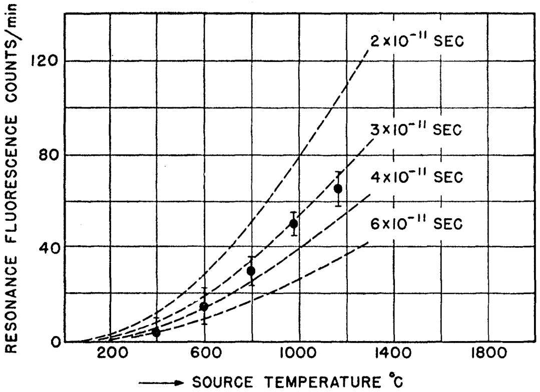

FIG. 1. Resonance fluorescence counting rate as a function of the temperature of the Au^{198} source for a mercury scatterer at room temperature. The dashed lines were calculated for different values of the lifetime τ_γ of the 411-kev gamma-ray transition assuming a pulse-height channel comprising one-third of the 411-kev photopeak and a source strength of eight millicuries.

In view of the large discrepancy between the reported values, Malmfors' experiment was repeated with improved technique. Thanks to the better energy resolution of the scintillation spectrometer and due to the large scattering angle used, the elastically scattered gamma rays could be clearly separated from the much more intense Comption-scattered radiation.

With a 40-millicurie source of Au^{198} the counting rate in the 411-kev photopeak was of the order of twenty thousand counts per minute. It was thus possible to detect small percentage changes in the number of quanta of full energy.

Using a gold source at room temperature, a lead and a mercury scatterer were first matched with respect to the elastic scattering of 411-kev quanta, i.e., the channel of a single-channel pulse-height analyzer was set on the 411-kev photopeak and the mercury scatterer was altered until the two scatterers produced the same counting rate. The temperature of the source was then raised and the counting rates due to the two scatterers were again compared. With increasing temperature the number of resonance scattered gamma rays from Hg^{198} increased. Consequently, the mercury scatterer caused larger counting rates in the full energy peak than did the lead scatterer. At 1175 degrees centigrade the contribution from resonance fluorescence amounted to approximately five percent of the total elastic scattering.

The resonance radiation has the same energy as the primary radiation. The determination of the effective cross section is therefore straightforward and does not involve the knowledge of the detection efficiency of the sodium iodide detector.

Assuming a Maxwellian distribution of the velocities of the emitting and absorbing nuclei, the temperature dependence of the resonance scattering was calculated for the arrangement used. The behavior expected for different values of the lifetime τ_γ of the 411-kev transition is indicated in Fig. 1 by dashed lines. The experimental points follow the expected temperature dependence within the experimental uncertainty. A least-squares fit leads to a value of $(3.3\pm0.3)\times10^{-11}$ second for the lifetime of this fast electric quadrupole transition. Taking into account a value of 0.044 for the total internal conversion coefficient[6] of the 411-kev transition, one finally arrives at a lifetime of $(3.15\pm0.3)\times10^{-11}$ for the first excited state in Hg^{198}. This is in good agreement with Davey and Moon's[3] value and is compatible with Graham and Bell's estimate.

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Scattering of 96-Mev Protons from Light Nuclei*

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WE are investigating the scattering of 96-Mev protons from various nuclei, using the external beam of the Harvard cyclotron. The scattered protons are detected with a range telescope of a type described previously.[1] The primary beam is monitored with an ionization chamber that has been calibrated with a

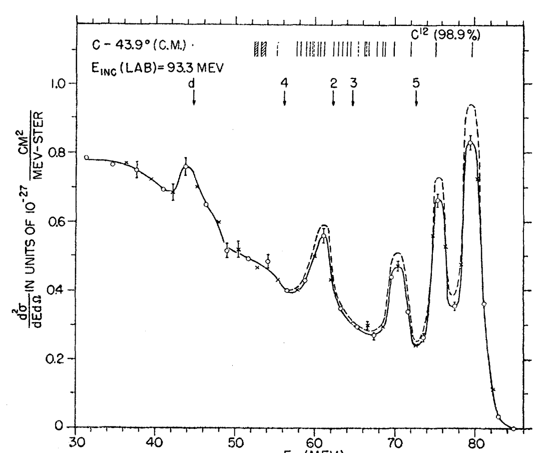

FIG. 1. Energy distribution of protons scattered from a carbon target. The numbered arrows indicate the thresholds for the following reactions: $2(p,pn)$; $3(p,2p)$; $4(p,dp)$; $5(p,\alpha p)$. The arrow labeled d indicates the energy of protons having the same range as pickup deuterons that leave the residual nucleus in its ground state.

Faraday cup.[2] Results obtained with carbon and sulfur targets at 40° in the laboratory system are shown in Figs. 1 and 2. The data are plotted in the c.m. system. The dotted and crossed points represent two sets of data taken one after the other and the full line is drawn through them. The broken line represents the results after a correction for nuclear absorption in the telescope has been applied.

For both carbon and sulfur targets, the highest-energy peak corresponds to elastically scattered protons: the half-width of 3 Mev represents the estimated energy resolution of our experiment at the high-energy end. The lower-energy peaks are due to inelastically scattered protons which leave the residual nucleus in well defined energy states. We have also plotted the known energy levels of C^{12} and S^{32} that are listed in recent compilations,[3,4] and the threshold energies for the simpler reactions. The low-energy peaks (around

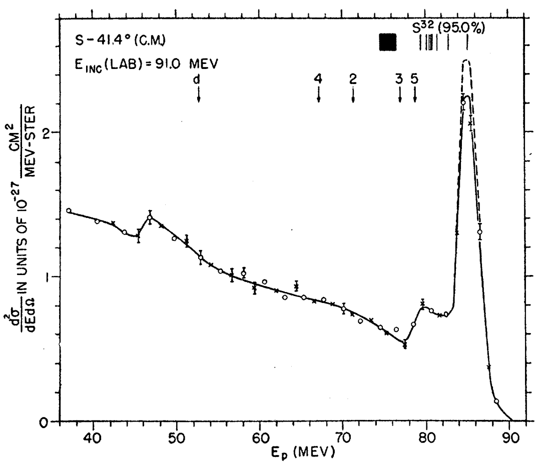

FIG. 2. Energy distribution of protons scattered from a sulfur target.

45 Mev) are believed to represent pickup deuterons whose range corresponds to protons of this energy.

The proton spectrum from carbon suggests that among the first three excited states, only the 4.43-Mev and the 9.61-Mev levels are strongly excited by high-energy protons. Due to our limited energy resolution, it is difficult to estimate any possible small contribution from protons exciting the residual nucleus to the 7.5-Mev level. The 61-Mev peak corresponds to a nuclear excitation of 20.0±1 Mev[5] which could correspond to one or more known levels of C^{12}. The continuum of protons corresponds either to unresolved energy levels of C^{12}, or to breakup of the carbon nucleus, or to both.

The rather broad high-energy inelastic peak obtained with the sulfur target probably corresponds to the unresolved excitation of some if not all of the low-energy levels known in this nucleus. No single peak stands out over the continuum in this case.

The results reported here are typical of the spectra of the light elements that we are investigating. It is quite apparent that many nuclear energy states can be excited by high-energy protons that interact with the target nucleus for a "short" time only; "short," that is, compared to the average time between collisions of the nucleons inside the nucleus. This type of excitation is different from that prevalent at low energies where compound nucleus formation occurs. Experimentally this means that the separation of truly elastic events from inelastic events is often difficult. This fact must be borne in mind in high-energy scattering investigations such as recent diffraction and polarization experiments. However at smaller scattering angles than those reported here, the elastic peak becomes much more prominent compared to inelastic events. Between 40° and 30° (laboratory system) the elastic and first inelastic peaks of C increase by factors of 4.80 and 2.66, respectively. This makes the elastic—inelastic separation easier at small angles.

We are very much indebted to the staff of the Harvard Cyclotron Laboratory for assistance in this investigation.

* Supported by the joint program of the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.

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Narrow Shower of Pure Photons at 100 000 Feet*

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A VERY unusual new event consisting of a large number of individual electron pairs has been found in a stack consisting of 18 Ilford G-5 600 μ pellicles flown in a Skyhook balloon from Goodfellow Air Force Base, Texas (41°N geomagnetic latitude). The pellicles were exposed in an aluminum exposure box with walls 0.7 g/cm^2 and free of other matter. The emulsions were flown for six hours over 100 000 feet. The event entered the side of the stack at a zenith angle of 66° and passed through 14 of the 18 pellicles with a total length of more than 50 000 μ at an angle of 7.5° to the emulsion surface. This makes it possible to carry out accurate measurements on individual tracks. Preliminary results of this analysis will be reported here.