SYSE 2: Fathoming Stellar Evolution (Part 2)

Time: Wednesday 16:30–18:15 Location: DO24 1.205

Invited Talk SYSE 2.1 Wed 16:30 DO24 1.205

Mass spectrometry of exotic nuclear species for the study of neutron stars — •David Lunney — CSNSM/IN2P3 – Université de Paris Sud, Orsay

A large fraction of stars end their lives in dramatic explosions forming ultra-compact objects with a density exceeding that of the atomic nucleus. These resulting neutron stars have a complex composition that requires a wide range of physics to model. Of particular interest is the neutron-star crust, which may contain exotic nuclear species that can be detected by astronomers.

The recent observation of a "kilonova" (an explosion larger than a nova but smaller than a supernova) has been associated with gravitational mergers involving neutron stars and hints at tantalizing evidence for the production of heavy elements from the rapid capture of abundant neutrons (the r process). Modeling the neutron star and its composition, as well as an associated r process, requires the knowledge of nuclear binding energies. These quanties are obtained by precision mass spectrometry at radioactive beam facilities.

This presentation will explain the neutron-star model and describe the ISOLTRAP spectrometer at CERN-ISOLDE that produces the mass data necessary for the neutron-star composition and r-process modeling, along with some results.

Invited Talk SYSE 2.2 Wed 17:00 DO24 1.205

High-resolution spectroscopy of (deuterated) molecular ions — •Oskar Asvany, Sandra Brünken, Sabrina Gärtner, Pavol Jusko, Lars Kluge, Alexander Stoffels, and Stephan Schlemmer — I. Physikalisches Institut, Universität zu Köln, Köln, Germany

One phenomenon in the initial phases of star formation is the deuteration of molecules and ions observed in many different environments. Since several decades there is a vivid interplay between astronomical detections and laboratory measurements in this field, recent examples being the tentative observation of CH_2D^+ towards Orion IRc2 and the firm detection of para-H_2D^+ towards I16293 in Ophiuchus using the GREAT receiver on the SOFIA airplane.

This talk concentrates on the laboratory methods to obtain rotational and rovibrational spectra of mass-selected molecular ions of astronomical interest. High-resolution is achieved by cooling and trapping a few thousand ions in a multipolar trap, while using narrow-band IR or mm-wave sources for their excitation. This excitation is detected by action spectroscopy, laser induced reactions (LIR) being the main workhorse in our laboratory.

Recently, the arsenal of action spectroscopy methods has been enriched by the newly developed method of Laser Induced Inhibition of Cluster Growth (LIICG), in which attachment of He atoms to ionic species below 10 K is hindered by resonant excitation. Advantages of LIICG are operation at 4 K, its apparent applicability to any ion, and response to any sort of excitation (rotational/vibrational/electronic), as will be shown on selected examples (CD_2H^+, H_3^+, CO^+).

SYSE 2.3 Wed 17:30 DO24 1.205

Entwicklung von zwei-, drei- und vierstufigen Anregungsschemata für höchste Ionisationseffizienz am Palladium — •Tobias Kron[1], Susanne Kreim[2,3], Fabian Schneider[1], Sven Richter[1] und Klaus Wendt[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]Max-Planck-Institut für Kernphysik, Heidelberg — [3]CERN, Genf, Schweiz

Untersuchungen der Eigenschaften des Atomkerns entlang der Palladium-Isotopenkette, sowie hochpräzise Massenmessungen im Bereich des N=82-Schalenabschlusses sollen wertvolle Informationen zur noch immer nicht vollständig geklärten astrophysikalischen Nukleosynthese der Elemente schwerer als Eisen liefern und ermöglichen damit wichtige Tests verschiedener Theoriemodelle.

Zur Produktion isobarenreiner Ionenstrahlen dieser kurzlebigen Isotope an Online-Ionenquellen, wie ISOLDE (CERN), wird die resonante Laserionisation genutzt. Die Effizienz dieses hochselektiven Ionisationsprozesses hängt dabei vorrangig von der genutzten Leiter optischer Dipolübergänge zwischen den elementspezifischen Energieniveaus ab. Am Offline-Massenseparator RISIKO wurden Schemata mit zwei bis vier Anregungsschritten weiterentwickelt und hinsichtlich ihrer Ionisationseffizienz verglichen. Die Spektroskopie mehrerer Rydbergserien oberhalb des ersten Ionisationspotenzials ermöglichte die Wahl des optimalen finalen Ionisationsübergangs, was die Ionisationseffizienz deutlich erhöht. Die anschließenden Messungen der Effizienz mittels kalibrierter Proben geben Aufschluss über die zu erwartende Teilchenrate bei der zukünftigen Online-Anwendung.

SYSE 2.4 Wed 17:45 DO24 1.205

Detecting Supernova Dust on the Earth's Sea Floor with AMS — •Jenny Feige[1], Anton Wallner[2], Dieter Breitschwerdt[3], L. Keith Fifield[2], Gunther Korschinek[4], Silke Merchel[5], Georg Rugel[5], Peter Steier[1], Steve Tims[2], Stephan R. Winkler[1], and Robin Golser[1] — [1]University of Vienna, Austria — [2]ANU Canberra, Australia — [3]TU Berlin, Germany — [4]TUM, Germany — [5]HZDR, Germany

An ^{60}Fe anomaly was detected with accelerator mass spectrometry (AMS) - a very sensitive method to measure extremely low isotopic ratios - in a 2 Myr old layer of a ferromanganese crust (Knie et al., 2004). This signal is assumed to be of supernova origin and might be linked to the observation of our solar system being located in a region of thin, hot interstellar medium. This region, called the Local Bubble, was presumably formed by multiple supernova explosions starting ∼14 Myr ago. Calculations suggest that at least one of these supernovae occured close enough to the solar system to leave a detectable ^{60}Fe trace on Earth.

New AMS measurements are performed in deep-sea sediments from the Pacific Ocean. An international collaboration of different AMS facilities searches for signatures of the long-lived radionuclides ^{26}Al, ^{53}Mn, and ^{60}Fe in a time range from 1.7 to 3.1 Myr. Magnetostratigraphic dating of the samples is confirmed by measurements of the cosmogenic radionuclide ^{10}Be. All ^{10}Be and ^{26}Al measurements are finished, ^{53}Mn and ^{60}Fe is in progress. First results will be presented and discussed.

SYSE 2.5 Wed 18:00 DO24 1.205

Tracing back the Local Bubble's formation from isotopic anomalies in the deep ocean crust — •Michael Schulreich and Dieter Breitschwerdt — Zentrum für Astronomie und Astrophysik, TU Berlin, Berlin, Germany

Supernova explosions responsible for the creation of the Local Bubble (LB) and its associated HI cavity should have caused geological isotope anomalies via deposition of debris on Earth. The discovery of a highly significant increase of ^{60}Fe (a radionuclide which is exclusively produced in explosive nucleosynthesis) in layers of a deep sea ferromanganese crust, corresponding to a time of 2.2 Myr before present, appears very promising in this context. We report on our latest results in relating these measurements to the formation of the LB by means of 3D hydrodynamical adaptive mesh refinement simulations of the interstellar medium in the solar neighborhood. These calculations are based on a sophisticated selection procedure for the LB's progenitor stars and take advantage of passive scalars for modeling the turbulent chemical mixing process.