THERMAL-NEUTRON CAPTURE BY ^{14}N

E. T. Jurney,[2] J. W. Starner,[2] J. E. Lynn,[2] and S. Raman[3]

The energies and intensities of 58 γ rays emitted in thermal-neutron capture by nitrogen (99.63% ^{14}N) have been measured accurately. A major reason was to establish this reaction as a standard for similar measurements on other nuclides. These γ rays have been placed between 19 known levels (including the ground state and the capturing state) in ^{15}N. The primary γ rays of both electric dipole (E1) and magnetic dipole (M1) types have been analyzed with existing theories of slow-neutron capture. Unlike many other light nuclides, the cross sections for E1 transitions in ^{15}N differ drastically from the calculations of pure direct-capture theory. The role of the resonance-capture contribution from the proton-unbound, neutron-bound level at 29 ± 2 keV below the neutron separation energy was considered. Some of the properties of this level are quite well known from the ^{14}C(p,γ) reaction, and others can be derived from an R-matrix analysis of the total cross section as a function of neutron energy. The thermal-neutron capture γ-ray spectrum is different from the proton-capture γ-ray spectrum, but if proper account is taken of the interference among the compound-nuclear processes, the valence neutron mechanism, and potential capture, the data can be satisfactorily explained. In the thermal-neutron reaction, compound-nuclear E1 and direct-capture E1 contributions are of comparable magnitude. Valence-neutron capture forms a significant component of capture by the neutron-bound level at –29 keV. Large destructive interference between compound-nuclear and valence processes in a few transitions in thermal-neutron capture gives rise to a much smaller total cross section than would be obtained from the compound-nuclear process alone. The M1 transitions also show some evidence of a direct process but not a dominant one. The magnitudes of the compound-nuclear transitions, both E1 and M1, are largely consistent with the values implied by giant resonance theories. The resonance parameters deduced for the –29 keV level are: total radiation width = 565 ± 24 meV, reduced neutron width = 51.6 ± 0.3 keV (for a channel radius of 3.5 fm), and proton width = 160 ± 30 meV.

---

1. Abstract of published paper: Phys. Rev. C 56, 118–134 (1997)
2. Los Alamos National Laboratory, New Mexico 87545
3. Oak Ridge National Laboratory, Tennessee 37831