Fingerprints of stellar nucleosynthesis revealed by Accelerator Mass Spectrometry at the ANU

A. Wallner, L.K. Fifield, M. Srncik and S.G. Tims

Department of Nuclear Physics, The Australian National University, ACT 0200, Australia

Accelerator mass spectrometry (AMS) represents a sensitive technique for studying long-lived radionuclides through ultra-low isotope ratio measurements. Here, we will focus on two applications pursued at the ANU that are related to open questions in nuclear astrophysics:

(i) the search for live supernova(SN)-produced radionuclides in terrestrial archives: such studies probe directly specific nucleosynthesis sites and will help understanding heavy element nucleosynthesis in massive stars. A long-lived isotope produced in SNe is ^{60}Fe ($t_{1/2}$=2.6 Myr). Previous measurements at TU Munich [1] of a Pacific Ocean crust-sample showed an enhanced ^{60}Fe signal that is interpreted as of extraterrestrial origin, possibly from a close-by SN about 2-3 Myr ago. We will demonstrate the sensitivity of ^{60}Fe-AMS at the ANU with the goal to search for live ^{60}Fe in deep-sea sediments. We will also detail a new approach to determine its disputed half-life value. This work adds to recent AMS measurements of extraterrestrial ^{244}Pu ($t_{1/2}$=81 Myr) suggesting an unexpected low interstellar abundance which allows the study of r-process nucleosynthesis and serves also as a probe for r-process sites.

(ii) the simulation of stellar nucleosynthesis processes in the laboratory via the study of dedicated nuclear reactions to elucidate current open questions in astrophysics. The combination of sample activation and subsequent AMS measurement is applied to key nuclear reactions in stellar nucleosynthesis where off-line decay counting is difficult or impossible.

This work is performed in collaboration including colleagues from TU Munich (Germany), Univ. of Vienna (Austria), Helmholtzzentrum Dresden/Rossendorf (HZDR, Germany), Karlsruhe Institute of Technology (KIT, Germany), ATOMKI (Hungary), Univ. of Frankfurt (Germany) and Hebrew University (Israel).

[1] K. Knie et al., Phys. Rev. Lett., **93**, 171103 (2004)