AN ATTEMPT TO STUDY T=2 STATES IN ^{16}N

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We report on an attempt to study the $^{18}O(p,^{3}He)^{16}N$ reaction in order to locate T=2 states in ^{16}N and, eventually, to identify T=2 states in ^{16}O as well. This attempt failed. We will describe here the conditions of the run and the analysis of the results.

In January 1988 we bombarded a 300 $\mu g/cm^2$ WO_3 (enriched to over 99% in ^{18}O) target evaporated on a 75 μ/cm^2 ^{12}C foil[1] with 90.5 MeV polarized protons (current $\sim$ 60 nA). Using an internal Faraday cup and the K600, runs were made at $\theta_{lab} = 8°$, 12°, and 18° for about 4, 7 and 7 hours, respectively. In addition shorter runs were made with a natural C foil (415 $\mu g/cm^2$)[2] for background comparison. In the runs with the $W^{18}O_3 + {}^{12}C$ target the ratio of ^{12}C to ^{18}O scatterers was approximately 1.6:1.

Figure 1 shows a spectrum of the ^3He ions at 12°. When the event tapes were replayed they were analyzed with the XSYS program. A polynominal was used to resort the focal plane spectra onto an axis commensurate with excitation energy in ^{14}N and to remove, insofar as possible, any spread in the ^{14}N peaks due to kinematic effects in the K600 magnet system. Thus in this spectrum the groups due to the $^{12}C(p,^{3}He)^{10}B$ reaction appear to be broad.[3] It was hoped that any states in ^{16}N would be easily identified in the resorted spectra.

The Q-values for the three reactions of interest are:

$^{12}C(p,^{3}He)^{10}B$	$Q_m = -19.692$
$^{16}O(p,^{3}He)^{14}N$	$Q_m = -15.243$
$^{18}O(p,^{3}He)^{16}N$	$Q_m = -14.107$

All the strong groups in this spectrum (and in the spectra at 8° and 18°) can be accounted for by known states in ^{10}B and ^{14}N. Known states in these two nuclei with widths less than or equal to the instrumental width are shown in Fig. 1.

The excitation region in ^{16}N covered by this spectrum is $7 < E_x < 16$ MeV. The only two groups which appear not to be accounted for by ^{10}B and ^{14}N states are those at channels 3120 and 7040. If they were due to ^{16}N states these would be located at E_x = 9.50 and 13.40 MeV. The first of these two states is also observed at 18° but it is very weak at 8°. Although a sharp state at E_x = 9.50 MeV has not previously been reported[4] it is

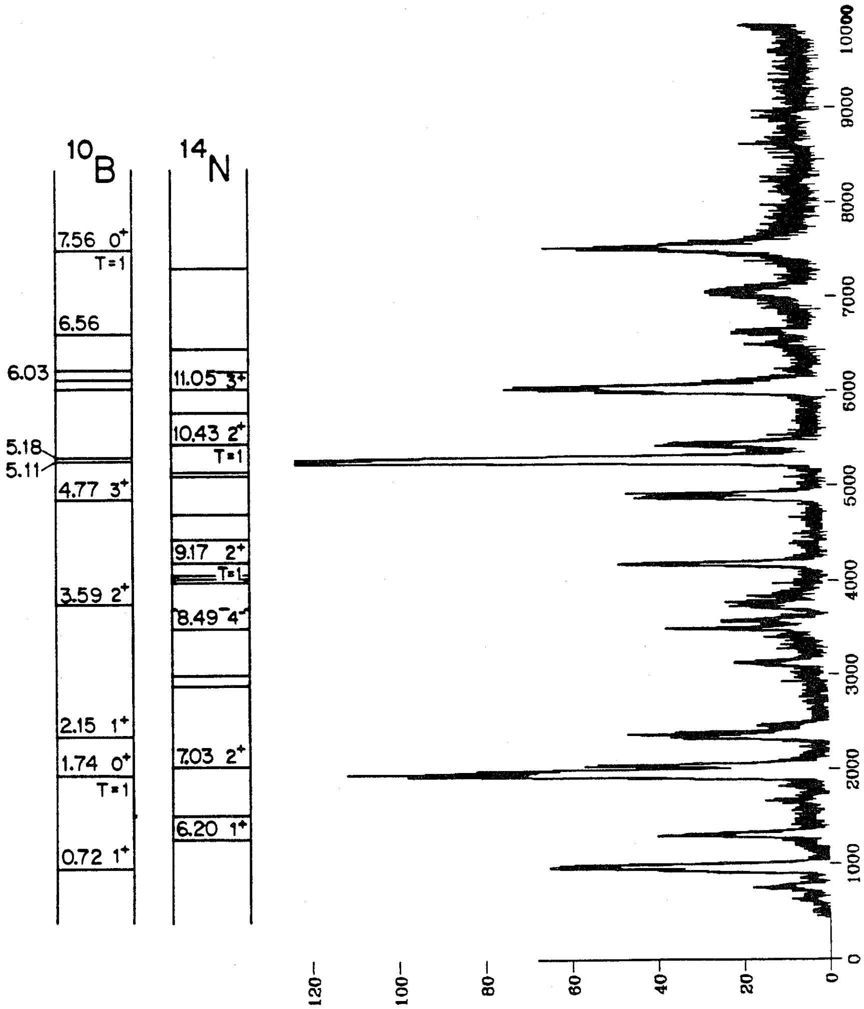

Figure 1. Spectrum of the ^{3}He ions at 12°.

not particularly surprising that one should exist at this energy. The known[4] T=2 states at 9.93 and 11.70 MeV have not been unambiguously observed in this experiment. There are groups which, if they were due to the $^{18}O(p,^3He)^{16}N$ reaction, would correspond to these excitation energies, but they are also consistent with the population of known ^{10}B and ^{14}N states. The density of states is too high, and the differential kinematic shift is too low, to separate the processes.

It would in principle be better to use the $^{14}C(^3He,p)^{16}N$ reaction to study the T = 2 states of ^{16}N. Unfortunately the problem of calibrating the spectra is insurmountable at this time: there are no (^{3}He,p) reactions to well-known states in other nuclei with Q-values comparable to that for the $^{14}C(^3He,p)^{16}N$ reaction (Q_m = 4.98 MeV; Q for $E_x = 7 \rightarrow 16$ MeV is −2 to −11 MeV). Thus there are no guideposts available to set the energy scale accurately.

We had hoped that the $^{18}O(p,^3He)$ reaction would enable us, at least, to locate a few states of ^{16}N with $E_x = 7$ to 16 MeV which would provide us with the energy markers to permit further study with the ^{14}C reaction. Unfortunately this was not the case.

Table I shows the cross sections we measured to some of the known states of ^{10}B. Determination of cross sections to states in ^{14}N (from the $^{16}O(p,^3He)$ reaction) are not

Table I

Differential cross sections for $^{12}C(p,^3He)^{10}B$ at $E_p = 90.5$ MeV[a]), in μb/sr

$^{10}B^*$ (MeV)	$\theta_{lab} = 8°$	12°	18°
g.s.			200
0.72		38	33
1.74	140	65	(*c*)
2.15	16	23	12
4.77	18	22	17
5.11+5.13[b]	53	80	58

[a] Estimated uncertainties, ± 20%.
[b] Unresolved.
[c] Group is not resolved from contaminant peak.

possible because we do not know how many ^{16}O nuclei were present in the target. We assume that most of them are due to the oxidization of the target in air, which is consistent with the ^{16}O peaks present in the C foil background runs, rather than with a lower than 99% ^{18}O enrichment of the original target material.[5]

Assuming that the groups corresponding to $^{16}N^*(9.50)$ are correctly identified, the differential cross sections are 12 and 8 μb/sr, respectively at $\theta = 12°$ and 18°. The cross sections of other states of ^{16}N, if they are well resolved from groups due to ^{10}B and ^{14}N, would have cross sections to $\lesssim 5$ μb/sr.

1. Prepared by L. Csihas, University of Pennsylvania
2. Prepared by W. Lozowski, IUCF.
3. At an earlier stage in the run, when dispersion matching was being set up on the K600 with a thin C target the FWHM of the elastic proton groups was ~ 18 keV.
4. F. Ajzenberg-Selove, Nucl. Phys. **A460**, 1 (1986).
5. We briefly ran a very thick ^{18}O target of different provenance and also found very little evidence of the $^{18}O(p,^3He)$ process.