DEVELOPMENTS IN X-RAY HOLOGRAPHY USING UNDULATOR RADIATION

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The use of x-rays to make holograms has been proposed, analyzed and planned since the earliest days of holography. However, it was a long time before even the simplest objects were imaged by reconstruction of an x-ray hologram. The key to success in imaging complicated objects has proved to be improved x-ray sources. Starting with bending-magnet radiation from the INS-SOR ring in Tokyo in the 1970's and continuing with undulator radiation from the Brookhaven and Orsay rings in the 1980's, it has now been demonstrated that x-ray-holographic images of complicated objects can be made with sub micron resolution. More recently, x-ray holography has also been demonstrated using x-ray lasers and laser-heated plasmas and the number of active groups in the world has been growing. In this presentation we explain the principles of x-ray holography and report the progress of the authors and other groups toward achievement of a viable x-ray-holographic technology for use in scientific investigations. For high-resolution in-line holography it is necessary to have a high-resolution recording medium and we describe our successful procedure using PMMA resist and an atomic force microscope to record, read and digitize the hologram followed by calculation of the final image.
To make holographic images which are free of radiation artifacts in spite of the relatively high radiation dose per hologram (around 10^9 rad) it is necessary either to use a sufficiently fast-pulsed x-ray source or use cryo-fixed samples. For such images to provide three-dimensional information, it is also necessary to have a multiplicity of view directions to enable a tomographic reconstruction and we discuss ways to accomplish this for both fast-pulse and cryo experiments. We report our progress toward practical realization of an artifact-free, three-dimensional imaging technique and discuss the prospects for eventual success.

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