VERA-Seminar, University of Vienna

From Supernovae to the r-process: Sample Processing and the Measurement of Be-10, Fe-60 and Pu-244 in a Ferromanganese Crust

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Since 1999, the AMS groups in Munich and Canberra frequently report about their discoveries of the interstellar radionuclide Fe-60 ($t_{1/2} = 2.6$ Myr) in geological archives. Traces of live stellar Fe-60 have been found in deep-ocean archives in the time period around 2 - 3 Myr ago pointing towards near-Earth supernova activities within the last 10 Myr. In addition to the 2 - 3 Myr old signal, a much younger continuous influx was found in Antarctic snow and in deep-ocean sediments and an older peak was detected around 7 Myr in deep-sea crusts. The only analytic technique capable of measuring down to the required isotope ratios of Fe-60/Fe $= 10^{-16}$ - 10^{-15} is accelerator mass spectrometry (AMS), to date still relying on large machines with terminal voltages > 10 MV.
In contrast to the well-known production mechanism and synthesis site of Fe-60, the long-lived plutonium isotope Pu-244 ($t_{1/2} = 81$ Myr) is a pure r-process nucleus. The nucleosynthesis site for the astrophysical r-process is still debated in the astrophysics community. Potential candidates involve rare supernovae and neutron star mergers. The search for interstellar Pu-244 on Earth is even more challenging than the search for Fe-60 because of lower abundances and significant anthropogenic production through nuclear activities within the last 80 years. A measurement of Pu-244 in the ferromanganese crust VA13/2-237KD at VERA yielded the most stringent limit for Pu-244 deposition on Earth until 2021. Only recently, the first detection of interstellar Pu-244 was reported in a ferromanganese crust. The unprecedented total efficiency of up to 1% for Pu AMS analysis at VEGA made this discovery possible.
I will give an overview on Fe-60 and Pu-244 investigations during the last 25 years and the astrophysical interpretation of the obtained results. Within my PhD project, I am currently investigating Fe-60 and Pu-244 abundances in the ferromanganese crust VA13/2-237KD. The characterization of the crust, element separation chemistry and preliminary AMS results as well as options for further radionuclide measurements in the future such as Al-26, Mn-53, Hf-182 and Cm-247 will be discussed.