

effects in scattering of partially coherent radiation [5].

The optical thickness of the scattering medium, for both continuous and pulsed radiation, was determined from the relation $\tau = \ln(I_0/I)$, where I_0 is the signal recorded when the radiation passes through a cell without scatterer and I is the signal with a scatterer in the cell.

The table lists the measured optical thicknesses of suspensions of polystyrene latexes with different values of the parameter $\rho = 2\pi a/\lambda$ (a is the particle radius and λ the wavelength of the incident radiation) and of lycopodium spores.

Scattering medium	ρ	τ_{cont}	τ_{pul}	$\tau_{\text{cont}}/\tau_{\text{pul}}$
Polystyrene latexes	3.6	2.8	1.9	1.5
	4.3	3.0	2.2	1.4
	6.5	2.8	2.0	1.4
Lycopodium	135	4.6	3.5	1.3

The values of τ_{pul} in this table are the results of averaging 4 - 5 individual measurements, with an absolute-value scatter not larger than 0.2. The maximum absolute error for τ_{cont} does not exceed 0.05. The results show that the attenuation of pulsed radiation in the investigated scattering media is systematically lower than the attenuation of continuous radiation in the same section of the spectrum. The obtained differences in the measured optical thicknesses τ_{pul} and τ_{cont} greatly exceed the possible maximum errors in the measurements and in the data reduction.

An analysis of the experimental conditions shows that the observed "transparentization" of the medium in the case of a short laser pulse, by more than three times compared with radiation that is constant in time, is not connected with such effects as the thermal action on the properties of the medium, the spectroscopic saturation effect, and self-focusing [3].

We note in conclusion that to explain the nature of the observed effect we need further experimental and theoretical studies. However, even the obtained data show that the interaction of an ultrashort radiation pulse with a scattering medium is described by optical characteristics that differ from those in the case of continuous radiation.

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GENERATION OF POWERFUL ELECTROMAGNETIC RADIATION PULSES BY A BEAM OF RELATIVISTIC ELECTRONS

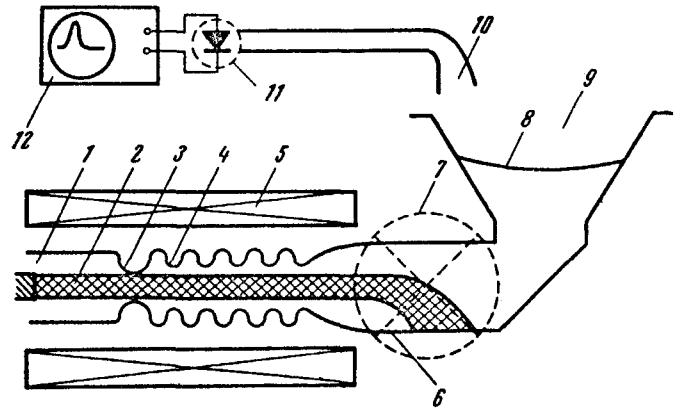
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Submitted 10 July 1973
ZhETF Pis. Red. 18, No. 4, 232 - 235 (20 August 1973)

The results are described of an experimental study of induced Cerenkov excitation of electromagnetic radiation in the centimeter band by a beam of relativistic electrons from a strong-current electron accelerator. The conversion coefficient of electron energy into electromagnetic radiation is 12 - 15%.

The power of an electromagnetic-radiation source based on the interaction of electromagnetic waves with electron beams can be increased appreciably only through a matched increase of the electron energy and of the electron-beam intensity. It is quite tempting to use for this purpose strong-current pulsed accelerators with electron energies $\sim 1 - 10$ MeV and currents 0.01 - 1 mA [1 - 3].

Some variants of devices based on induced Cerenkov radiation, transition radiation, or

electron bremsstrahlung, and providing effective conversion (with coefficients on the order of 0.1) of electron-beam energy into electromagnetic-oscillation energy at relativistic, and particularly ultrarelativistic electron velocities, were investigated theoretically in [4, 5]. We describe here an experiment with one of the simplest devices based on induced Cerenkov radiation, an autogenerator in which a straight electron beam interacts with a synchronous spatial harmonic of an electromagnetic wave having a group velocity opposite to the electron motion¹⁾, viz., an electromagnetic wave with the necessary dispersion and polarization characteristics is formed in a waveguide with corrugated walls.



Schematic diagram of experimental setup

Elements of generator theory. In the ultrarelativistic approximation (total electron energy ϵ much larger than their rest energy ϵ^2), according to [4], the following relations between the system parameters is optimal:

$$L/\lambda \sim \epsilon^2/\epsilon_0^2,$$

$$IQ\epsilon^2 \sim 2 \cdot 10^4 (S/\lambda^2)(\epsilon_0/\epsilon).$$

Here λ is the working wavelength, L , S , $Q = 2\pi(L/\lambda)(c/v_{gr})$ are the length, cross section, and effective Q of the working space, c is the speed of light, v_{gr} is the group velocity of the wave, ϵ^2 is the ratio of the square of the amplitude of the longitudinal component of the electric field of the synchronous harmonic to the mean-squared wavelength, and I is the electron current in amperes.

The transverse dimensions of the waveguide and the period of the corrugation must be chosen from considerations of stability of single-frequency generation. In the experimental generator described here, a mode E_{02} was produced, in addition to the working mode E_{01} , in the band of synchronism between the electrons and the traveling waves, but in view of the smallness of the parameter ϵ^2 the condition for self-excitation of the E_{02} mode was not satisfied.

Construction features of experimental generator. The source of electrons in the generator (see the figure) was the strong-current accelerator 1 described in [2]. The electron beam 2 was focused by the quasistationary magnetic field of a pulsed solenoid 5, which ranged from 2 to 5 kOe. Since it was convenient to extract the electromagnetic radiation in the direction of the electron motion, the working space of the generator (the corrugated waveguide 4) was separated from the region adjacent to the injector by a narrow neck 3, which is beyond cutoff for the E_{01} wave. The wave reflected from the neck, with practically no interaction with the electron beam, passed through the corrugated waveguide 4, the gradual matched junction, and an oversized waveguide with a kink, and then was radiated from horn 9 through a mica vacuum window 8 into free space. The kink in the waveguide, as well as a special pulsed deflecting solenoid 7, prevented electrons and products of cathode disintegration from striking the window. The residual gas pressure in the vacuum volume did not exceed $2 \cdot 10^{-5}$ Torr.

Measurement procedure. The electron-beam parameters (distributions of the electron energy and of the current density over the beam cross section) were determined by the methods described in [6]. The system for measuring the high-frequency power consisted of a receiving horn 10 (with dimensions small enough to exclude significant reflections of the radiated wave), a one-mode waveguide, a liquid-nitrogen cooled germanium detector capable of large overloads, and a high-speed oscilloscope 12. The sensitivity of the detector to power propagating in the output waveguide in the form of an E_{01} wave was determined with a special calibration assembly. The radiation frequency was measured with interchangeable filters (each with 5% bandwidth) placed ahead of the detector. The field distribution over the aperture of the output horn was measured by displacing and rotating the receiving horn, which was coupled to the detector by a flexible dielectric waveguide.

Results of experiment. The investigations were performed with the accelerator [6] producing electrons of energy 670 ± 70 keV. The structure of the radiation field corresponded to the E_{01} mode, the radiation wavelength was 3.1 ± 0.1 cm, and the pulse duration at half the maximum power was about 10 nsec.

The largest coefficient of conversion of the electron energy into electromagnetic radiation reached $\sim 12 - 15\%$, in satisfactory agreement with the calculation.

The authors thank A. V. Gaponov and M. S. Rabinovich for suggesting the problem, for interest in the work and for valuable advice, A. A. Andronov, A. A. Rukhadze, and V. K. Yulpatov for useful discussions, and P. V. Bubnov, V. I. Pulin, and G. V. Samyshev for help with the work.

¹⁾ A similar mechanism, which ensures a distributed internal feedback, is used in a traveling wave tube (carcinotron).

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MEASUREMENT OF THE SHIFT OF THE BISMUTH FERMI LEVEL IN STRONG MAGNETIC FIELDS

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Submitted 11 July 1973

ZhETF Pis. Red. 18, No. 4, 236 - 238 (20 August 1973)

It is proposed to measure the shift of the Fermi level in bismuth in a strong magnetic field by investigating the quantum oscillations and the velocity of the magnetoplasma waves. Preliminary measurement results are given for a magnetic field parallel to the bismuth crystal binary axis.

There are several known experiments on the behavior of bismuth in strong magnetic fields that satisfy the condition

$$H > cS_{\text{ext}}/eh \quad (1)$$

where S_{ext} is the extremal section for some part of the Fermi surface. The condition (1) for light electrons is satisfied in bismuth already in fields $H \gtrsim 15$ kOe. Owing to the strong anisotropy of the Fermi surface, the Landau levels for holes and heavy electrons are of the order of 10, and the quasiclassical approach remains valid for these groups.

In the earlier investigation methods, use was made of the study of quantum oscillations [1] or of the velocity $v = \omega/k$ of the magnetoplasma waves [2, 3]. The first method makes it possible to measure the relation

$$S(H) \propto p_x p_y \quad (2)$$

(p is the limiting momentum). The second yields

$$k(H)H \propto \sum_{e,h} [p_z p_\alpha^2 m(H)]^{1/2}, \quad (3)$$

$$\alpha = x, y; \text{axis } oz \parallel H, \text{ } oy \parallel K.$$