SYAR 1: The state of the art in actinide research

Time: Wednesday 10:45–12:45 Location: Audimax

Invited Talk SYAR 1.1 Wed 10:45 Audimax

Application of Inorganic Mass Spectrometry in Nuclear Forensics — •Klaus Mayer[1], Maria Wallenius[1], Zsolt Varga[1], Magnus Hedberg[2], and Michael Krachler[1] — [1]European Commission, Joint Research Centre, P.O. Box 2340 — [2]International Atomic Energy Agency

Mass spectrometric techniques are widely applied analytical tools in different fields of science. They enable identifying unknown compounds, quantifying known materials and elucidating the structural and chemical properties of molecules. In inorganic mass spectrometry, emphasis is given to determining the elemental and isotopic composition of materials.

Mass spectrometric techniques play an important in the investigation of nuclear material for nuclear forensic purposes. The versatility and the sensitivity of mass spectrometric methods provide access to a wealth of information inherent to the nuclear material. Different variants of mass spectrometry are applied and provide hints on the history and on the intended use of the material, based on elemental and isotopic data. This includes major constituents and trace impurities; applicable to bulk samples as well as to individual micrometer sized particles. The analytical method to be applied depends on the physical and chemical appearance of the material and on the information to be obtained. Recent progress in the development and application of the most prominent mass spectrometric techniques (thermal ionization mass spectrometry, inductively coupled plasma mass spectrometry and secondary ion mass spectrometry) are provided in the paper.

Invited Talk SYAR 1.2 Wed 11:15 Audimax

Actinide elements and fundamental nuclear structure studies — •Iain Moore — Department of Physics, University of Jyväskylä, Survontie 9, 40014, Finland.

The chemical elements known as the actinides (atomic number 89<Z<103) offer some of the most exciting and challenging opportunities for multidisciplinary science: fundamental nuclear structure research, atomic physics, chemistry and tests for Physics beyond the Standard Model. Elemental atomic spectra provide a unique window to fundamental nuclear properties, with laser spectroscopy sufficiently sensitive to probe isotopic shifts and hyperfine structure, giving access to measurements of nuclear shape, size, electromagnetic moments and spin.

In this contribution, I shall summarize efforts undertaken in recent years to realize a program of optical research at the IGISOL facility, Jyväskylä, in collaboration with colleagues at the University of Mainz. Long-lived isotopes of Pu, Th and U have presented opportunities for high-resolution collinear laser spectroscopy. Online production of short-lived actinide isotopes has been realized through a combination of high intensity proton beams and novel drop-on-demand thin targets. This offers access to a region of expected octupole (pear-shaped) deformation, which with support from modern energy density functionals, may be probed via measurements of charge radii. I will also summarize the possibility to use these new beams for mass- and nuclear decay spectroscopy. These efforts are in line with wider international efforts towards the study and application of actinide nuclei.

Invited Talk SYAR 1.3 Wed 11:45 Audimax

Pushing the Limits: Detection of Long-Lived Actinides at VERA — •Karin Hain[1], Michael Kern[1], Jixin Qiao[2], Francesca Quinto[3], Aya Sakaguchi[4], Peter Steier[1], Gabriele Wallner[1], Andreas Wiederin[1], Akihiko Yokoyama[5], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]Technical University of Denmark, Denmark — [3]Karlsruhe Institute of Technology, Germany — [4]University of Tsukuba, Japan — [5]Kanazawa University, Japan

Long-lived actinides, e.g. ^{236}U, ^{237}Np, ^{239,240}Pu, ^{241}Am can be measured largely background-free by Accelerator Mass Spectrometry (AMS) so that the minimum sample size is basically limited by the detection efficiency including chemical sample preparation, which, compared to other AMS nuclides, is rather low for actinides (around 10^{-4}). Recent experiments at the Vienna Environmental Research Accelerator (VERA) laboratory indicate an increase of the negative ion yield of uranium by one order of magnitude by using fluoride compounds and a modified sample preparation. In combination with previous modifications to the setup and measurement procedure, this will result in an increase of detection efficiency by almost a factor 100. This improvement is especially important for the analysis of the ^{233}U/^{236}U ratio which has the potential to become a novel sensitive fingerprint for releases from nuclear industry. This talk will give an overview of the recent improvements in actinide detection at VERA and of on-going projects like the production of an isotopic Np spike or on the respective applications, like the retrospective analysis of actinides in lungs or on aerosols.

Invited Talk SYAR 1.4 Wed 12:15 Audimax

Use of the actinides in medical research — •Thomas Elias Cocolios — KU Leuven, Leuven, Belgium

The actinides present many features that are of interest for medical applications, such as a wide variety of half-lives and decay modes. Moreover, they share very similar chemistry which can help in the development of radiopharmaceuticals. However, access to these isotopes is notoriously difficult and their chemical similarities renders the purification arduous. Nonetheless, in the recent years, new efforts have been invested towards their use in medical research, in particular for targeted alpha therapy (TAT).

TAT is the treatment of cancer by the injection of a radiopharmaceutical product with a targeted action - namely that will seek out the cancer cells - where upon delivery the alpha particle emitted during the decay will ensure the destruction of the targeted cell. Due to its heavy mass and charge state, the alpha particle offers a high linear energy transfer over a short distance of only a few cells, ensuring maximal damage to the DNA of the targeted cells while minimizing collateral damage to healthy tissues.

In this presentation, I shall review the recent work on TAT with actinides. I shall present the current research towards the sustainable production of radioisotopes for TAT with a special emphasis on the role of actinides in this research.