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ИНСТИТУТ ЯДЕРНОЙ ФИЗИКИ СО АН СССР

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НОВОСИБИРСК

EXPERIMENTAL STUDY OF THE CIRCULAR POLARIZATION LEVEL SOFT X-RAY RADIATION FROM HELICAL UNDULATOR INSTALLED IN THE STORAGE RING VEPP-2M

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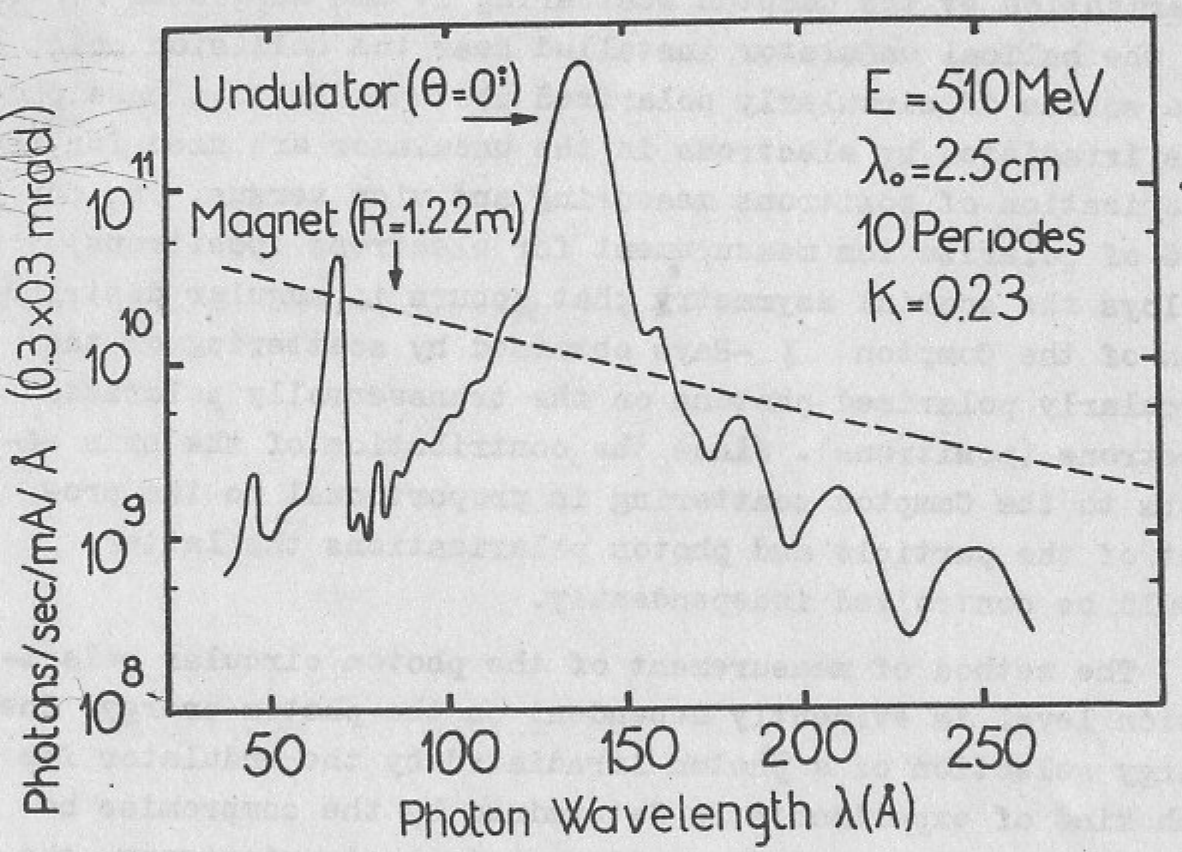

Fig. 1.

sults /3/.

In the work presented here we describe the experimental setup and the method of circular polarization level measurement from the undulator in the ultrasoft X-ray wavelength range. The results of preliminary measurements are also given. The polarization properties of the undulator radiation have been studied before /4/ only for the visible range. In this case the method of measurements is based upon the use of the well known set of linear polarizers rotated around the undulator radiation axis for obtaining the polarization characteristics. In principle such method depending upon the availability of a suitable linear polarizer for the desired wavelength range is applicable. It is evident that the circularly polarized radiation does not cause any change in the output polarizer intensity when it is rotated around radiation axis.

For the visible range traditionally transmission polarizers are used whereas in the soft X-Ray range one can only use

reflecting polarizers. For this wavelength range the optimum incidence angle for reflecting polarizer is close to 45° /5/. It is well known to obtain at such angle of incidence to the homogeneous surface that appreciable (~ 1%) reflection coefficients are impossible. On the other hand Bragg crystals with an incidence angle close to 45° can be used as the X-Ray polarizers /6/. Up to recently the only Bragg reflectors with convenient for the X-UV 2d spacing were organic multilayers /7/. So the number of accessible wavelengths is limited by the 2d offered by these organic crystals. In addition, the organic multilayers are destroyed quickly by intense radiation and so they are not convenient for an undulator source monochromator. For the whole X.U.V rang all these difficulties can be overcome by using metallic multilayers tailored and optimized /8/. Such multilayers have been prepared for our experiment by a laser evaporation method /9/. Table 1 shows the main parameters of some of them, corresponding to different wavelengths selected by a 45° reflexion.

Table 1.

Material	d (A°)	Number of periods	$\Delta\theta$°
W - C	140.9	11	2.95
W - C	120.5	10	2.39
Au - C	108.4	12	2.46
Ag - C	108	10	3.92
Ag - C	100	10	4.05
Cr - C	50	40	3.61

Previous tests using synchrotron source VEPP-2M and a grazing incidence grating monochromator have allowed us to determine the wavelength bandpass at 45° like given in table 1 and the rocking curve at the corresponding peak wavelength.

Typical bandpass is some Å half width and match very well the undulator emission band this yields high flux and a simple photocathode detector with a picoampermeter can be used.

The X-UV polarimeter designed for this experiment is analogue to systems with 45° mirror used in the UV range /10/. In our instrument, shown schematically in figure 2, two 45° reflectors can be set and the same photoelectric detector can be rotated successively to receive the direct, the singly or the doubly reflected beam.

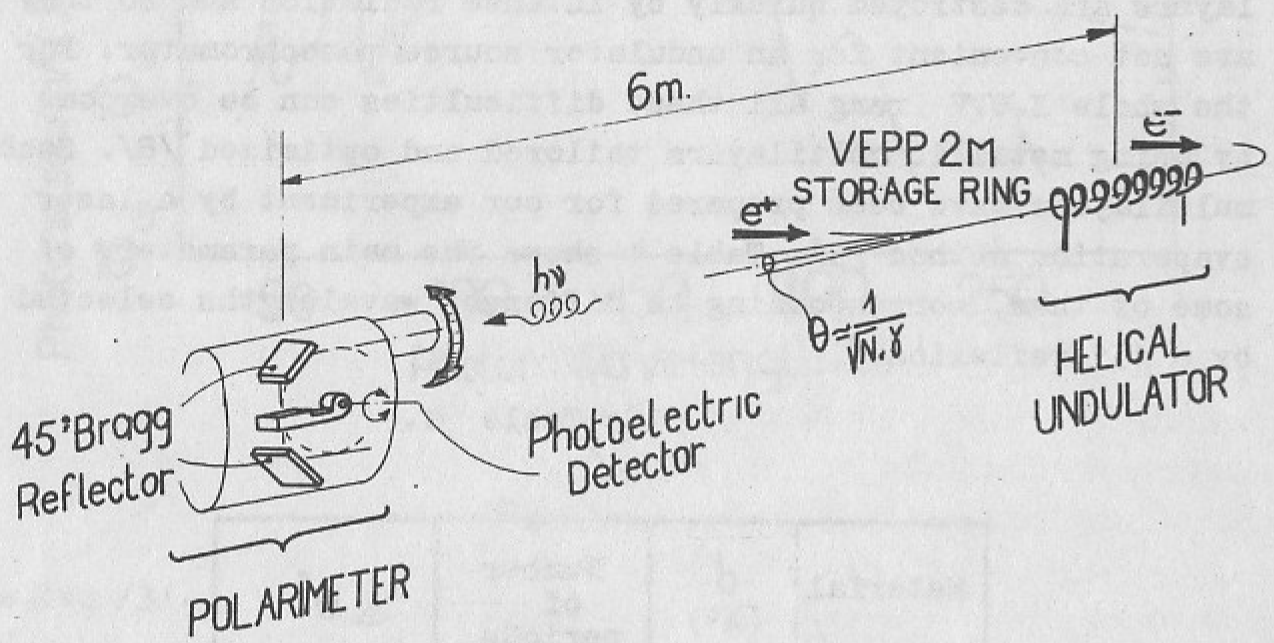

Fig. 2.

A rotating sample holder, not shown in the figure, in front of the first mirror permits to set different samples or holes to filter or to attenuate the beam. All these components are first adjusted inside the vacuum chamber by using a visible laser light to check the precision of setting and rotation. Care must be taken to keep the direct and reflected beam striking the same place of the photocathode. It is also necessary to set the rotation axis of the polarimeter collinear to the undulator axis to avoid too large variation of the incidence angle during the polarimeter rotation. The precision to achieved for this adjustment is connected with the Bragg reflector

rocking curve width. In our case, as a consequence of the large bandpass of the multilayer, the rocking curve have a width of some degrees. A setting with a precision of two tenth of degree does not introduce noticeable reflectivity variation of the multilayers during rotation. Such a precision can be easily checked with an autocollimator and obtained mechanically with, at the front, a rotation vacuum feedthrough teflon sealed and a classical ball bearing support at the near of the vacuum chamber.

With our helical undulator the first order spectrum is emitted inside a cone width aperture $\theta \sim \lambda/\sqrt{N}\cdot\gamma = 0.3$ mrad. This angle being much smaller than the multilayer rocking curve we don't need a slit collimator in front. A first hole with a convenient diameter is set at fixed position in the beam line to define the undulator spectrum received on the polarimeter. A second hole, presently set on the sample holder in front of the multilayers, acts like a collimator to reduce the aperture and to decrease the light coming from the bending magnets. This light appears like elliptically polarized noise superimposed on the circulary polarized undulator light signal. To perform a measurement of the circularity at a specific wavelength, it is first necessary to set the electron beam close to the correct energy needed and to adjust the beam trajectory at the center of the helical undulator with the best straight pass before and after it. This adjustment is achieved with the help of the positioning coils and by trying to get the maximum ratio between the signals received on the direct beam with and without undulator. Next the detector is rotated to receive the Bragg reflected band pass by multilayer choosen and the storage ring energy is scanned to obtain the coincidence between the undulator peak wavelength and the 15° Bragg reflected wavelength. Figure 3 shown the flux variation obtained on the picoampermeter with one of our multilayers selecting the 130 Å band; the lower scale indicates the VEPP-2M storage ring energy and the upper scale the corresponding undulator peak wavelength emitted. For a comparison the dashed curve indicates the multilayer bandpass obtained by previous test of this multilayers.

In the case of the measurements shown on this figure, a silicon oxyde filter have been set on the sample holder to decrease the UV light coming from magnet. With that, a ratio better than one hundred has been obtained between flux measured with and without undulator. With such ratio we do not need to introduce correction in the circularity measurement to take in account the magnet light which has not the same polarization. After these adjustments the polarimeter is rotated by step and the flux is measured for each angle to test the circularity. The results of these measurements are given in Fig. 4. One of the curve shows the variation output flux from the helical undulator as a function of the rotation angle, another one - dashed curve - the samething from the storage ring magnet in media plane.

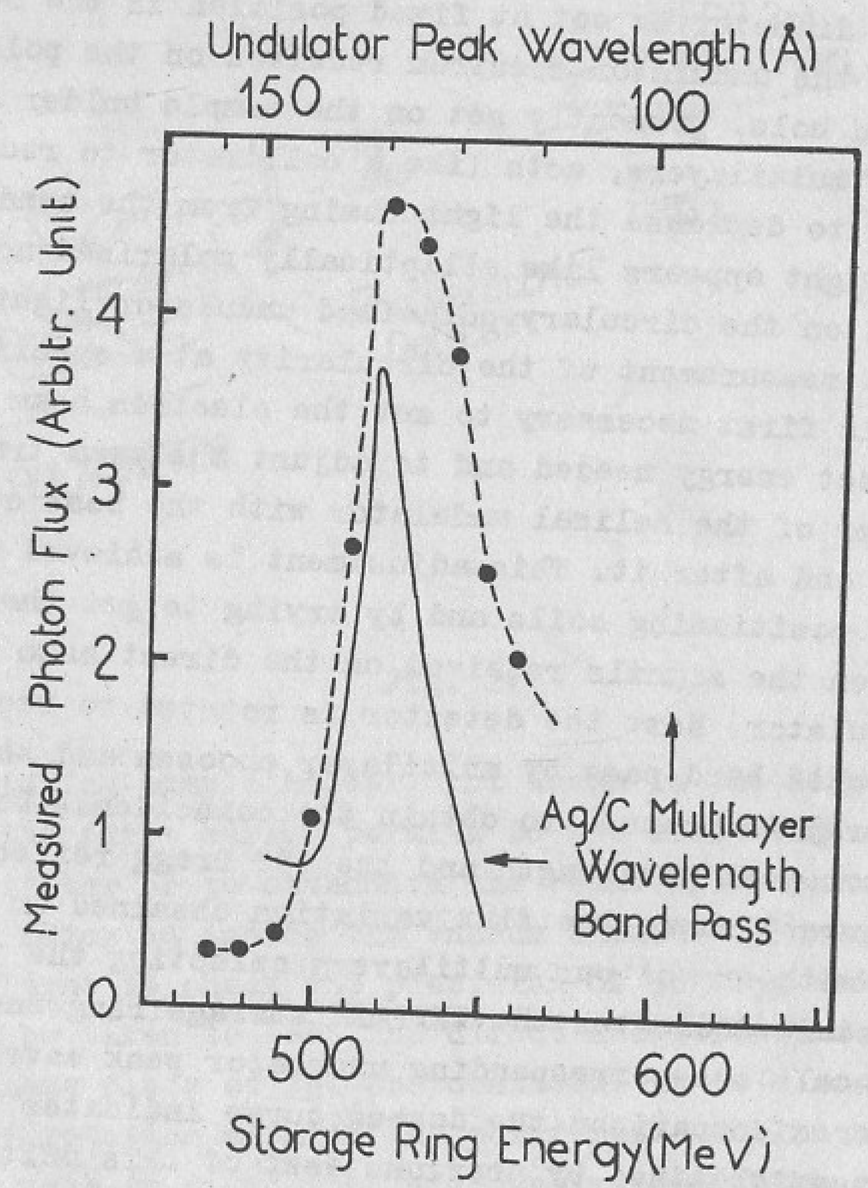

Fig. 3.

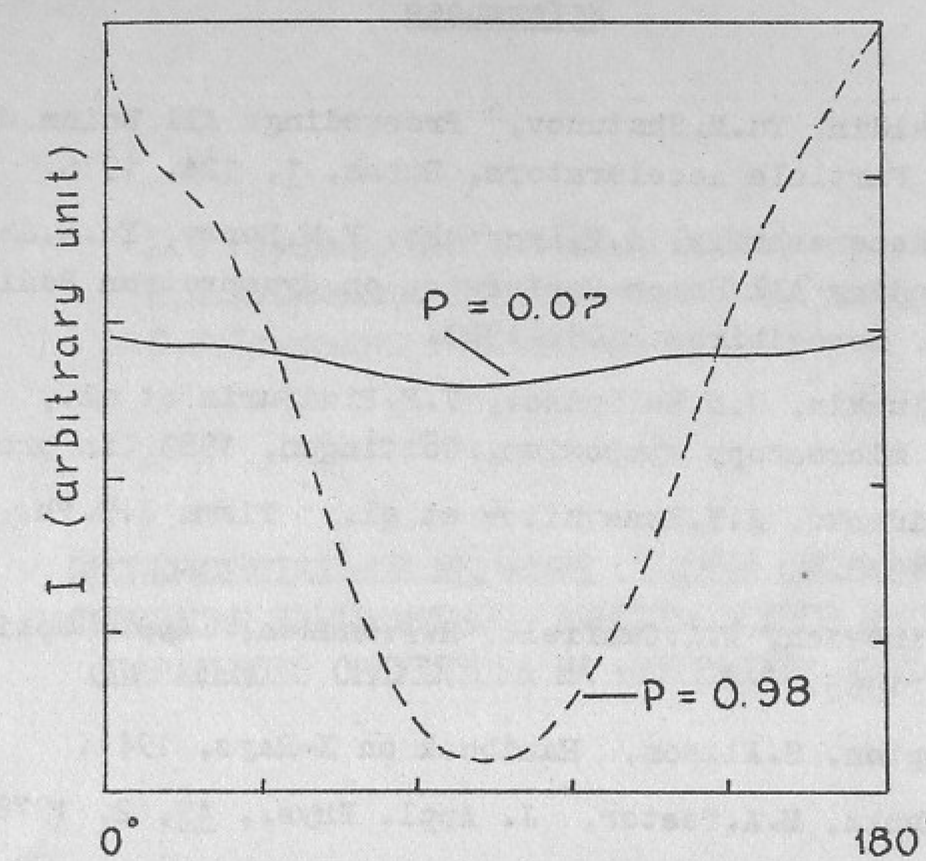

Fig. 4.

In these first measurements the sample holder in front of the multilayers is used like a second collimator hole and rotates with the polarimeter, so preliminary carefull adjustment is needed. In view to decrease the light coming from magnets and to increase the precision of the circularity measurements this second hole will be soon inserted directly at fixed position inside the beam line to get a collimator aperture equivalent to the undulator divergency.

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ЭКСПЕРИМЕНТАЛЬНОЕ ИЗУЧЕНИЕ СТЕПЕНИ ЦИРКУЛЯРНОЙ ПОЛЯРИЗАЦИИ УЛЬТРАМЯГКОГО РЕНТГЕНОВСКОГО ИЗЛУЧЕНИЯ ИЗ СПИРАЛЬНОГО ОНДУЛЯТОРА НА НАКОПИТЕЛЕ ВЭПП-2М

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