experiment. Taking into account both the H_2 and HD contribution to the line width, the required separation of components is found to be 52±6 cps. The result can be considered in good agreement with the theoretical predictions, since relatively crude wave functions[5] were used in predicting the separation.

We are indebted to Dr. Ramsey and Dr. Purcell[6] for their invaluable suggestions and information and to Dr. O. C. Simpson of this laboratory who encouraged us to made these measurements.

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[3] N. F. Ramsey and E. M. Purcell, Phys. Rev. **85**, 143 (1952).
[4] B. Smaller, Phys. Rev. **83**, 812 (1951).
[5] N. F. Ramsey, private communication.
[6] We have been informed recently that H. Y. Carr, using pulse echo techniques in HD, has obtained results in substantial agreement with our own.

The Probability of Internal Conversion of *K* Series Radiation of Au Arising from the Interaction of the *L* Subshells*

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If a vacancy is created in the K shell of an atom, for example, by a K capture event, an L electron can fall into this vacancy, losing energy either by emission of an x-ray photon or by transfer of energy to an outer electron (Auger effect). Calculations have been made by Massey and Burhop[1] for the probability of internal conversion of the K series radiation for gold arising from the interaction of the L_IL_I, L_IL_{II}, and L_IL_{III} shells. They used the Møller correspondence principle, employing Dirac wave functions, and treat the process as a transition between states of equal energy of the system comprised of the two electrons. Two approximations were made: (1) the treatment of the problem as a two-electron problem, neglecting the perturbation of the wave function of the atomic electrons due to the ionization of the atom; (2) the use of screened hydrogen-like wave functions for the atomic electrons. They obtained the probability of the Auger transitions $L_I,L_I \rightarrow K,\infty$, $L_IL_{II}\rightarrow K,\infty$, and $L_I,L_{III}\rightarrow K,\infty$ for gold. These results for the relativistic theory were compared with those obtained in the nonrelativistic approximation of Burhop[2] (see Table I).

We have obtained an experimental value for the relative probability of the Auger transitions for which they made calculations, and in addition, we have obtained values for the transitions $L_{II},L_{II}\rightarrow K,\infty$, $L_{II},L_{III}\rightarrow K,\infty$, and $L_{III},L_{III}\rightarrow K,\infty$. The source, Hg^{197m}, which decays to Au^{197m} by K capture, was prepared by Dr. A. DeShalit by irradiating Au with protons in the Princeton cyclotron.[3] The Auger electrons were analyzed in a 180° permanent magnet photographic spectrograph. The measured energies of the lines, along with the energies expected using a recent compilation of x-ray level energies,[4] are listed in Table I. The measured intensities are compared with the two sets of theoretical calculations. It may be noted here that energy and intensity considerations eliminate the possibility of these Auger lines arising in Hg^{197m}.

TABLE I. Experimental and theoretical energies and intensities for Auger transitions in Au involving two L electrons.

Transition	Energy (kev) Meas.	Energy (kev) Calc.[a]	Intensity Theoretical Nonrel.[b]	Intensity Theoretical Rel.[c]	Intensity Measured This work	Intensity Measured $Z=83$[d]
$L_IL_I\rightarrow K\infty$	51.87	52.00	1.0	1.0	1	1.0
$L_IL_{II}\rightarrow K\infty$	52.51	52.62	1.14	5.5	1.7	1.83
$L_IL_{III}\rightarrow K\infty$	54.26	54.43	2.28	5.3	1.2	1.33
$L_{II}L_{II}\rightarrow K\infty$	53.10	53.24			~0.3	<0.2
$L_{II}L_{III}\rightarrow K\infty$	54.89	55.05			1.4	2.33
$L_{III}L_{III}\rightarrow K\infty$	56.64	56.86			0.8	1.25

[a] Using x-ray critical absorption edge energies (see reference 4).
[b] See reference 2.
[c] See reference 1.
[d] See reference 5.

In addition, Ellis[5] has obtained similar data for Auger transitions in $Z=83$ [using Th(B+C)], which are listed in the table.

It is clear that the experimental data on intensities, which have an experimental uncertainty of about 25 percent, are incompatible with the relativistic results of Massey and Burhop, who suggested the experiment as a test for the extension of the Dirac equation to two bound electrons, believing it was not likely that the inaccuracies in the approximations discussed above would be great enough to mask the relativistic effect. However, it may be that a recalculation of this effect, using the Hartree self-consistent field method as suggested by Massey and Burhop, would modify the theoretical values. One would hesitate to question the validity of the Dirac equation on the basis of existing calculations for this Auger effect.

Two additional points are of interest. First, we observe the L_{II}, $L_{II}\rightarrow K,\infty$ transition which Ellis did not detect and for which he set an upper limit of 0.2 of the intensity of the other transition. Second, Ellis notes that the Auger electron energies were less (by ~0.2 kev) than the calculated values (E_K-2E_{LI}), etc., where E_K and E_{LI} are the x-ray absorption edge energies for the K and L_I shells. This is a measure of the additional energy required to remove an L electron from an atom ionized in the L shell. Robinson and Cassie[6] have noted a similar energy defect (~0.07 kev) for Cu, by directly comparing the energies of photoelectrons with the energies of Auger electrons. We also observe such an energy defect (~0.15 kev) which is just outside experimental error.

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Interaction between Nuclear Spins in HD Gas*

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A number of nuclear resonance experiments have disclosed effects that could be explained only by an internuclear interaction of the form $\mathbf{I}_1\cdot\mathbf{I}_2$, I_1 and I_2 being the spins of the two nuclei involved.[1–3] Ramsey and Purcell[4] have pointed out that such an interaction can arise from the indirect coupling of one nuclear spin to another via the exchange-coupled electrons of the molecule and that an especially clear test of this theory would be afforded by the molecule HD. In this molecule the interaction should split both the H and the D resonances into multiplets. The separation of the multiplets is calculable and should be field independent.

Fine structure in both the H and D resonances of HD gas has now been observed. Furthermore, the fine structure has been observed in the H resonance at both 30 Mc/sec and 5 Mc/sec and found to be field independent. According to the theoretical prediction, the H resonance should consist of three equally intense lines, equally spaced in frequency, the separation between the central line and the satellites being denoted δ cps. The D resonance should consist of two equally intense lines, δ cps apart. This is the structure observed. An approximate calculation based on Heitler-London wave functions gave 70 cps as the order of magnitude of δ. The observed δ is 43.5±1 cps, which agrees with the theoretical prediction as well as one could expect.