SYAW 1: Awards Symposium

Time: Wednesday 10:15–12:30 Location: Audimax

Prize Talk SYAW 1.1 Wed 10:15 Audimax
Prospects for understanding the physics of the Universe — •Hiranya Peiris — University College London, U.K. — Oskar Klein Centre, Stockholm University, Sweden — Laureate of the Max-Born-Prize 2021

The remarkable progress in cosmology over the last decades has been driven by the close interplay between theory and observations. Observational discoveries have led to a standard model of cosmology with ingredients that are not present in the standard model of particle physics: dark matter, dark energy, and a primordial origin for cosmic structure. Their physical nature remains a mystery, motivating a new generation of ambitious sky surveys. However, it has become clear that formidable modelling and analysis challenges stand in the way of establishing how these ingredients fit into fundamental physics. I will discuss progress in harnessing advanced machine-learning techniques to address these challenges, giving some illustrative examples.

Prize Talk SYAW 1.2 Wed 10:45 Audimax
The ^{229}Th nuclear isomer — •Benedict Seiferle — LMU Munich, Garching b. München, Germany — Laureate of the Gustav-Hertz-Prize 2021

While nuclear transitions are typically situated in the keV or MeV range, the first nuclear isomeric excited state in ^{229}Th (^{229m}Th) with an excitation energy of only ≈8 eV [1, 2] occupies an exceptional position in the nuclear landscape. Such a low excitation energy is accessible with today's lasers and thus ^{229}Th can principally be excited with laser radiation. Together with an expected (radiative) lifetime of several 1000 s ^{229m}Th can be used as a basis for a nuclear optical clock [3] which could be employed in the search for new physics.

In this talk I will give an overview on the progress that has been reached during the last years and present the current status of the ^{229m}Th research at LMU Munich.

[1] B. Seiferle et al., Nature 573, 243-246, 2019.
[2] T. Sikorsky et al., PRL 125, 142503, 2020.
[3] E. Peik und C. Tamm, Europhys. Letters, 61, 2, 181-186, 2003.

15 min. break

Prize Talk SYAW 1.3 Wed 11:30 Audimax
A Sustainable Future Model of Energy and Mobility — •Michael Düren — Justus-Liebig-Universität Giessen, Germany — Laureate of the Robert-Wichard-Pohl-Prize 2021

The future of our civilization is challenged by overpopulation, the reduction of biodiversity and climate change. Energy and mobility are preconditions of a modern society where we as physicists can search for an optimum future model. Solutions for energy supply that work on a global scale are those renewable sources, that are abundantly available: solar, wind and marine power. To minimize resources and waste, energy should be harvested in the most viable places. In a physicist's world, we should start to manage the energy flow of our planet globally and transport energy across borders and continents using high voltage DC lines and other energy carriers.

Electrification of mobility is another must of a future society that minimizes resources and optimizes efficiencies. From simple physics arguments follows that electric railways can save a factor of 10 in energy consumption compared to the current individual mobility. If rail transport is taken seriously as a future mainstream of transport, it is clear that the current automobile infrastructure has to be reused to minimize additional land consumption. The author proposes a system of speed-trams that run on the 'Auto-Bahn' with batteries and overhead lines. Their batteries are simultaneously used as short-term storage to stabilize the national energy grid.

Prize Talk SYAW 1.4 Wed 12:00 Audimax
Digital manipulation of single ions for high-precision mass spectrometry — •Jost Herkenhoff — Max-Planck-Institut für Kernphysik, Heidelberg, Germany — Laureate of the Georg-Simon-Ohm-Prize 2021

The mass of a nuclide is an important property, as it provides detailed insights into its binding energies and nuclear structure. Today, Penning traps provide one of the most precise mass measurements, making them an ideal testbed for theories like quantum electrodynamics or neutrino physics. By measuring the tiny oscillations of a single ion stored within a magnetic and electric field, its mass can be determined with a relative precision of up to 10^{-11}. The measured ion signal can be electronically fed back to the ion itself, allowing control over the ion's motion.

In this talk, a new feedback system architecture based on digital signal processing is presented, which opens the possibility for advanced ion manipulation techniques. Multiple applications, including feedback cooling of a single ion down to 1 K or the implementation of a single-ion self-excited oscillator are illustrated. The digital architecture allows highly-dynamic variation of feedback parameters, which was used to realize a phase-sensitive ion detection technique. Its impact on the precision of the Pentatrap experiment is discussed.