where $x=(\omega_{i,\,i+1}-\omega)\tau$, W is the kinetic energy of the electron, and $Q=\omega_0\tau$. In the nonrelativistic limit, i.e., for $W/m_0c^2=0$, the cyclotron resonance line is Lorentzian. However, for $QW/m_0c^2>1$, the function φ may become negative, corresponding to a net stimulated emission instead of absorption. This effect is shown in Fig. 1 where we have taken $QW/m_0c^2=1.5$, e.g., $Q=10\,000$ and $W=76$ ev.

If the electrons are not monochromatic, but have rather a distribution of energies, one obtains essentially the same effect, if there is an overpopulation of the upper states.[2] The above formulas (7) and (8) have also been derived[2] by means of the Boltzmann transfer equation, taking into account the dependence of the electron mass on the kinetic energy.

It does not appear unlikely that this effect could be used for a new type of maser, which would require no microwave "pump" and no low-temperature operation.[2]

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STRENGTHS OF HIGH-ENERGY CAPTURE GAMMA RAYS IN W^{184}

D. J. Hughes, M. K. Brussel, J. D. Fox, and R. L. Zimmerman
Brookhaven National Laboratory, Upton, New York

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During the past few years the Brookhaven fast chopper[1] has been devoted to an extensive study of the parameters of energy levels in heavy nuclides excited by the capture of slow neutrons. The results, obtained primarily from total cross sections alone, have given information on the distribution laws of radiation widths, neutron widths, and spacings of these energy levels.[2] However, little is known of the spins, J, of the levels, aside from the limitation to two values, $I\pm\frac{1}{2}$, with I the target nucleus spin. In a few favorable cases, for which Γ_n is larger than Γ_γ, the total cross section suffices for J determination, but in general, partial cross sections, scattering or capture, must be measured as well.

Another possible method for spin measurement is based on the capture gamma rays emitted from the individual levels. The most direct use of capture gamma rays for determination of J applies when the ground-state transition is allowed for one of the spins only.[3] An example[4] is the compound nucleus W^{184}, in which the electric dipole ground-state transition, of energy[5] 7.42 Mev, is allowed for the $J=1$ but forbidden for the $J=0$ levels. In this ground-state technique of spin identification the question of the variation in transition probability from level to level is important, for it might be possible that a $J=1$ level would exhibit no observable ground-state gamma because of an extremely weak transition probability. Because of this application to spin determination, and the intrinsic interest in transition probabilities as well, it is desirable to gain information on the high-energy capture gamma rays in heavy nuclides.

Essentially no information exists concerning the relative transition probabilities involved in the present situation, that is, the emission of gamma rays from neighboring levels a few ev apart to the same final state, some 6 or 7 Mev distant. The typical neutron capture gamma-ray measurements do not supply the necessary information, for they are limited to excitation by one energy only, usually thermal neutrons. Electric dipole transitions in the hundred-kev range[6] show wide variations in transition probability and are usually hindered by large amounts relative to the high-energy capture gamma rays; the latter are in reasonable agreement with estimates[6] based on Weisskopf's single-particle model, although exhibiting variations of the order of a factor of ten from nuclide to nuclide.

Earlier capture gamma measurements with the Brookhaven fast chopper showed[4] strong ground-state transitions[7] for several of the known resonances in the target nucleus W^{183}, indicating that $J=1$ for these resonances. In that work gamma-ray energies were measured in sodium iodide crystals located near the capturing sample, and neutron energies simultaneously by time of flight to the sample. The same equipment has now been installed at the NRU reactor, Chalk River, Canada, where the fast chopper flux is some 80 times greater and correspondingly higher resolution is possible. Definite ground-state gamma rays have now been detected in five of the six known levels up to an energy of 100 ev; thus these levels are identified as $J=1$. The spins are in agreement with the results of Waters et al.[8] based on partial cross sections, except for the 41- and 66-ev levels, too weak to be analyzed by partial cross-section methods. It is noteworthy that ground-state gammas can be detected by the present method for such weak levels.

The transition probabilities of the ground-state gamma rays for the five $J=1$ levels are given in Table I relative to the average value, taken as unity. The absolute value of this average probability, obtained by comparison with thermal neutron results,[5,9] is 2.6×10^{-3} ev, expressed as a partial radiation width. The striking fact about the transition probabilities is their small variation from level to level, an average deviation from the mean of only 20% which is very different from the wide variation of neutron widths, also listed in Table I for comparison purposes. These results are surprising in the light of the discussion of Porter and Thomas,[10] who assume that the individual gamma rays would show an extreme variation from level to level of the same type as that observed[11] for neutron widths. Although the number of levels in the present work is small as yet, the close grouping of the observed transition probabilities is suggestive that the high-energy radiation from neighboring levels in heavy nuclides does not exhibit a range as wide as the Porter-Thomas neutron width distribution. Measurements for other similar nuclides are continuing because of the intrinsic interest of the transition probabilities and for the determination of spins of more levels.[12] We wish to acknowledge the cooperation of the Chalk River scientists in setting up the cooperative program that made these results possible, particularly H. B. Lewis and C. H. Westcott. H. Palevsky and R. E. Chrien have given valuable help in the design of the equipment and W. C. Olsen in its operation.

Table I. Relative transition probabilities of ground-state gamma rays emitted from specific $J=1$ levels in W^{184}. The levels are identified by the energy of the corresponding neutron resonance and the reduced neutron widths of these resonances are also listed.

Neutron energy (ev)	Reduced neutron widths (10^{-3} ev)	Relative transition probability (mean value = 1.00)
7.6	1.2	1.27 ± 0.24
27.1	9.2	1.01 ± 0.03
41	0.16	0.53 ± 0.12
47	37	1.00 ± 0.04
66	0.26	1.19 ± 0.27

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