COULOMB EXCITATION OF THE 2_1^+ STATE IN ^{26}SI

J.A. Church, P.D. Cottle, M. Fauerbach, T. Glasmacher, R.W. Ibbotson, K.W. Kemper
B. Pritychenko, H.Scheit

B(E2; $0^+_{g.s.} \rightarrow 2^+$) values for the 2_1^+ state in ^{26}Si have been measured twice in the inverse reaction ^{3}He(^{24}Mg, n) ^{26}Si and show some discrepancy [1,2]. The value obtained by Bell *et al*. was 160 e^2fm^4 [1] while Alexander *et al*. reported 352 e^2fm^4 [2]. To reconcile the existing data, the experiment reported here measures the same isotope in the Coulomb excitation reaction ^{197}Au(^{26}Si,^{26}Si* γ)^{197}Au.

A 100 MeV/u ^{36}Ar beam from the K1200 cyclotron was fragmented in a 564 mg/cm^2 Be target. The beam was then separated in the A1200 [3] leaving a secondary beam of ^{26}Si at 54 MeV/u. The number of light fragments reaching the focal plane was reduced by a 233 mg/cm^2 wedge located at the intermediate image of the A1200. To identify the fragments, their momentum was limited to 1% by slits at the first dispersive image of the A1200. A time of flight method identified the particles by measuring the velocities of the projectiles between a thin plastic scintillator at the A1200 focal plane and a PIN silicon detector located up the beamline from the target. The energy loss in the PIN detector was also measured to define the atomic numbers of the nuclei.

In the experimental vault the beam struck a 518 mg/cm^2 ^{197}Au target. The maximum scattering angle from the target was limited to $\theta_{lab}< 4.0\ (–\ 0.1)^{o}$ to ensure dominance of Coulomb interaction. This maximum scattering angle corresponds to a minimum impact parameter of 21.7 – 0.6 fm, which can be compared to a sum of the radii of the projectile and target of 10.53 fm. Beam particles remaining after the collision were identified in a zero degree detector consisting of a thick slow plastic scintillator (BC 444) and a thin fast plastic scintillator (BC 400) by measuring the energy loss in the thin plastic and the time of flight from the A1200. Gamma rays in coincidence with scattered ^{26}Si were detected in a cylindrical array of position-sensitive NaI detectors [4]. Photomultiplier tubes on each end of the NaI crystals allowed for position determination of the gamma-ray interaction point to within 2 cm, thus providing a method for Doppler correction of the gamma rays on an event-by-event basis. The photon spectra in coincidence with ^{26}Si are shown in Fig.1.

Both Doppler and non-Doppler corrected data were analyzed, giving results for both ^{26}Si and, as a check, ^{197}Au. Gamma rays in coincidence with ^{26}Si were counted and the resulting spectrum peaks fit with Gelifit. The efficiency of the detector was folded with the angular distribution and a half-thickness correction. The total number of incoming particles to the zero-degree detector was found to be 1.76 x 10^8 particles and was obtained by comparing the downscaled number of counts not in coincidence with gamma rays to the beam line time, and then subtracting out the particles not hitting the target. Finally, the total number of particles in the target itself was measured directly and found to be 1.58 x 10^{21} atoms/cm^2 for the 518 mg/cm^2 ^{197}Au target.

These data led directly to the Coulomb excitation cross section for ^{197}Au and ^{26}Si. For gold, the cross section was found to be 29.4 –1.2 mb. For ^{26}Si, the values were 47.7 –3.5 mb. The Coulomb excitation cross section is directly proportional to the B(E2$\uparrow$) value. For ^{197}Au the B(E2; $3/2^+_{g.s.} \rightarrow 7/2^+$) was found to be 5670 –270 e^2fm^4. As a check, the results for gold were compared to known values and agree to within 5% [5]. For ^{26}Si the B(E2; $0^+_{g.s.} \rightarrow 2^+$) was found to be 298.3 –16 e^2fm^4. This value agrees with Alexander *et al*. [2] to within 15% and is approximately twice the value given by Bell *et al.* [1]. As is evident in Fig. 1 the excitation energy for the $0^+ \rightarrow 2^+$ state in ^{26}Si was found to be 1795.9 keV, and for the $3/2^+ \rightarrow 7/2^+$ state in ^{197}Au, 547.5 keV. Both are in agreement with previously measured values.

In summary, ^{26}Si has been measured by intermediate energy Coulomb excitation as a comparison to previously obtained data. The measured energies for both ^{26}Si and ^{197}Au were found to compare well with known values. The Coulomb excitation B(E2↑) data for ^{26}Si is in agreement with Alexander *et al*. to within 15%, thus supporting currently adopted values listed by Raman *et al*.[6].

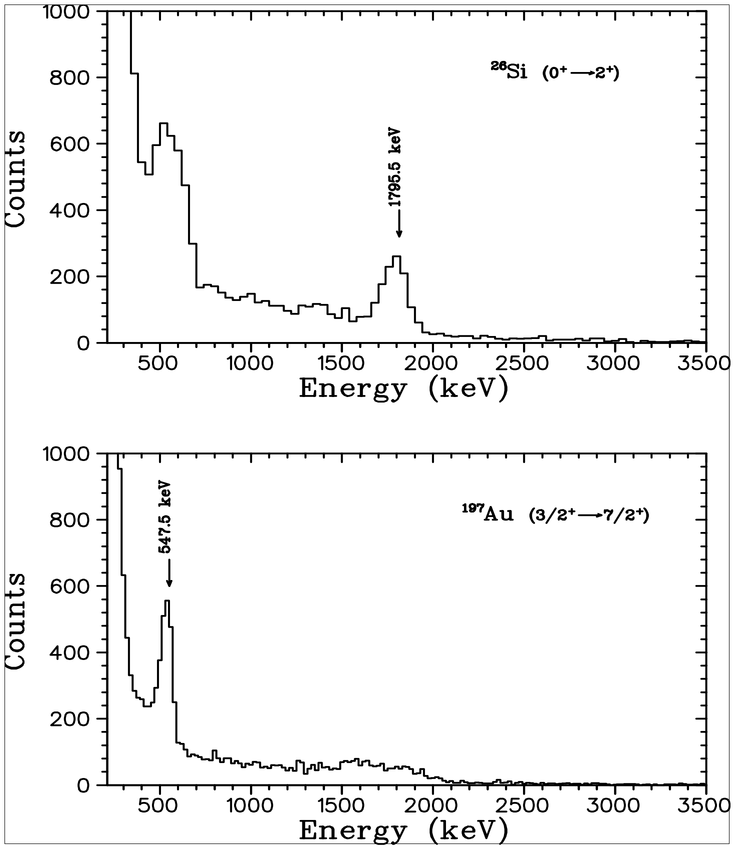

FIG. 1. Doppler and non-Doppler corrected photon spectra in coincidence with ^{26}Si particles.

References

1. R.A.I. Bell, J. L'Ecuyer, R.D. Gill, B.C. Robertson, I.S. Towner, H.J. Rose, Nucl. Phys. A **133** (1969) 337.
2. T.K Alexander, G.C. Ball, W.G. Davies, J.S. Forster, I.V. Mitchell, H.B. Mak, Phys. Lett. B **113** (1982) 132.
3. B.M Sherrill, D.J. Morrissey, J.A. Nolen Jr., J.A. Winger, Nucl. Instrum. Methods B **56** (1991) 1106.
4. H. Scheit, T. Glasmacher, R.W. Ibbotson, P.G. Thirolf, Nucl. Instrum. Methods A **422** (1999) 124-128.
5. C. Zhou, Nucl. Data Sheets **76** (1995) 399.
6. S. Raman, C.H. Malarkey, W.T. Milner, C.W. Nestor, Jr., and P.H. Stelson, At. Data Nucl. Data Tables **36** (1987) 1-96.