Further comparisons pertain to the motion of a point under the influence of friction:

$$F = -\varkappa \dot{r} \qquad -X = -R\dot{x}$$

$$\varkappa \qquad R.$$

The resistance matrix corresponds to the coefficient of friction.

There exists also an analogy in that respect, that the positive definite matrices $(LgL)^{-1}$ and R correspond, in the case of $|g| \neq 0$ and $|L| \neq 0$ to positive values of m and κ. The analogy remains in full force also in that case when we consider, instead of the motion of a point under the influence of friction, the rotation of a solid body in the presence of an anisotropic friction force.

Thus, the mechanical model of irreversible thermodynamics comprises rotation of a solid about a certain point in the presence of anisotropic friction. This model, to the extent that it is practically realizable, can be used to integrate the equation of motion of irreversible processes.

*For other work by Popov on this subject see the literature of reference 1.

†See Eq. (10) of reference 1.

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*ON THE POSSIBILITY OF APPLYING THE BELEN'KII-TAMM EQUILIBRIUM SPECTRUM TO THE DETERMINATION OF (γ, n) REACTIONS**

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THE measurement of photonuclear cross sections in the energy range of 25 to 80-100 Mev with presently-known methods involves many difficulties. These difficulties are in a large measure due to the smallness of cross section of the (γ, n) reaction and to the relatively high neutron background in experiments of this kind.

A further difficulty is connected with the necessity of knowing the sensitivity of the monitor as a function of the photon energy. In contrast to earlier work, where the (γ, n) excitation functions were determined with thin specimens, we propose a new method of determination of photonuclear cross sections. The basic idea of this method is the utilization of the equilibrium photon spectrum obtained when the original monoenergetic electron beam strikes a target so thick that practically the full electron-photon shower can develop.

The number of photoneutrons thus generated in the thick block of the investigated material is connected with the equilibrium photon spectrum and with the cross section $\sigma_{\gamma n}(E)$ by the integral equation (see, e.g., reference 1)

$$Q(E_0) = \int_{E_t}^{E_0} \sigma_{\gamma n}(E)\, \Gamma_p(E_0 E)\, dE,$$

which in our case has a solution

$$\sigma_{\gamma n}(E_0) = \sigma_T(E_0) f(0) \left[\frac{E_0 \beta}{f(0)} \frac{d^2 Q(E_0)}{dE_0^2} + E_0 \frac{dQ(E_0)}{dE_0} - Q(E_0)\right], \tag{1}$$

where $\sigma_{\gamma n}(E_0)$ is the photoneutron production cross section, $\sigma_T(E_0)$ the total photon absorption cross section at energy E_0, β the critical energy, $Q(E_0)$ the neutron yield per primary electron of energy E_0, $f(0) = 2.29$, E_t the energy of the (γ, n) threshold in the material under investigation, $\Gamma_p(E_0 E)$ the so-called equilibrium photon spectrum[2] which results when electrons of energy E_0 bombard a target of such thickness that practically the full electron-photon shower can develop.

Equation (1) was obtained by using the explicit expressions for $\Gamma_p(E_0 E)$ given in reference 2.

It was reported in reference 3 that the uncertainties connected with the monitor problem alone can lead to errors in the cross section of (γ, n) reactions of the order of 100% in the 30 to 80 Mev energy region. In the same energy range, the cross sections can have additional errors of 50% due to errors in the determination of the photoneutron yield. In the presently proposed method the monitoring can be performed on the electron beam with greater accuracy (e.g., by means of a Faraday cup) than is possible on the bremsstrahlung beam.

We hope that our proposed method of the determination of the excitation functions of (γ, n) reactions in the region of relatively high energies will eliminate such large errors.

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DETERMINATION OF THE MOMENTUM AND EXCITATION ENERGY ACQUIRED BY A HEAVY NUCLEUS IN THE INTERACTION WITH A FAST NUCLEON

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According to the model proposed by Serber,[1] particles with energy ~100 Mev and higher interact with the individual nucleons of the nucleus. As a result of the cascade of nucleon-nucleon collisions, the nucleus that remains after the emission of a few fast nucleons acquires a momentum and an excitation energy which, on the average, amount to a fraction of the momentum and the energy of the incident particle. Steiner and Jungerman[2] measured the component of the momentum of the nucleus along the direction of incidence of the proton for the interaction of uranium nuclei with protons of energy 190 and 340 Mev. The value found is $\sim 1/3$ of the momentum of the incident proton. The calculations of Porile and Sugarman[3] lead to the conclusion that, in the interaction of bismuth with protons of energy 468 Mev, the nucleus acquires a perpendicular momentum component which is of the same order of magnitude as the parallel component.

We determined experimentally the mean value of the parallel as well as the perpendicular component of the momentum of the nucleus for the interaction of 660-Mev protons with uranium nuclei. The photo-emulsion technique was used. We have assumed, in first approximation, that the angular distribution of the fission fragments is isotropic in the system of the fissioning nucleus. The parallel component of the nuclear momentum $P_{\|} = Mv_{\|}$ was determined from the expression $N_f/N_b = (1+\eta_{\|})/(1-\eta_{\|})$, where N_f, N_b are the numbers of fragments in the forward and backward hemispheres, respectively, $\eta_{\|} = v_{\|}/V$ is the ratio of the mean transfer velocity of the nucleus to the mean velocity of the fission fragments, and M is the mass of the nucleus after the emission of the cascade nucleons. Corrections were made for the failure of the apparatus to register fissions with an angle of inclination of $\leq 15°$ to the vertical. The perpendicular component of the momentum of the nucleus was determined from the angle between the tracks of the fragments which make an angle of $\leq 5°$ with the plane of the plate. The plate was exposed to a proton beam perpendicular to its surface:

$$P_{\perp} = Mv_{\perp}, \ \eta_{\perp} = \frac{v_{\perp}}{V} = \frac{\pi}{2}\tan\frac{\gamma_{\perp}}{2} \approx \frac{\pi\gamma_{\perp}}{4},$$

where $\gamma_{\perp}$ is the mean value of the complement to the angle between the fragments. Both equalities presuppose $M_h = M_l$. The effect of the scattering of the fission fragments from the nuclei of the emulsion is much smaller than the effect we are looking for. It was assumed

	$P_{\|}$ (Mev/c)	$P_{\perp}$ (Mev/c)	$P_{\perp}/P_{\|}$
Experiment	340	430	1.26
Computation	280	380	1.35

that nucleon evaporation occurs until fission sets in, and that the former is isotropic. In the discussion we exclude fissions accompanied by the emission of particles with $Z \geq 2$, since the momentum of these particles is larger than or equal to the momentum we want to measure, and thus "smears out" the picture. The values found are: $\eta_{\|} = 0.039 \pm 0.010$ and $\eta_{\perp} = 0.049 \pm 0.007$. In the table we list the values of the components of the momentum of the nucleus and their ratio, calculated from the experimental values for $\eta_{\|}$ and $\eta_{\perp}$, where we assume $V = 0.04c$. We also list