The Beta-Delayed Proton Decay of ^{23}Si

M. W. Rowe, D.M. Moltz, T. J. Ognibene†, J. Powell and Joseph Cerny

The relationship between mass and binding energy makes the ground state mass one of the most interesting features of nuclei. Predictions of masses serve as a stringent test of the various mass models. One method that may be used to accurately estimate ground-state (g.s.) masses of proton-rich nuclides involves measuring β-delayed proton emission through the isobaric analog state (IAS) of the nuclide of interest. The β-decay branch to this state is favored due to its similarity to the initial state; the two are related simply through the Coulomb displacement energy (CDE) [1]. We have used this approach to determine the g. s. mass of ^{23}Si.

^{23}Si was produced in the 110 MeV ^{3}He bombardment of ^{24}Mg targets. Reaction products were transported by He-jet to a shielded counting station, where they were deposited on a slowly rotating catcher wheel. The unusually-large proton energy (~11 MeV) predicted for β-delayed proton decay from the ^{23}Si IAS in ^{23}Al to the g. s. of ^{22}Mg would act as a signature for this decay, permitting the measurement to be made without mass separation of the reaction products. Two specially designed particle-identification telescopes measured particle decays; they were similar in design to those in Ref. 2, but employed a single gas ΔE detector, a second, 300 μm Si ΔE detctor and a 600 μm Si E detector, allowing proton energies of up to ~13 MeV to be measured. The 88" Cyclotron beam was pulsed to eliminate fast-neutron–induced events during counting. Calibration was performed *in situ* from ^{22}Al, ^{25}Si and ^{21}Mg β-delayed protons produced in this reaction, using the method in Ref. 2.

Figure 1 shows the proton sprectum that resulted. Two of the labelled peaks, at 7839 and 8149 keV are from the β-delayed proton decay of ^{22}Al. A scattering of events is seen up to ~12 MeV, including several possible peaks; three of them have energies of 10.83, 9.64 and 7.67 MeV. Though the paucity of events and the "background" prevent a definitive assignment, these energies agree with the energies expected for decay to the g. s. and first two excited states of ^{22}Mg. We calculate a ^{23}Si g. s. mass of 23.12 MeV from the CDE and the center of mass proton energy.

Blank *et al.*, have recently published a measurement of the β-delayed one and two proton decay branches of ^{23}Si using mass analysis [3]. Their result is compared to our result and to various mass predictions [4] in Table 1.

Footnotes and References

† Current address: LLNL, Livermore, CA

1. M.Antony, *et al*, At. Data Nuc. Data Tab. **66,** 1 (1988).
2. M. Rowe, *et al.*, NIM A**397**, 292 (1997).
3. B. Blank, *et al.*, Z. Phys. A**357** 247 (1997).
4. P. Haustein, At. Data Nuc. Data Tab. **39,** 185 (1988).

Table 1-- The mass of ^{23}Si	Mass Excess (MeV)
Pape-Antony	23.44
Möller-Nix	23.86
Comay-Kelson-Zidon	23.51
Janecke-Masson	23.43
Wapstra-Audi	23.77
Blank *et. al.*	23.42
This work	23.12

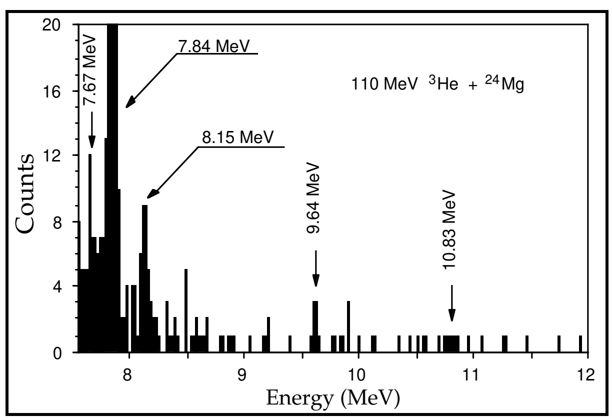

Fig. 1. High-energy β-delayed proton spectrum.