particle an even number of times has physical meaning. One sees easily that from the eight vertices (1) one can choose independently only four products, e.g.,

$$a: (\Sigma\Sigma\pi)\,(NN\pi),\ \ b: (\Sigma\Sigma\pi)\,(\Xi\Xi\pi),$$
$$c: (\Sigma\Lambda\pi)\,(\Sigma\Sigma\pi)\,(\Sigma NK)\,(\Lambda NK),\ \ d: (\Sigma\Lambda\pi)\,(\Sigma\Sigma\pi)\,(\Sigma\Xi K)\,(\Lambda\Xi K). \quad (2)$$

Here $(\Sigma\Sigma\pi),\ldots$ denotes the sign of the $\Sigma\Sigma\pi,\ldots$ vertex. Further products of vertex signs having a physical significance can be obtained from (2) by multiplying again among themselves a, b, c, and d.

As a consequence of (2), one can choose arbitrarily the signs of four vertices, while the signs of the remaining four can be determined experimentally. It is, for instance, convenient to choose as arbitrary the signs of the four vertices containing the Σ hyperon. The signs of $a: (\Sigma\Sigma\pi)(NN\pi)$ and $ab: (\Xi\Xi\pi)(NN\pi)$ (and consequently of $b: (\Sigma\Sigma\pi)(\Xi\Xi\pi)$ can be fixed by investigating the scattering of the Σ and Ξ hyperons by nucleons. At the same time, one has to determine (e.g., using the interference with the Coulomb scattering) the sign of the single-meson (polar) scattering amplitude (see Fig. 1). The signs of c and d are much harder to fix, because they require the determination of the sign of a more complex amplitude.

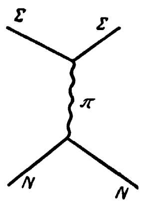

FIG. 1

Let us show how to find out which amplitudes correspond to a particular product of signs of constants.

Let us examine, for example, the product $ac: (\Sigma\Lambda\pi)(NN\pi)\cdot(\Sigma NK)(\Lambda NK)$. We compare it to the closed diagram in Fig. 2. The Feynman diagram of the amplitudes in question may now be obtained by cutting two arbitrary lines in Fig. 2. If the figure is cut at points x and y, we obtain a diagram corresponding to the two-meson amplitude of the Σ-hyperon scattering by a nucleon, shown in Fig. 3.

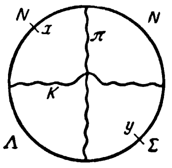

FIG. 2

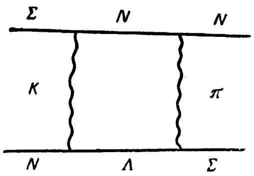

FIG. 3

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ELECTROMAGNETIC RADIATION FROM ELECTRON DIFFUSION

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We shall study the emission of electromagnetic radiation in the multiple elastic scattering of electrons formed in a medium by some ionizing agent (e.g., an ionizing particle).

We assume that the molecules of the medium have a small probability of electron capture and that a number of free electrons are formed which rapidly multiply and lose energy so fast that they soon have insufficient energy to excite the molecules in the medium. Subsequently the collisions become elastic, and in each strong scattering event an electron loses only a small part of its energy: $\Delta\epsilon \approx \epsilon m/M$, where ϵ is the kinetic energy of the diffusing electrons and m/M is the ratio of the electron mass to the molecules of the medium. The reciprocal gives the number of collisions necessary for the electron to dissipate its energy.

If the average time between collisions exceeds the periods of the wavelengths that are of interest, then radiation pulses will have time to form in each collision, and the energy radiated will be comparable with that radiated in an instantaneous stop: $\Delta\epsilon_r \sim r_0\epsilon\Delta\omega/c$ (see, e.g., reference 1) where $r_0 = e^2/mc^2$ is the classic electron radius, c the velocity of light, and $\Delta\omega$ the width of the spectrum detected.

However, the necessary condition between the frequency of collisions and the wave frequency is not always fulfilled, especially in condensed media. For example, for a mean free path $l_s \simeq 3\times10^{-8}$ cm and an electron velocity $v = 3\times10^{8}$ cm/sec, the collision frequency is $v/l_s \gtrsim 10^{16}$, which exceeds the frequency of light oscillations by almost an order of magnitude. Therefore, for waves to be effectively generated by these electrons, the diffusion process must be extended in time, i.e., the free path must somehow be increased. This can be done by reducing the density of the medium, i.e., by passing from condensed media to compressed gases. In this connection it is interesting to investigate the pressure dependence of the radiation intensity from the drifting electrons (sharp variation when $l_s \sim v/\omega$).

We wish to evaluate the number of quanta radiated by an electron during elastic collisions in a medium in which the conditions for radiation-pulse formation have been fulfilled for every scattering event; i.e., $l_s \gtrsim v/\omega$. When moderated, each electron radiates a number of quanta

$$\nu \approx \frac{r_0}{c} \varepsilon \frac{\Delta\omega}{\hbar\omega} \frac{M}{m}.$$

Assuming that $\Delta\omega/\omega \simeq 0.5$ and that the electron energy is $\epsilon \simeq 10$ ev and $M/m \approx 10^5$ (these last figures being characteristic for argon, for example), we obtain $\nu \simeq 10^{-2}$ quanta per drifting electron. The number of these drifting electrons formed by a single-charge relativistic particle per unit mass of track is $n_e \approx 10^4$ electrons/g, so that $\nu n_e \approx 10^2$ quanta/g; i.e., the radiation from the diffusing electrons comprises a significant part of the radiation of luminescence (on the order of one percent of the quantum yield of a good luminophor). Incidentally, in places where ionization and excitation are concentrated (e.g., along the tracks of secondary electrons or of other heavily-ionizing particles) there may be an additional energy transfer from the excited atoms to the drifting electrons because of collisions of the second kind.

The radiation discussed here, unlike luminescence radiation, has a continuous spectral distribution, i.e., it also exists in regions of the spectrum where there is little or no luminescence radiation. The emission time of this radiation, $\tau \sim l_s M/vm$, has nothing in common with the lifetime of the excited atoms and may be very much shorter than this lifetime. All this, and the sensitivity of the diffusion radiation to the addition of impurities that absorb free electrons and to variation in the density of the medium and other peculiarities, facilitates its differentiation even in regions of the spectrum where luminescence radiation is stronger.

Incidentally, the total radiated energy from each strong elastic scattering event can constitute a significant portion (on the order of one percent) of the energy transferred to the molecule.

The difference between the radiation effect discussed here and true luminescence should be apparent also when there are superimposed strong electric fields capable of compensating for the reduction of the energy of the drifting electrons in low-density media; thereby causing a sharp increase in scattering events and in the number of radiated quanta.

In some media, e.g., in inert elements, a sharp decrease occurs in the scattering cross section for an electron energy ~ 1 ev (the so-called Ramsauer effect). In crossing this energy range, the conditions for pulse formation for infrared frequencies may be fulfilled even in condensed media.

The discussed specific radiation processes can be used, for example, to analyze the stages and dynamics of electron behavior; to generate waves less than a millimeter long by exposing a substance to a beam of light, to a stream of ionizing particles, or to x rays from a powerful x-ray tube; to sort out the conditions needed for increasing the fast portion of the radiation created by a recorded particle, and for other practical applications.

[1] L. D. Landau and E. M. Lifshitz, Теория поля, Gostekhizdat (1948) p. 208. see English translation, L. Landau and E. Lifshitz, The Classical Theory of Fields, (Addison-Wesley Press, Cambridge, Mass., 1951) p. 197.

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OSCILLATOR DEPENDENCE OF THE SURFACE RESISTANCE OF A METAL ON A WEAK MAGNETIC FIELD

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THEORETICAL investigation of the dependence of surface resistance of a metal on a constant magnetic field applied to it leads to the conclusion that the surface resistance in a weak field must change monotonically with increasing field.[1,2] Measurements were carried out[3] which are in full agreement with these calculations. However, as