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High energy X-ray vortex generation using inverse Compton scattering

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An optical vortex forming a helical wave front along the direction of propagation of the beam has been actively investigated over the past few decades. Such vortices possess a phase singularity at the center of the beam, and the field strength there is zero. More importantly, it has been shown that an optical vortex which possesses a phase term $\exp(im\varphi)$ carries discrete values $m\hbar$ of orbital angular momentum per photon. Fundamental and applied research on optical vortices using visible wavelength lasers is ongoing. However, vortex beams are not limited to visible light but include the sub-MeV electron vortex, ~10 keV X-ray vortex, terahertz wave vortex, and cold neutron vortex. It has been proposed on theoretical grounds that high energy X-ray vortices in the MeV and GeV range could be generated using inverse Compton scattering between an electron and an optical vortex laser. A high energy X-ray vortex providing an additional degree of freedom will open new research opportunities. Potential applications include nuclear physics, magnetic Compton scattering in solid state physics, and electron-positron pair production generated from an X-ray vortex. In this presentation, we will present a development of high-energy X-ray vortex using inverse Compton scattering at the Thomas Jefferson National Accelerator Facility. Basic experiments including the generation of the optical vortex laser by a hologram and interferometric measurement will be reported. Also a feasibility study for storing the optical vortex laser in a Fabry-Perot optical cavity already installed at the Continuous Electron Beam Accelerator Facility (CEBAF) will be presented.

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