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1) It would be necessary here to allow also for the change in τ_S. It is easy to verify that for a specified electron and positron mass we obtain $\tau_S \Delta W = (\hbar c/e^2)\hbar \simeq 137\hbar = \text{const.}$ for any value of $|\Psi(0)|^2$.

INTERFERENCE OF DIFFERENT FREQUENCIES IN BREMSSTRAHLUNG

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We consider in the classical-electrodynamics approach the radiation produced by collision of a charge moving in a straight line before and after the collision (Fig. 1).

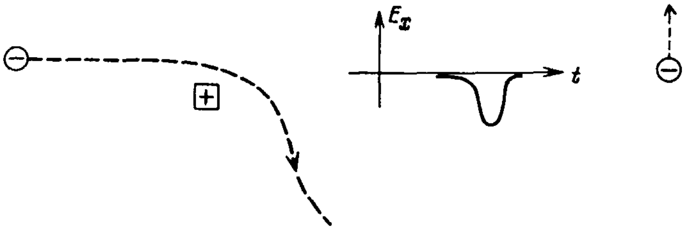

Fig. 1

The charge experiences an acceleration pulse whose time dependence is close to a delta-function. In accord with the Lienard-Wiechert formulas, the electric field E of the resultant electromagnetic radiation is proportional to the acceleration. Consequently, $\vec{E}(t)$ has at a distant point the form shown in the middle of Fig. 1. $\vec{E}$ is directed downward (Fig. 1 shows a moving negative charge), and E(t) is similar to $r^{-1}\delta(t - t_0 - r/c)$, where t_0 is the instant of deflection of the radiating particle. The purpose of the present note is to call attention to the fact that E does not reverse sign in the wave, with $\vec{E}$ either zero or directed downward, i.e., there are no "oscillations" in the proper sense of the word.

A pulse of this type can, naturally, be expanded in a Fourier integral, i.e., represented as a superposition of sinusoidal (alternating-sign) electromagnetic waves of different frequencies. However, if we specify only the spectral density (the amplitude modulus squared) of the expansion as a function I(ω), the we lose the very property causing the unique shape of the pulse (the lack of an alternating-sign field). The shape of the pulse depends essentially on the phase relations between the waves (the Fourier components) of different frequencies. It is just in this sense that we can speak of the effect connected with the interference of waves of different frequencies.

When a wave acts on a free negative charge (electron), the electron again acquires in classical electrodynamics an upward velocity, since the force acting on it is upward and does not reverse sign. The acquired velocity is proportional to r^{-1} and the energy to r^{-2}, in accord with the fact that the radiated-energy flux decreases like r^{-2}.

Thus, in classical theory there should be a correlation between the direction of the deflection of the radiating particle and the direction of emission of a particle acted upon by radiation. This correlation is not the same as that following from the transversality of the electromagnetic waves and described by the polarization of the wave. In fact, polarization correlates with the planes of deflection of the radiating particle and the detector particle, but up and down on par in our plane (see Fig. 1).

It is easy to verify that in the case of the photoeffect there will be no up-down difference in the detector: the S electron is transferred by the radiation to the P wave of the continuous spectrum, and $|\Psi|^2$ in the P wave is symmetrical under the replacement of x by -x.

The correlation can apparently be observed only in the Compton effect, and it would be of interest to clarify this question both experimentally and theoretically. The latter is more difficult than might be assumed, since it calls for a technique for taking account of the interference of different frequencies, and perhaps - as in the Kapitza-Dirac effect [1] - account of stimulated radiation as well.

A similar field symmetry exists also in the radiation of a relativistic electron in a magnetic field. As is well known [2], in this case the radiation measured by the detector occurs predominantly when the electron moves toward the detector. The field E(t) is such that $\int E\,dt = 0$ (asymptotically as $v \to c$), but the principal maximum of $|E|$ has a definite direction.

Measurement of the plane of polarization of the radiation gives the direction of the magnetic field H only accurate to within the sign; were it possible to measure E(t), we could determine the direction of H completely, knowing the charge of the radiating particle.

Finally, we note that inasmuch as the foregoing effects depend on the interference of different frequencies, it is necessary that the light propagate in vacuum (in order that the phase relations remain the same during the propagation. The presence of a dispersive medium violates these relations and distorts the form of the signal.

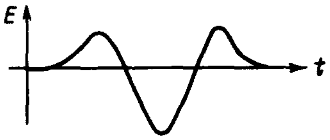

Fig. 2

The distortion takes place when the amount of matter (in the simplest example free electrons) is such as not to cause a noticeable absorption and scattering of the light. In other words, the phase relations are much more sensitive than the spectral density.

An elucidation of the feasibility of observing effects connected with the phase relations of interfering rays of different frequencies is a most interesting problem.

I am grateful to L. Pitaevskii, S. Kapitza, and B. Meerovich for discussions.

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SPONTANEOUSLY FISSIONING ISOMER WITH HALF-LIFE 10^{-7} SEC

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In several recently observed cases of isomerism of transuranic elements, the de-excitation of the isomer state was via fission [1-3], with a half-life ranging from fractions of a millisecond to several minutes. The nature of these states has not been explained as yet. In analogy with usual isomerism, it can be assumed that the number of such states increases with a decrease in their lifetime. Therefore a search for spontaneously fissioning isomers with half-lives in the microsecond and nanosecond regions is of great interest.

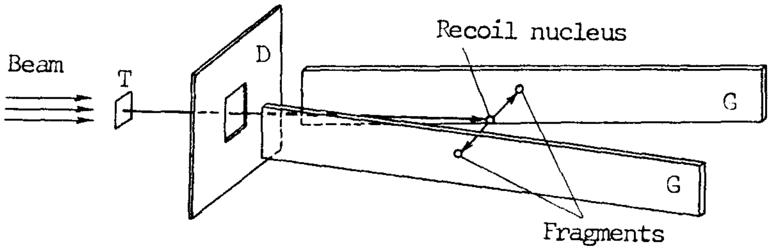

Fig. 1

We used for this purpose the apparatus shown in Fig. 1. A beam of heavy ions accelerated by the 150-cm cyclotron of the JINR Nuclear Reactions Laboratory is incident on target T. The nuclei knocked out of the target, which receive a large momentum, are collimated by the diaphragm and move along glass detectors G, which register the fragments of the nuclei fissioning in flight.

Targets of Th^{232}, U^{235}, and U^{238} were bombarded with C^{12} ions having energies from 60 to 82 MeV. The fission fragments traveling between the detectors were registered in the reaction $U^{238} + C^{12}$. From the distribution of the tracks along the detectors, we found the half-life of the spontaneously fissioning nucleus to be $(0.8 \pm 0.3) \times 10^{-7}$ sec. Inasmuch as all the isotopes formed in this reaction had a much larger lifetime, the observed half-life is obviously connected with the isomer state of the nucleus.

The excitation function of the reaction that leads to the spontaneously fissioning isomer state (Fig. 2) has a form characteristic of reactions with formation of a compound nucleus and evaporation of several nucleons. Apparently, several neutrons are evaporated and Cf isotopes are produced. No α particle is likely to be evaporated with the neutrons,