Multi-particle emission from ^{31}Ar at IDS

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Introduction

In the beta decay of exotic nuclei, far from stability, the daughter nuclei might be formed in an excited state, which is unstable against particle emission. This phenomenon is called β-delayed particle emission and is due to a high Q-value and low separation energy for particle emission.

The decay of the proton drip-line nucleus ^{31}Ar is one of the most exotic β-delayed multi-particle decays. It has a large Q_β -window and as a consequence many different β-delayed decay channels are open: βγ, βp, βpγ, β2p, β2pγ, β3p and perhaps also β3pγ [1].

The aim of the IS577 experiment performed last October at the ISOLDE Decay Station (IDS) was the identification of the β3p-decays in ^{31}Ar as well as to provide important information on the resonances of ^{30}S and ^{29}P, relevant for the astrophysical rp-process [2].

Text communication

The IDS is a new installation at ISOLDE devoted to β-decay measurements. Our collaboration installed a new detection chamber; the *MAGISOL Si-Plugin Chamber,* consisting in 5 Double Sided Si Strip Detectors (DSSSD) backed by un-segmented Si-pad detectors in ΔE-E telescope configuration. This setup is compact with high efficiency for multi-particle emission detection and with low cutoff energy. The Si-array (Fig. 3) detects multi proton emission over a wide energy range with the good energy (25 KeV) and angular (3^{O}) resolution that are needed to characterize the different p-channels of ^{31}Ar. A proton spectrum from one of the DSSSDs is shown in Fig. 5.

The IDS station also includes 4 HPGe clover-detectors surrounding the chamber for high gamma ray detection efficiency (Fig. 2). Gamma rays from the decay of ^{16}N and ^{15}C were observed indicating presence of N_2H and CO molecules on mass 31 from the CaO target which was operated at an unusual low temperature of ~500ºC. It should be stressed the stable ^{31}Ar yield of 1-2 atoms/μC over the 7 days of experiment. This value remained in spite of a significant power cut on the Meyrin site affecting all systems at ISOLDE.

Figures, tables and equations

Nucleus	drip line nucleus
Half-life	14.4 ms
T_z, J_p	$5/2^-$, $5/2^+$
Q_{EC}	18.5 MeV
Decay modes	Beta delayed protons

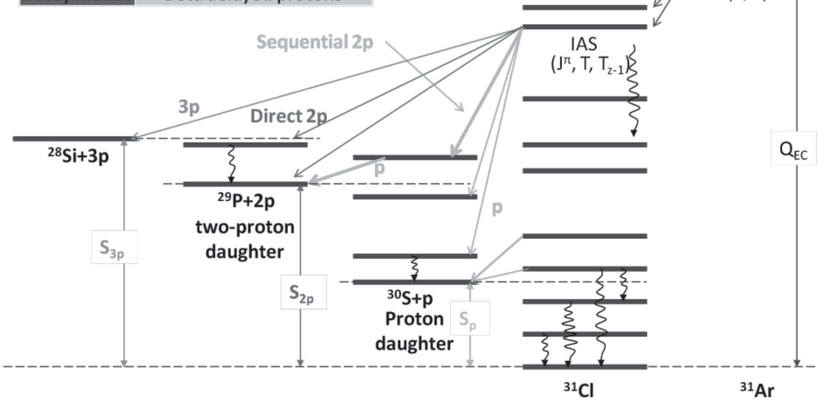

Figure 1. The decay of ^{31}Ar not to scale. This decay scheme is drawn as an illustration. The proton separation energy (S_p) are marked with dashed lines.

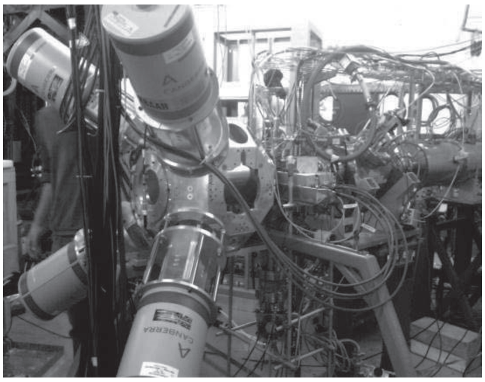

Figure 2. MAGISOL Si-plugin Chamber is surrounded by 4 HPGe clover-detectors for gamma detection.

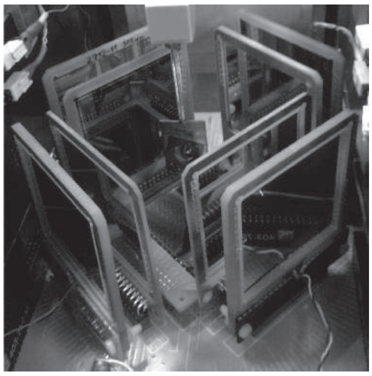

Figure 3. Charged particle detector setup. The beam was collected in a carbon foil located at the middle of the detector setup.

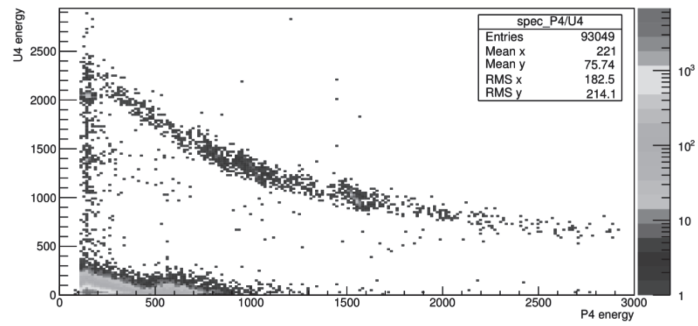

Figure 4. ΔE-E plot from two of the detectors in telescope configuration which enables particle identification. A clear proton band is seen in the plot as well as "two beta zones".

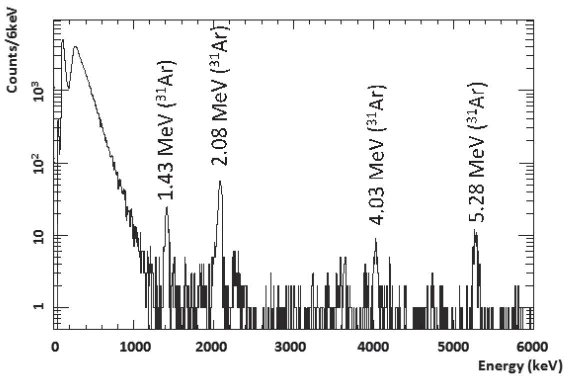

Figure 5. β-delayed proton spectrum from ^{31}Ar (only small part of the data recorded is shown). Several proton lines from the decay are observed.

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References

[1] Proposal to the ISOLDE and Neutron ToF Committee, INTC-P-386, September 2013
[2] G.T. Koldste et al. Phys. Letters B 737 (2014) 383-387.