single case of scattering was found. At 15°, one finds $\sigma_{\pi\alpha}(15°) \approx 50 \times 10^{-27}\text{cm}^2/\text{ster}$. From Eq. (12) and the known value of the total cross section, which is equal to $150 \times 10^{-27}$ cm$^2$, we obtain $\sigma_{\pi\alpha}(0°) \geqslant 75 \times 10^{-27}$ cm$^2$/ster, which means that there is a minimum in the angular distribution of mesons scattered by helium nuclei. The presence of a minimum in the cross section is indicative of a different sign for the amplitudes of nuclear and Coulomb scattering, and this reveals a change in the sign of the nuclear amplitude in a $(\pi - \alpha)$ interaction in comparison with what took place at energies below 200 mev. This may be connected with the change in the sign of the amplitude for $(\pi - N)$ scattering in the same energy region. The inequality (9) is near equality at high energies. For the region of solid angles $\Delta\omega$ , where the differential cross section increases, it is possible to obtain the value $\Delta\omega \leqslant (4\pi / k)^2 \sigma_s / \sigma_t^2$, where $\sigma_s$ is the elastic cross section.

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## On Light Emission by a Shock Wave Front

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IN experiments using a ballistic type of apparatus, emission of light by the leading front of a shock wave in various gases was observed[1] although the temperature behind the shock wave in a polyatomic gas was insufficient in these cases to cause light emission. The following hypothesis may be advanced to explain this phenomenon.

As a result of molecular collisions at the front of a shock wave the energy of directed motion is converted into random heat energy. Zener's calculations[2] have shown that after approximately ten collisions Maxwellian velocity distribution of the molecules is established, while the rotational and vibrational degrees of freedom remain practically unexcited ("frozen"). In the above process all the energy is transferred only to the translational degrees of freedom, and the local gas temperature becomes much higher than the temperature corresponding to thermodynamic equilibrium which is established later.

Electronic energy levels and rotational degrees of freedom are excited only subsequently to the excitation of the translational degrees of freedom. Depending on the individual properties of the molecules the electronic levels may be excited before the rotational levels, or the two may be excited simultaneously. In both cases the local temperature remains higher than the equilibrium value. It is just this nonequilibrium distribution of energy that may be used to explain the observed emission of light, particularly since the light is emitted by the front of the shock wave where the vibrational degrees of freedom have not yet been excited; for their excitation $10^4 - 10^5$ collisions are needed[3].

The subsequent excitation of rotational and vibrational degrees of freedom leads to a lowering of the gas temperature which tends to the equilibrium value, and consequently leads to the cessation of light emission. A more rapid rate of excitation of the internal degrees of freedom will lead to a narrower zone of light emission; therefore in gases with polyatomic molecules the region of light emission will be narrower than in monatomic gases in which the temperature decreases only as a result of light emission.

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## Surface Electrical Conductivity of Germanium

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IN a previous work[1] it was shown that in cuprous oxide, the mobility as determined by the Hall effect is greater with molecular adsorption than in vacuum. This may be explained either by a surface zone conductivity, or by scattering of electrons by surface charges. A conclusive answer was not obtained in Ref. 1.

With molecular adsorption, as is well known, the surface charge changes not only as a consequence of changes in the filling of existing surface levels, but also as a consequence of the formation of new ones. Cleaner conditions for experimentation with change of surface charge may be obtained if the latter is changed by means of an external electric field. In this case, only a change in the filling of existing surface levels occurs, no new surface levels being created. Therefore, the present work was carried out using an external electric field as a means for the reversible change of surface change.

The investigation was made on germanium. A monocrystalline plate of germanium with soldered contacts for the measurement of the Hall effect

| Sample No | V, kV | $R$, Ω | $\Delta R$, Ω | $V_x$, mV | $\Delta V_x$, mV | $u_e$, cm$^2$/V-sec | $\Delta u_e$, cm$^2$/V-sec | $\rho$, Ω·cm |
|---|---|---|---|---|---|---|---|---|
| 24 | 0 | 997 | | 1.65 | | 2340 | | 12.0 |
| | —2 | 1015 | +18 | 1.86 | +0.21 | 2580 | +240 | 12.2 |
| | 0 | 1008 | | 1.67 | | 2340 | | 12.0 |
| | +2 | 943 | —65 | 1.44 | —0.23 | 2148 | —192 | 11.3 |
| 27 | 0 | 4537 | | 1.02 | | 653 | | 47.6 |
| | —2 | 4882 | +245 | 1.43 | +0.41 | 850 | +197 | 51.3 |
| | 0 | 4556 | | 1.04 | | 661 | | 47.9 |
| | +2 | 3556 | —1000. | 0.36 | —0.68 | 294 | —367 | 37.3 |

and conductivity was cemented with polystyrene lacquer to a thin sheet of mica (50-30μ). A metallic plate was cemented to the rear side of the mica sheet (opposite the surface of the sample) with a guard ring around it. The Hall effect and conductivity were measured both with and without an external electric field (+$V$ and $-V$ on the metal plate). Based on the results obtained, the effected value of mobility $u_e$ was calculated by the usual formula. In view of the fact that the samples had bipolar conductivity, the real value of mobility could have been obtained by Peierls' formula, but because of the lack of appropriate data, we could not use it. Therefore, for such samples, the calculated values of $u_e$ are somewhat low. The calculated results for some of the samples are given in Table I which contains values of the resistance $R$ , its changes $\Delta R$, evoked by the external electric field, the Hall emf $V_x$ and its change $\Delta V_x$, and also calculated values of $u_e$ and $\Delta u_e$. The specific resistances of the samples $\rho$ are also indicated. The measurements were repeated many times and were fully reproducible.

Under the action of an external electric field, the resistances of the samples with electronic and proper conductivity increased with +$V$ and decreased with $-V$ on the metal plate. This corresponds with the results observed by us[2] as well as by other authors[3,4]. The Hall emf $V_x$ and the mobility $u_e$ also changed; with $-V$ on the metal plate they increased, and with +$V$ they decreased.

The change of mobility under the influence of an external electric field may be treated as was done by us in a previous work[1], where the surface