energy (<100 kev) or of low intensity (< ten percent of disintegrations if gamma-ray were of 1 Mev). Further comparison of the He^6 curve with the P^{32} and UX_2 curves gives ranges of 1.85 and 1.88 g/cm² of aluminum, respectively. This corresponds to a maximum energy of 3.7 Mev, using the range-energy relationship $E_{max}=1.85R+0.245$,[6] with an estimated possible error of ±0.2 Mev. This value for the energy is in close agreement with previously reported values.[4,5]

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The Nuclear Spin and Magnetic Moment of Na^{22} *

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THE atomic beam magnetic resonance method,[1] as used by Zacharias[2] to determine the nuclear spin and magnetic moment of K^{40}, has been modified to permit similar observations to be made with radioactive nuclei having considerably shorter half-lives. These modifications involve the use of a mass spectrometer for separating the Na^{22} peaks from the large background of Na^{23} and a beryllium copper multistage electron multiplier[3,4] for detecting the Na^{22}. The source of atoms for the beam is a monel metal oven with an exit canal long compared with its width, designed so as to conserve radioactive material. A sample of NaN_3 containing 330 microcuries of Na^{22} (3×10^{-9} mole) in a dilution of one part in 10^4 of $Na^{23}N_3$ was placed in the oven. Decomposition occurs at 320°C, providing an atomic sodium beam. A 16-hour run was sufficient for all present determinations and required the evaporation of only 4×10^{-10} mole of Na^{22} out of the oven. The beam intensity of Na^{22} was naturally small, a few thousand atoms/sec., and the radiofrequency transition intensities were less than 100 atoms/sec.

Two types of transitions were observed, first at low frequency with $\Delta m_f=\pm1$ and $\Delta F=0$. These permit direct comparison of g_F for Na^{22}, with g_F for Na^{23}. For an unexcited alkali atom, $F=I+\frac{1}{2}$, and the spin of the Na^{22} is obtained as soon as a transition is observed at the mass position 22 of the mass spectrograph.

Search was made for resonances with the homogeneous field (as determined by the Na^{23} transition) and radiofrequency set for transitions corresponding to $I=0$, 1, 2, 3, 4, 5, and 6, and with the mass spectrometer set for 22. Resonances were observed only for spin 3 at mass 22.

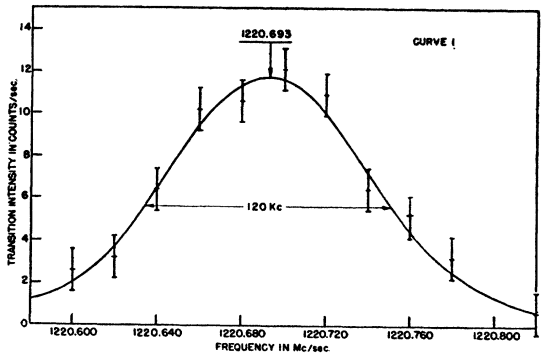

FIG. 1. Transition intensity *vs.* frequency of oscillating field for the two Na^{22} lines $F=7/2$, $M_f=\pm1/2\leftrightarrow F=5/2$, $M_f=\pm1/2$ at a field of 6.17 gauss. One count/sec. is equivalent to about 7 atoms/sec.

These peaks faded out for mass numbers $22\frac{1}{3}$ and $21\frac{2}{3}$ and could not possibly have been a spurious effect from the more abundant Na^{23}. These low frequency resonances were followed as the magnetic field was increased to permit an evaluation of the h.f.s. $\Delta\nu$ of Na^{22}. The second type of transition can then be made in which $\Delta F=\pm1$. Curve 1 shows the result of an experiment in which a $\Delta F=\pm1$ transition was made in almost zero field.

The results show that the spin of Na^{22} is 3 in units of $h/2\pi$, and its h.f.s. $\Delta\nu$ is 1220.64 ± 0.04 mgc/sec. By comparison with the value of the nuclear magnetic moment of Na^{23}, given by Millman and Kusch,[5] we obtain for Na^{22}, 1.746 ± 0.003 nuclear magnetons. The sign of this nuclear moment was also shown to be positive in just the way that was used by Zacharias on K^{40}.

Good, Peaslee, and Deutsch[6] report that the disintegration of Na^{22} goes by 100 percent positron emission to an excited state of Ne^{22}, and they conclude also that the spin of this excited state differs from that of Na^{22} by at most one unit. The spin of Ne^{22}* is therefore either 2, 3, or 4. Further unpublished data by Professor Deutsch indicate that the effective half-life for the possible transition to the ground state of Ne^{22} is at least 5000 years, consistent with a spin change of three units.

I am greatly indebted to Dr. E. T. Clarke who prepared the Na^{22} by a $Mg^{24}(d,\alpha)Na^{22}$ reaction in the M. I. T. cyclotron, to Professor J. W. Irvine, Jr., for the separation[7] of the Na^{22} from the cyclotron target and for the conversion of the $Na^{22}Cl$ to $Na^{22}N_3$, to Dr. Darragh Nagle for the design and construction of the molecular beam apparatus adapted for use in this experiment, and to Professor J. R. Zacharias who suggested the problem and some of the methods, and with whom constant discussions of the problems involved led to the successful conclusion of this experiment.

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