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SYNCHROTRON RADIATION FROM ENDS OF STRAIGHT-LINEAR INTERVAL

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Summary

The phenomenon of synchrotron radiation interference (SRI) in the region of overlap of the electron radiation from the farther and closer ends of the straight-linear synchrotron interval was experimentally investigated. The experimental results on the dependences of the intensity of the SRI linear polarization components on the electron energy in the optical region of the spectrum are presented. The angular distribution of the SRI polarization components was examined at fixed values of the electron energy. The value of the scattered magnetic field and the radius of the curved electron trajectory in the radiation points were determined by the position of the maximum in the experimentally investigated universal spectrum of synchrotron radiation.

Description

The investigation of the synchrotron radiation (SR) in the direction of the axis of straight-linear interval of the electron synchrotron SIRIUS revealed a phenomenon of synchrotron radiation interference (SRI) in the region of overlap of the electron radiation from the farther and closer ends of this interval [1]. The radiation from the interval ends may be presented as radiation of two quasi-point SR sources, the distance between of which being L , synchronized subsequently by the electron. On the trajectory of the SRI beam an objective was mounted, in the focal plane of which a point diaphragm was placed cutting up the radiation with angular spreading of $49{,}5\cdot10^{-10}$ sterad. During the measurement of the SRI spectrum the point diaphragm was placed in the centre of the region of overlaped radiations from father and closer interval ends. The experimental technics was similar to the one used in the study of the undulator radiation [2-6]. Fig.1 shows the dependence of the number N of the SR σ-component photons emitted on the electron energy E on fixed wavelength observed λ_f. The polarization components of SR adopted by Sokolov and Ternov [9]: perpendicular to the magnetic field (σ) and directed along the field (π). This dependence represents the radiation spect-

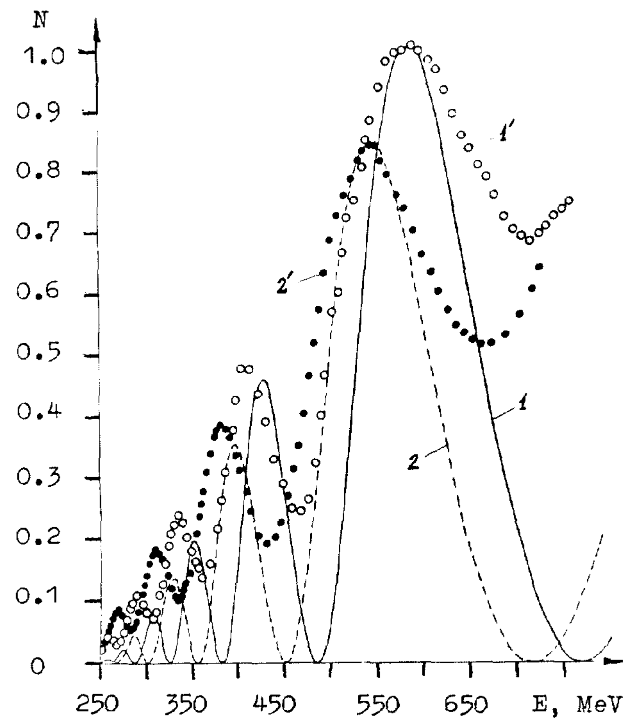

Fig.1. The dependence of the number of photons emitted on the electron energy on fixed wavelength observed.

rum, since the electron energy is associated with the harmonic number ν of radiation by the relationship

$$\nu = 2\pi R / 3\lambda_f \gamma^3,$$

where γ is the relativistic factor, R - - the radius of curved electron trajectory in the points of radiation. The values of L and R were found independently from one another by technics of [1, 7]. The value of the scattering magnetic field and the radius R in the radiation points were determined by the position of the maximum in the experi-

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mentally investigated universal spectrum of synchrotron radiation [7, 8]. It was found that L $\approx$ 135 cm and R $\approx$ 69 m. Fig.1 gives the experimental curves taken at λ_f = 500 nm (curve 1') and λ_f = 582 nm (curve 2'). The curves 1 and 2 are the results of the suitable theoretical calculation [8]. The first-order maxima of interference were normalized to their theoretical value. With reducing the wavelength observed the given interference order arises from higher electron energy. The total increase of radiation with the increase in electron energy is due to the characteristic dependence of the SR intensity on given wavelength observed in points of radiation on the electron beam energy [9]. Visibihty of the interference pattern is significantly influenced by the electron angular spreading in the beam. At high electrons energies (more than 700 MeV) in the centre of the SRI pattern the zero-order interference intensity grows.

Fig.2 exibits the measured SRI on the wavelength 582 nm at the electron energy 903 MeV. The intensity of π-component radiation is normalized to the maximum of the SRI σ-component. In the centre of the σ-component the growing zero-order maximum of component is seen, then with the angle of observation increased the 1-st, 2-nd, etc. order maxima occur. The non-zero minimum of π-component at angle θ = 0 as well as smearing of the interference maxima on both curves result from vertical-angular spreading of particles in the beam. The angular position of the interference maxima in the σ- and π-components of SRI do not coincide the angular size of maxima being of order 10^{-4} rad.

Comparison of the theory (1) and the experiment (2) for the σ-component (λ_f = = 582 nm, E = 722 MeV) is made in fig.3. Here the normalization is made so that the areas under the experimental and calculated curves are aqual. At angle $\theta \simeq \pm 0{,}6 \cdot 10^{-3}$ rad are the localised first-order.

The most significant influence of the SRI on its properties of particle angular spreading will be when observed in more short-length region.

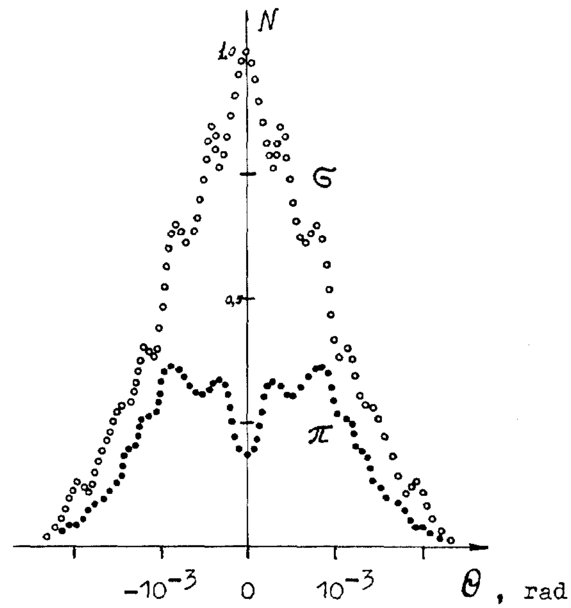

Fig.2. The vertical-angular distribution of the SRI both components.

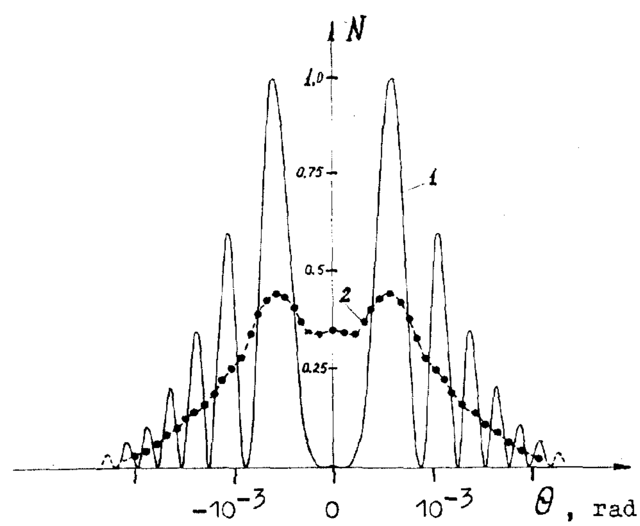

Fig.3. The vertical-angular distribution of the SRI σ-component on the wavelength 582 nm at the electron energy 722 MeV.

The interference of synchrotron radiation in devices with a sharp decrease of the magnetic field in a straight gap and in which the electron beam possesses a weak dispersion of the angular spread of the particles may be of practical interest, along with synchrotron and undulator radiation, for solving a broad range of scientific and applied problems.

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