MS 4: Application to Astrophysics

Time: Tuesday 15:45–17:15 Location: HS 2 Chemie

Invited Talk MS 4.1 Tue 15:45 HS 2 Chemie

A big scale to measure the tiniest mass - closing in on the neutrino mass with the KATRIN experiment — •Alexander Marsteller for the KATRIN-Collaboration — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

The neutrino mass is a fundamental parameter with profound implications for cosmology, shaping structure formation in the universe, and offering a gateway to physics beyond the Standard Model. The kinematics of weak decays provide the only model-independent laboratory approach to determine the absolute neutrino mass scale.

The KArlsruhe TRItium Neutrino experiment (KATRIN) aims to measure the mass of the electron anti-neutrino via high-precision beta-decay spectroscopy of tritium. KATRIN combines a high-luminosity, windowless gaseous molecular tritium source with an electrostatic spectrometer employing magnetic adiabatic collimation. This setup achieves eV-scale energy resolution while maintaining a large accepted solid angle. Since commencing measurements in 2019, KATRIN has achieved stable and precise operation, recently establishing the most stringent direct upper limit of 0.45 eV (90% C.L.) for the neutrino mass.

This presentation will highlight results from the most recent data release and gives an overview of current and future KATRIN activities beyond the neutrino-mass measurement. The talk will conclude with an outlook on KATRIN's remaining path to its 0.3 eV sensitivity goal, and long-term perspectives for pushing neutrino mass measurements in the laboratory by at least another order of magnitude in sensitivity.

MS 4.2 Tue 16:15 HS 2 Chemie

Using metastable C^- ions to infer limits on room temperature radiation in the Cryogenic Storage Ring — •Mira Newe, Manfred Grieser, Florian Grussie, Oldřich Novotný, Viviane C. Schmidt, Aigars Znotiņš, and Holger Kreckel — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

In order to investigate molecular processes of astrophysical relevance the Cryogenic Storage Ring (CSR) is operated at very low temperatures ($\sim 4\,$K). In this low black-body radiation field molecules can cool to their lowest rotational states. Nevertheless, small radiation leaks, as e.g. by laser viewports or beamline ports, lead to a slightly elevated radiation field with a small room temperature component [1]. For future experiments and new detector developments it is important to quantify this room temperature component. To probe the room temperature contribution we measured the lifetime of metastable C^- anions in the highly excited ^{2}D states, which can be photodetached by room temperature radiation. Using the method of laser probing we measured the radiation-limited lifetime of the metastable ions at cryogenic temperatures. Corresponding measurements were also made at room temperature (without laser probing) to verify previous results [2]. The results and implications will be presented and discussed.

[1] C. Meyer *et al.*, Phys. Rev. Lett. 119, 02320 (2017)
[2]T. Takao *et al.*, J. Phys. Conf. Ser. 88, 012044, (2007)

MS 4.3 Tue 16:30 HS 2 Chemie

Interstellar ^{60}Fe in Antarctic Ice Tracing the Local Interstellar Cloud — •Annabel Rolofs[1], Dominik Koll[1,2,3], Florian Adolphi[4], Sebastian Fichter[1], Maria Hörhold[4], Johannes Lachner[1], Stefan Pavetich[2], Georg Rugel[1], Stephen Tims[2], Sebastian Zwickel[1,3], and Anton Wallner[1,2,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Australian National University, Canberra, Australia — [3]TUD Dresden University of Technology, Dresden, Germany — [4]Alfred-Wegener-Institut, Bremerhaven, Germany

^{60}Fe ($t_{1/2}$=2.6 Myr) is formed in massive stars and can be transported to Earth if embedded into interstellar dust grains. Previous studies found ^{60}Fe in million-year-old marine archives and on the Moon. A recent influx of interstellar ^{60}Fe was discovered in Antarctic surface snow and with sediment data it was shown that this recent influx extends back to at least 33 kyr ago. The solar system entered a denser substructure of the otherwise thin Local Bubble about 40 kyr ago, the Local Interstellar Cloud (LIC).
To investigate a connection between the entry into the LIC and an interstellar ^{60}Fe influx, 295 kg of continuous flow analysis water from the EDML ice core in Antarctica, spanning 40 - 80 kyr BP, were analysed. A suite of cosmogenic radionuclides, ^{10}Be, ^{26}Al, ^{41}Ca and ^{53}Mn, was measured by accelerator mass spectrometry to assess any potential losses of interstellar ^{60}Fe. The cosmogenic radionuclide abundance as well as the amount of interstellar ^{60}Fe deposited into Antarctic ice will be discussed and a connection to the LIC will be drawn.

MS 4.4 Tue 16:45 HS 2 Chemie

Interstellar Radionucildes in Lunar Regolith Tracing Supernova and *r*-Process Events — •Sebastian Zwickel[1,2], Sebastian Fichter[1], Michael Hotchkis[3], Dominik Koll[2], Johannes Lachner[1], Marc Norman[4], Stefan Pavetich[4], Georg Rugel[1], Konstanze Stübner[1], Stephen Tims[4], and Anton Wallner[1,2] — [1]HZDR, Dresden, Germany — [2]TU Dresden, Germany — [3]ANSTO, Sydney, Australia — [4]ANU, Canberra, Australia

The search for live interstellar radionuclides on Earth and the Moon via accelerator mass spectrometry provides valuable insights into the history and dynamics of our galaxy. The detection of ^{60}Fe in deep-sea archives has shown that two supernova explosions occurred in the solar neighbourhood during the last 10 Myr. While lunar regolith lacks time resolution, it offers an integral measurement of interstellar radionuclide deposition over the last few to several hundred million years. Interstellar ^{60}Fe in lunar regolith already provided a clearer understanding of the total amount of ^{60}Fe arriving on Earth and the Moon. Further insight into the evolution of the solar neighbourhood could be realised using ^{244}Pu as a probe. This radionuclide provides a signal essentially only derived from r-process events that occurred in the last few hundred million years, and could shed light on the heavily disputed astrophysical sites of the r-process. This project aims to simultaneously measure ^{60}Fe and ^{244}Pu in lunar regolith, with the goal of linking them to nearby supernova and r-process nucleosynthesis events. I will show the importance of cosmogenic radionuclides for this research and present new preliminary results on ^{60}Fe in lunar regolith.

MS 4.5 Tue 17:00 HS 2 Chemie

Challenges in the extraction of ^{182}Hf from geological archives — •Sebastian Fichter[1], Dominik Koll[1], Sebastian Zwickel[1], Martin Martschini[2], Silke Merchel[2], Laurenz Widermann[2], Robin Golser[2], and Anton Wallner[1] — [1]HZDR, Dresden, Germany — [2]University of Vienna, Faculty of Physics, Austria

The identification and measurement of the astrophysically relevant radionuclide ^{182}Hf ($t_{1/2} = 8.9 * 10^6$ yr) in different geological archives would significantly advance our understanding of potential r-process sites, especially when its abundance is compared to other nucleosynthesis radionuclides such as ^{60}Fe and ^{244}Pu over time. In this work, we present our recent efforts to develop a suitable chemical protocol to extract ^{182}Hf from various sample matrices including deep-sea ferromanganese crusts. The main objective of this work is to maintain a high chemical yield while separating other elements as much as possible. Special attention is paid to the suppression of the stable isobar ^{182}W, which is yet one of the limiting factors preventing the actual measurement of live ^{182}Hf using Accelerator Mass Spectrometry (AMS). This work is partly funded by ChETEC-INFRA.