MS 11: Applied Noble Gas Physics Part 1

Time: Thursday 11:00–13:00 Location: C/gHS

Invited Talk MS 11.1 Thu 11:00 C/gHS

Development of a new facility for measuring 81Kr and 85Kr at ultratrace level in environmental samples. — •Bernard Lavielle[1], Eric Gilabert[1], Bertrand Thomas[1], Romain Rebeix[1], Grégory Canchel[1], Christophe Moulin[2], Sylvain Topin[2], and Fabien Pointurier[2] — [1]CENBG, University of Bordeaux, BP 120, F-33175 Gradignan Cedex, France — [2]CEA-DASE, F-91297 Arpajon, France

Mainly produced on Earth by nuclear reactions induced by cosmic rays in the atmosphere, the radionuclide 81Kr (t1/2=229,000yr) is considered as the best tracer for absolute dating of old groundwaters or ice cores in the range of 50,000 yr to 1,000,000 yr. Kryton-85 (t1/2=10.76yr) is mainly released into the atmosphere by the reprocessing facilities for nuclear fuel. This isotope is of great interest as a tracer for nuclear activities but also for dating young groundwater (<50 yr). Several instruments and lines are being developed at CENBG in order to measure both 81Kr and 85Kr in groundwater using small volume of water (20 l). It includes: 1) a line for gas extraction from water, Kr separation and purification; 2) A double-focusing mass spectrometer operating a 81Kr and 85Kr enrichment process based on implantation of separated Kr isotope in Al foils; 3) An instrument based on RIS-TOF technique capable to perform Kr isotopic abundance measurements from samples containing only a few thousands of atoms. The extremely high sensitivity of this instrument also allows measurements of cosmogenic Kr at very low concentration to determine cosmic ray exposure of small meteorite samples.

Invited Talk MS 11.2 Thu 11:30 C/gHS

Atom counting system to measure trace krypton contamination in ultra-pure xenon — •Andre Loose, Tanya Zelevinsky, and Elena Aprile — Columbia University, 550 W 120th Street, New York, NY 10027, USA

The Atom Trap Trace Analysis (ATTA) Project at Columbia University is an experiment designed to measure the abundance of Kr in a Xe sample to the parts per trillion (ppt) level. Setting an upper limit on the amount of Kr-85 present in natural Xe is critical for knowing the sensitivity of dark matter searches based on LXe as target and detector medium. In particular, the ATTA will be an essential assaying tool for the XENON program. We completed the full ATTA setup and it's characterization for metastable Ar-40* in Ar and Kr-84* in Xe. The abundance of Kr-85 will then be inferred using previously measured relative isotopic abundances. We designed and tested custom pipettes to avoid air contamination of samples during the transport from the XENON1T detector to our ATTA setup. We verified the system calibration by comparing ATTA and rare gas spectrometer measurements for the same sample, and conducted first ATTA measurements of ultrapure Xe.

Invited Talk MS 11.3 Thu 12:00 C/gHS

Krypton-85 and Radioxenon: Environmental Tracers and Indicators for Nuclear Activities — •Clemens Schlosser, Verena Heidmann, Martina Konrad, and Sabine Schmid — Bundesamt für Strahlenschutz, Rosastraße 9, 79098 Freiburg

Already in the 1940s scientists recognized the usefulness of radioactive noble gases as for monitoring nuclear activities. Krypton-85 is a very good indicator for the reprocessing of nuclear fuel and Xe-133 can be used for the detection of clandestine nuclear weapon tests and nuclear reactor operation. Additionally, Kr-85 can be used as tracer in environmental sciences. The German Federal Office for Radiation Protection (BfS) operates a noble gas laboratory and a global network which continuously monitors the Kr-85 and Xe-133 activity concentrations in ground level air since the 1970s. The laboratory of the BfS and the techniques used will be presented. Currently, the mean activity concentrations at German sampling sites are approx. 1.5 Bq/m3 for Kr-85 and in the order of 1 mBq/m3 for Xe-133. Based on the long time series of the BfS the global atmospheric distribution and the influence of different sources on the atmospheric activity concentrations over the last decades are discussed. Since 2004, radioactive Xenonisotopes are continuously measured at Schauinsland by an automated system *SPALAX* as part of the International Monitoring System of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The network capacity of this global monitoring network is demonstrated on the basis of particular events, like the Fukushima nuclear power plant accident and the Nuclear Weapon Tests in North Korea.

MS 11.4 Thu 12:30 C/gHS

Miniature High Sensitive Time-of-Flight Noble gas Mass spectrometer for very low gas measurements — •Ramakrishna Ramisetty and Ingo Leya — University of Bern, Space Research and Planetary Sciences,Bern, Switzerland

Noble gas analysis in early solar system materials, which can provide valuable information about early solar system processes and timescales, are very challenging because of extremely low noble gas concentrations (ppt). We therefore developed a new, high sensitive, compact sized (33 cm length, 7.2cm diameter, 1.3 L internal volume) Time-of-Flight (TOF) noble gas mass spectrometer. The instrument uses electron impact ionization coupled to an ion trap, which allows us to ionize and measure all noble gas isotopes with high efficiency. Using a reflectron set-up we reach a mass resolution of >1000amu. In addition, the reflectron set-up also enables some extra focusing. The detection is via MCPs and the signals are processed either via ADC or TDC systems. The instrument can be tuned automatically and under normal operational conditions the electronics and valves are fully computer controlled Noble gas calibrations showed a detection limit in the range 10-14 cm3STP and about 7 orders of dynamic range.

MS 11.5 Thu 12:45 C/gHS

Studying the constancy of galactic cosmic rays using cosmogenic noble gases and radionuclides in iron meteorites — •Thomas Smith[1], Ingo Leya[1], Silke Merchel[2], Georg Rugel[2], Stefan Pavetich[2], Anton Wallner[3], Keith Fifield[3], Stephen Tims[3], and Gunter Korschinek[4] — [1]University of Bern, Switzerland — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [3]The Australian National University, Canberra, Australia. — [4]TU Munich, Germany.

Cosmogenic noble gases and radionuclides in meteorites are the only tools that provide information about the cosmic ray exposure (CRE) history of meteorites. In space, meteoroids are irradiated by galactic cosmic ray (GCR), which produces, among others, stable and radioactive cosmogenic nuclides. It has been demonstrated that periodic variations in the GCR intensity induce periodic peaks in the CRE age histograms. Therefore, searching for periodic peaks in CRE histograms enables one to obtain information about GCR fluency variations. Since expected GCR fluency variations have periodicities of a few hundred million years, one needs meteorites irradiated for at least that long. Iron meteorites, which have CRE ages ranging from a few million to a few billion years, are the best candidates. So far we measured noble gases and radionuclides in 28 iron meteorites by noble gas mass spectrometry and accelerator mass spectrometry. First CRE age histograms have been established and will be presented. Further analyses are ongoing and will improve the statistical interpretation, providing new information on the temporal variability of the GCR fluency.