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High Resolution Wavelength-Dispersive Spectrometry Based on X-ray Diffraction on Bent Crystals

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A single crystal X-ray diffraction method has been developed to determine the hard X-ray spectrum with high resolution. The design and performance of the wavelength-dispersive spectrometer are based on diffraction by bent crystals in Laue geometry. It is shown that in this case we lose intensity, but have approximately twice the wavelength-dispersion as in the von Hamos geometry. The spectrometer is equipped with an X-ray diffraction crystal, the reflected atomic plates of which are curved with a temperature gradient and provides an energy resolution of about 0.25 eV and 1 eV in the energy range of 24,000 eV–26,000 eV.
The theoretical analysis of the experimental results is based on the eikonal approximation of the theory of dynamic diffraction of X-rays in a crystal lattice with a slowly changing continuous deformation field. Formulas are obtained that determine the depth in the crystal at which rays with a given deviation from the Bragg condition on the input surface of the crystal and a given wavelength enter the angular region. This makes it possible to determine the spatial width and orientation of the reflected beams with different wavelength of the characteristic spectrum of the original radiation. This, in turn, makes it possible to estimate the spatial and angular dispersion of the proposed spectral analyses experimental scheme.

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