Application of the Newly Discovered Dynamical Diffraction Effects in Neutron Diffraction Instruments

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It has been recently shown both theoretically and experimentally that the back face (BF) diffraction (so-called "Neutron Camel") from the Si channel-cut crystal plays significant role in performance of the Ultra-Small-Angle Neutron Scattering (USANS) instruments, based on the Double-Crystal Arrangement. Application of the modified monochromator and analyzer channel-cut crystals with cadmium absorbers, which block the BF diffraction, improves the signal-to-noise ratio of the USANS instruments by over three orders of magnitude. This created a real breakthrough to the µm-scale range of neutron diffraction structural analysis, $10^{-5} < Q < 10^{-3}$ $Å^{-1}$ (Q is the scattering vector, Q = 4psin?/?, ? is the diffraction angle and ? is the wavelength), which is now opened for systematic studies.

The BF and garland reflections from a thick slab-shaped crystal are extremely sensitive to the ultra-small deformation strain, which has been proved in two different experiments. In the first study the 9 mm thick Si crystal was bent by the controlled external deformation force. The second experiment was done on the same crystal, but at this time the deformation strain was created by the 0.2 µm thick Ni film deposited on the diffractive surface. The latter also can be considered as a new approach to study of the residual stress in thin films deposited on single crystal substrates.