prozesse auf der Sonne zur Energieerzeugung auch auf der Erde nachvollzogen werden können. Diese so genannte „Fusion“ leichter Wasserstoffkerne zu schwererem Helium ist ein verblüffend einfaches Konzept, aber äußerst schwierig im Labormaßstab zu realisieren. Jedoch hat es in aller Stille gewaltige Fortschritte gegeben, die es jetzt sinnvoll erscheinen lassen, Versuchsanlagen im Kraftwerksmaßstab aufzubauen. Gelingt es, die verbliebenen physikalischen und technologischen Herausforderungen zu meistern, hätte man damit eine neue Energieform der Menschheit verfügbar gemacht, die viele Vorteile hat: Sie ist unerschöpflich und für alle verfügbar. Sie ist aus sich heraus sicher und ohne Endlagerproblematik. Sie würde die Grundlast bedienen und wäre damit die ideale Ergänzung zur schwankenden Verfügbarkeit erneuerbarer Energien. Und sie könnte die dringend benötigte Prozeßwärme für chemische Katalyse liefern. Der durchaus steinige Weg zu dieser neuen Energie wird in diesem Vortrag in einem breiten Kontext weitgehend allgemein verständlich erläutert.

Plenarvortrag PV VII Fr 9:00 S1/01 A1

High-precision comparison of the antiproton-to-proton charge-to-mass ratio — •Christian Smorra for the Baryon Antibaryon Symmetry Experiment-Collaboration — CERN, 1211 Geneva 23, Switzerland — Ulmer Initiative Research Unit, RIKEN, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan

Invariance under the combined charge, parity and time-reversal (CPT) symmetry is the most fundamental symmetry of the Standard Model. As consequence, particles and their conjugate antiparticles have identical masses, lifetimes, and charges and magnetic moments of opposite sign. This allows to test CPT invariance by high-precision measurements of these fundamental properties.

In this talk, I will present our recent charge-to-mass ratio comparison of the proton and the antiproton. The measurement was carried out at the Baryon Antibaryon Symmetry Experiment (BASE) located at CERN's Antiproton Decelerator. To this end, the cyclotron frequencies of a single antiproton and a negative hydrogen ion as a proxy for the proton are compared by placing them alternately in the same magnetic field. Therefore, we developed a fast adiabatic shuttling technique, which allows to exchange particles non-destructively and 50 times faster than in previous experiements. From 6500 cyclotron frequency ratio measurements we obtain a fractional difference of $(q/m)_{\overline{p}} \,/\, (q/m)_p$-1 = -1(69) $\cdot 10^{-12}$. This tests the standard model with an energy resolution of $8{\cdot}10^{-18}$ eV. In the next step we are aiming to measure the antiproton magnetic moment with a fractional precision of 10^{-9}. The progress towards this measurement will also be reported.

Plenarvortrag PV VIII Fr 9:45 S1/01 A1

Nuclear physics for tests of fundamental symmetries and searches for physics beyond the Standard Model — •Martin Hoferichter — Institute for Nuclear Theory, University of Washington, Seattle, USA

Precision measurements of low-energy observables can provide constraints on physics beyond the Standard Model that are complementary to direct searches at the energy frontier. However, in order to unambiguously establish anomalies that signal departures from the Standard Model or at least extract limits on the New-Physics parameter space, calculations of hadronic matrix elements with controlled uncertainties are becoming increasingly important. In the talk, this interplay between nuclear and particle physics will be discussed in the context of dark-matter searches, the anomalous magnetic moment of the muon, and lepton flavor violation.