Electric Monopole Transitions in C^{12} and O^{16}

J. P. Elliott
Atomic Energy Research Establishment,
Harwell, Berkshire, England
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SCHIFF[1] has considered the $0^+\rightarrow 0^+$ electric monopole transitions between the 7.68-Mev state and ground state of C^{12} and between the 6.06-Mev state and ground state of O^{16}, from the point of view of both the alpha-particle and the individual-particle models of the nucleus. He found that the α-particle model gave a value four times too large for the matrix element $\sum_p r^2$ of the monopole operator whereas his independent-particle calculation for C^{12} gave a value six times too small. In this Letter we point out that his shell-model configurational assignment for the excited 0^+ state is not a reasonable one, and that if one takes a configuration consistent with the results of intermediate coupling the value for $\sum_p r^2$ could quite easily agree with experiment.

Although the spectra drawn by Inglis[2] were derived by interpolating between the $L-S$ and $j-j$ coupling extremes, subsequent exact calculations have shown that his results are qualitatively reliable. In the configuration s^4p^8 for C^{12} Inglis shows no 0^+ level in the first 15 Mev of excitation for any degree of coupling. The 0^+ state observed at 7.68 Mev should therefore come from some excited configuration. This argument is confirmed from the 0^+ state in O^{16} at a similar excitation 6.06 Mev, which must come from an excited configuration since the lowest configuration s^4p^{12} for O^{16} is a closed shell having only one level, the 0^+ ground state. The excited 0^+ state in O^{16} must therefore be composed of some mixture of the configurations

$$\begin{array}{ll}
\text{(i)} & (1s)^3\ (1p)^{12}\ (2s), \\
\text{(ii)} & (1s)^4\ (1p)^{11}\ (2p), \\
\text{(iii)} & (1s)^4\ (1p)^{10}\ (1d)^2, \\
\text{(iv)} & (1s)^4\ (1p)^{10}\ (2s)^2, \\
\text{(v)} & (1s)^4\ (1p)^{10}\ (1d,2s),
\end{array}$$

each of which is doubly excited above the ground configuration $(1s)^4\ (1p)^{12}$ if one assumes an oscillator well. The excited 0^+ state in C^{12} will consist of similar configurations with four less $1p$ particles. In its present form, the individual-particle model only predicts the relative positions of levels within a configuration. It does not predict the position of one configuration relative to another since this would be analogous to a binding energy calculation for which the model is inadequate. It is admittedly unsatisfactory that the individual-particle model has not yet explained why these excited configurations are so low, but since they are observed we must introduce them in an empirical way. A detailed study of the low excited configurations in and around O^{16} is being carried out at Harwell to try to answer this question.

Since configurations (iii), (iv), and (v) differ in two particles from the ground state they cannot contribute to the $E0$ transition. The configurations (i) and (ii) do contribute, and, putting in oscillator wave functions with their parameter fitted to the nuclear size, we find the values 6.8×10^{-26} cm^2 and 8.8×10^{-26} cm^2, respectively, for the matrix element $\sum_p r^2$. The observed value, measured by Devons, Goldring, and Lindsey,[3] is 3.8×10^{-26} cm^2, so that if the mixture of configurations contains a total of about 50% of configurations (i) and (ii), which is a reasonable requirement, the matrix element calculated on the individual-particle model will be in agreement with experiment.

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[2] D. R. Inglis, Revs. Modern Phys. **25**, 390 (1953).
[3] Devons, Goldring, and Lindsey, Proc. Phys. Soc. (London) **A67**, 134 (1954).

Ratio of K^- Mass to K^+ Mass*

Francis H. Webb, Warren W. Chupp, Gerson Goldhaber,
and Sulamith Goldhaber
Radiation Laboratory, University of California,
Berkeley, California
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MEASUREMENTS on the mass of the positive K particle have recently been carried out by direct comparison of the ranges of K^+ and τ^+ mesons and by comparison of ranges of K^+ mesons and protons of the same momentum.[1–4] For negative K particles no such direct comparison is possible. Hornbostel and Salant[5] determined the K^- mass by a range-momentum method as $931\pm24\ m_e$.

In order to compare the negative K-meson mass with the positive K-meson mass, we have exposed stacks of nuclear emulsions to the focused K^+ and K^- beams[1,2] of the Bevatron, maintaining the geometry constant and reversing the magnetic field[6] in the focusing spectrometer.

The stacks were exposed with the plane of the emulsions in the vertical direction. The horizontal

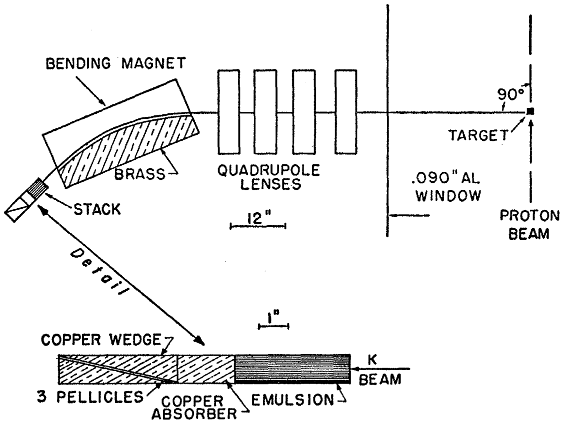

Fig. 1. Exposure geometry.