of the as yet unknown electric dipole moment of the molecule. On the basis of a rough estimate of this quantity, however, we believe the fraction of OH present to be a few tenths of one percent. This figure is in agreement with some earlier values,[5] but does not seem to be consistent with others.[6]

The very substantial intensity of the lines gives hope that one may be able to study by microwave methods OH radicals produced in a variety of chemical reactions, and that other free radicals may prove accessible to microwave techniques.

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[1] For a discussion of this type of spectrum see Hicks, Ossofsky, and Jones, Technical Note No. 130, Ballistics Research Laboratory, Aberdeen Proving Grounds, November, 1949 (unpublished).
[2] G. H. Dieke and H. M. Crosswhite, Bumblebee Report No. 87, The Johns Hopkins University, November, 1948 (unpublished).
[3] The different behavior of the two Λ-doubled states is a consequence of the interaction between a spin on the symmetry axis and off-axis spins. This type of effect has been observed in the inversion spectrum of ammonia, and will be discussed in a future paper by G. R. Gunther-Mohr *et al.*
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Experimental K to $L+M$ Ratios for Internal Conversion Lines

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MEASUREMENTS have been made on the K to $L+M$ ratios of seven γ-rays, four of which have not been reported previously. These values were obtained by means of a solenoidal type β-ray spectrometer of the design described by DuMond,[1,2] using a value for the fundamental radius R of 20 cm.

Sources were prepared by deposition and evaporation of solutions onto a polyethelene backing $\sim$0.5 mg/cm^2 thick. Gold foil $\sim$100 μg/cm^2 was vacuum evaporated on the backing to render the source conducting. Sources varied in thickness between 1 mg/cm^2 and 10 mg/cm^2, yielding resolutions of the order of one percent.

The K conversion line was completely separated from the corresponding $L+M$ line in every case, although neighboring conversion lines of other γ-rays interfered in some measurements. In the case of Cs^{134}, the K line resulting from the 602-kev γ-ray masked the $L+M$ line of the 560-kev γ-ray, so that it was necessary to estimate the size of the latter. In the case of the equilibrium run of $Ba^{140}-La^{140}$, the K line resulting from the 540-kev γ-ray in Ba^{140} partially interfered with the $L+M$ line of the 488-kev γ-ray in La^{140}.

Uncertainties in the ratios were increased by the low intensity of the $L+M$ lines as a result of the relatively low transmission of the instrument. The counting rates at the peaks of the $L+M$ lines in Nb^{95}, Sb^{124}, and Ba^{140} were all less than 10 cpm above background, and in addition, the latter line was superimposed on top of a relatively strong continuous β-background $\sim$400 cpm.

TABLE I. Values of $K/(L+M)$ obtained.

Isotope	γ-ray energy, kev	$K/(L+M)$
Cs^{137}	663	4.52 ±0.07
Cs^{134}	602	6.6 ±0.2
Cs^{134}	799	7.8 ±0.4
Sb^{124}	607	15.5 ±2
Nb^{95}	774	6.6 ±0.4
Ba^{140}	540	6 ±2
La^{140}	488	3.7 ±0.2

The results obtained for the two Cs^{134} conversion lines compare favorably with those reported recently by LeBlanc *et al.*[3] The value for the 663-kev γ-ray in Cs^{137} also is in good agreement with the results of Kelly.[4]

The experimental values appear in Table I.

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The Charge Independence of Nuclear Forces*

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IN this note we should like to call attention to some consequences of the charge-independence hypothesis for high-energy neutron-proton and proton-proton scattering. Let us consider the general process of the elastic scattering of a nucleon by a nucleon,

$$N_1+N_2\rightarrow N_3+N_4, \quad (1)$$

where N_i denotes a nucleon of momentum $\mathbf{p}_i$ and spin s_i. If we agree to keep the incident and final momenta and spins fixed throughout our considerations, then, by varying the charge assignments of the individual nucleons, we can obtain a number of physically distinguishable reactions.[1] These include

$$p_1+p_2\rightarrow p_3+p_4, \quad (2a)$$

$$n_1+p_2\rightarrow n_3+p_4, \quad (2b)$$

$$n_1+p_2\rightarrow p_3+n_4, \quad (2c)$$

plus three additional reactions which are directly related to (2a), (2b), and (2c) by charge symmetry. The notations n and p indicate neutron and proton, respectively; the subscripts refer to the preassigned momenta and spins.

It may now be readily shown that, if f and g denote the isotopic triplet and singlet scattering amplitudes, respectively, for the two-nucleon system (where f and g are functions of the initial and final momenta as well as the spins), the scattering amplitudes for the three processes (2a), (2b), (2c) are f, $\frac{1}{2}(f+g)$, $\frac{1}{2}(f-g)$, so that with proper normalization of the wave functions we have for the corresponding differential cross sections

$$\sigma_{pp}=|f|^2, \quad (3a)$$

$$\sigma_{np}=\tfrac{1}{4}|f+g|^2, \quad (3b)$$

$$\sigma_{pn}=\tfrac{1}{4}|f-g|^2. \quad (3c)$$

The three cross sections are here expressed in terms of three unknowns (the magnitudes of the triplet and singlet scattering amplitudes as well as their relative phase) so that one cannot derive *equalities* relating the cross sections, but one can deduce *inequalities*. For example, it can be proved that σ_{pp}, σ_{np}, and σ_{pn} will be compatible with the charge-independence hypothesis if and only if

$$(\sigma_{np})^{\frac{1}{2}}+(\sigma_{pn})^{\frac{1}{2}}\geq(\sigma_{pp})^{\frac{1}{2}}, \quad (4a)$$

$$(\sigma_{pn})^{\frac{1}{2}}+(\sigma_{pp})^{\frac{1}{2}}\geq(\sigma_{np})^{\frac{1}{2}}, \quad (4b)$$

$$(\sigma_{pp})^{\frac{1}{2}}+(\sigma_{np})^{\frac{1}{2}}\geq(\sigma_{pn})^{\frac{1}{2}}. \quad (4c)$$

Now, when the incident nucleons are unpolarized, the corresponding differential scattering cross sections σ_{pp}, σ_{np}, and σ_{pn} (which involve an averaging over the initial and a summation over the final spins) are given by expressions similar to (3a)–(3c), so that the inequalities (4a)–(4c) remain valid. In the center-of-momentum system we have $\sigma_{pn}(\theta)=\sigma_{np}(\pi-\theta)$, whence the restrictive relations become

$$[\sigma_{np}(\theta)]^{\frac{1}{2}}+[\sigma_{np}(\pi-\theta)]^{\frac{1}{2}}\geq[\sigma_{pp}(\theta)]^{\frac{1}{2}}, \quad (5a)$$

$$[\sigma_{np}(\pi-\theta)]^{\frac{1}{2}}+[\sigma_{pp}(\theta)]^{\frac{1}{2}}\geq[\sigma_{np}(\theta)]^{\frac{1}{2}}, \quad (5b)$$

$$[\sigma_{pp}(\theta)]^{\frac{1}{2}}+[\sigma_{np}(\theta)]^{\frac{1}{2}}\geq[\sigma_{np}(\pi-\theta)]^{\frac{1}{2}}. \quad (5c)$$