TABLE I. Angular distributions of the 14-Mev and 17-Mev gamma-rays. Relative intensity $=I$. Ratio of relative intensity, $R=I_{17}$ Mev$/I_{14}$ Mev. Absolute intensity ratio, 17 Mev/14 Mev $=cR$.

Type of radiation	Angle in degrees	I_{14} Mev	I_{17} Mev	R	c*
440-kev resonance radiation. $E_p=0.50$ Mev	0	1.00 ± 0.07	1.00 ± 0.07	1.00 ± 0.06	1.70 ± 0.20
	35	0.97 ± 0.07	1.03 ± 0.07	1.06 ± 0.06	
	70	0.98 ± 0.07	0.99 ± 0.07	1.01 ± 0.06	
Nonresonant radiation. $E_p=1.15$ Mev	0	1.00 ± 0.05	1.00 ± 0.05	1.00 ± 0.05	0.62 ± 0.07
	35	0.74 ± 0.06	0.69 ± 0.06	0.94 ± 0.08	
	75	0.77 ± 0.05	0.56 ± 0.05	0.72 ± 0.05	

* The value of c, the ratio of absolute intensities in the forward direction, was obtained from a weighted average of the present data and earlier data of Walker and McDaniel. Corrections have been made for the variation with energy of the spectrometer detection efficiency. Resolution width, loss from vertical scattering, and pair cross section have been considered. Stated errors are standard deviations based on statistics and estimated accidental errors.

The nonresonant radiation is strongly anisotropic, and the angular distribution is clearly different for the two gamma-ray components.

Following Devons' arguments concerning the resonance radiation, one may suggest the following level assignments. Because of the isotropy of both components under resonance excitation, the resonance level is produced by s-protons and has an angular momentum $J=1$ and odd parity. Since the separate angular distributions of the two lines for nonresonant excitation are anisotropic and different from each other, it is likely, though not necessary, that the 2 lower states have different angular momenta. The long lifetime[7] of the Be^8 ground state would seem to favor the assignment of $J=2$, even, to that state and $J=0$, even, to the 3-Mev level. The separate angular distributions of the two components of the nonresonant radiation are not consistent with the angular distribution $(1+a\cos^2\theta)$ which would exist if p-protons alone caused this radiation. It is therefore likely that the s-protons which produce the resonant radiation, or d-protons forming some higher level, are interfering with the p-protons in producing the nonresonant radiation at these energies.

* Assisted by the ONR.

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Microwave Collision Diameters and Associated Quadrupole Moments*

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In recent papers[1,2] Smith and Howard reported an investigation of the broadening of the 3-3 inversion line of NH_3 by other gases. From the data obtained, they calculated a collision diameter for the NH_3-foreign gas collision. In the cases for which this diameter was markedly greater than that obtained from kinetic theory, the collision was ascribed to the interaction of the NH_3 dipole moment and a permanent electric quadrupole moment (averaged over the rotation)[2] of the foreign gas. The quadrupole moments for these gases were calculated.

Anderson[3] has since shown that the interaction of the quadrupole moment of NH_3, calculated from its structure, and the dipole induced in the foreign gas gives a collision diameter in good agreement with those molecules whose experimental collision cross sections approached kinetic theory values. However, for N_2 and others this diameter is too small, and the assignment of a permanent electric quadrupole to these molecules seems justified.

TABLE I. Collision diameters (b) of NH_3 with various colliding molecules.

Gas	$b\times10^8$ (cm) (microwave)	$b\times10^8$ (cm) (kinetic theory)	Polarization (α) $\times10^{24}$ [a]	$b\times10^8$ (cm) (Anderson)	Quadrupole moment (Q) $\times10^{16}$ (cm^2)
C_2H_2	8.79		3.33	3.92	1.1
C_2H_4	6.67	4.79[b]	4.27	4.09	0.48
C_2H_6	5.64	4.86[b]	4.53	4.15	(0.28)
C_6H_6	9.76	4.50[c]	10.32	4.85	1.3
N_2O	7.32	4.35[d]	2.99	3.89	0.59
NO	5.64	3.90[d]	1.72	3.52	0.28
CO	5.97	3.96[d]	1.95	3.59	0.34

[a] H. A. Stuart, *Molekulstruktur* (Verlag. Julius Springer, Berlin, 1934).

[b] E. H. Kennard, *Kinetic Theory of Gases* (McGraw-Hill Book Company, Inc., New York, 1938), p. 149.

[c] Landolt-Bornstein, *Phys. Chem. Tab.*, Eg. I (a), p. 105.

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The NH_3 3-3 line breadth has been measured for mixtures of NH_3 with several more gases, using the same experimental technique as in reference 1. The results obtained are listed in Table I. For the gases investigated, either the dipole moment or its average over a collision was zero, and the collision may be described by an interaction other than dipole-dipole.

The diameters calculated from Anderson's formula are quite a bit lower than those found from broadening data, and except for C_2H_6 a quadrupole moment has been given. For C_2H_6 the microwave diameter is sufficiently close to the kinetic theory diameter that the quadrupole moment is given only as an upper limit.

For the C_2H_2, C_2H_4, C_2H_6 series the microwave diameter and associated quadrupole moment are seen to increase with the order of the C—C bond, indicating an increase in the asymmetry of the charge distribution. The moments obtained for NO and CO are very close to that for N_2 found by Smith and Howard, while the quadrupole moment for N_2O agrees very well with their values for COS, CS_2, and CO_2.

Further work in the interpretation of these data is in progress.

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Survey Experiment on Elastic Scattering*

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Using cameras similar to those described by Fulbright and Bush[1] two survey experiments on the elastic scattering of protons have been performed.

In one, the angular dependence of the differential elastic cross section in the range 26° to 106° was measured at 15° intervals for the elements W, Pd, Ni, and Al. The proton beam energy, as determined from the magnetic field strength and the camera geometry, was 18.6 ± 0.4 Mev. The total energy spread at the half-maximum intensity of the incident beam was less than 1 Mev. The circulating beam was scattered by wires 0.001 in. in diameter.

The camera used in this experiment had three slits. In a single run the relative values of the elastic scattering at three angles could be obtained. The measurements were extended to other angles by overlapping sets of observations.

The relative values of the cross sections were then determined by counting the number of tracks per unit area in the elastic lines which appear on the developed film.

The results of this experiment are shown in Fig. 1. We have plotted $\ln(\sigma_o/\sigma_R)$ *vs* θ, where σ_o is the observed cross section, σ_R is that expected for Rutherford scattering, and θ is the angle