Contribution ID: **17** Type: **Oral talk**

Spatial coherence of compact sources with respect to X-ray phase contrast imaging formation

Wednesday, 17 January 2024 11:25 (20 minutes)

Significant successes and important results of research on synchrotron radiation sources raised a new urgent question, namely the development of bright compact radiation sources with coherence parameters that allow the implementation of phase-informative methods. This is due to the growing demand for the use of new research methods based on X-ray radiation in engineering, materials science and medicine. The study concerns the topical issue of implementation of diffraction research methods on compact radiation sources [1]. Taking into account phase information helps to increase the sensitivity and informativeness of the obtained images, making their use more effective in a wide range of research and diagnostic tasks.

The aim is to determine the research capabilities of various types of installations in solving specific applied problems, as well as to develop applied calculation methods for planning and conducting X-ray phase contrast experiments. X-ray phase contrast arises due to the difference in the phase of X-rays when they pass through objects with different refractive or absorption indices. One of the approaches for modeling X-ray phase contrast is the Fresnel-Kirchhoff scalar diffraction theory [2-4]. This study presents a method for calculating phase-contrast images of test objects. A two-stage algorithm for calculating the X-ray phase contrast image from sources of different shapes and sizes has been developed. The evolution of the wave front along the source-object and object-screen path is taken into account. The source-object and object-screen distances at which it is possible to observe phase-contrast images in the Fresnel region have been found. Simulated images of test objects were obtained in the form of intensity contrast on the screen and its phase profile. As the calculations show, increasing the thickness of certain sections of the test object leads to changes in the phase distribution and intensity of the resulting image. This is manifested in the form of the appearance of intensity maxima at the edges of the object, where there is a fast change in its thickness, as well as minima, where the thickness is the largest, which is explained by a greater deviation of X-rays from their original direction.

The results of the research will be useful for the development of methods for studying the internal structure of materials, as well as for solving problems in medical diagnostics, where X-ray phase contrast can help distinguish tissues with different physical properties, for example, in the study of soft tissues and organs.

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Session Classification: Morning Session 2

Track Classification: Condensed Matter Physics