Diffraction of electronic wave packets by crystals

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It is well-known that light travels as sinusoidal waves described by Maxwell’s equations. When passing through narrow openings, light spreads out (diffracts) and eventually interferes resulting in the formation of bright (maxima) and dark (minima) fringes. Interference and diffraction (I&D) are fundamental phenomena which confirm the wave characteristic of light. They are discussed in different degrees of sophistication ranging from basic undergraduate physics courses to special topics. The formation of I&D patterns with quantum particles, such as electrons in motion, proves the existence of matter waves. These waves are usually represented as the Fourier transform of sinusoidal waves called “wave packets”. Our goal is to understand the formation of wave packets through experiments involving electron diffraction by crystals. It is known that a diffraction grating acts as a Fourier transform for light. Likewise, we can show that the crystal lattice can Fourier transform the sinusoidal waves associated to free electrons traveling toward a crystal. The regular array of atoms in a crystal acts similar to the slits of a diffraction grating. We perform experiments of crystallography with the purpose of analyzing the interaction between the electronic wave packets and the atomic array in crystals. Applications in electron microscopy, crystallography, analysis of microstructures in bulk matter and biologic samples, including the investigation of proteins are discussed. This project is done under the STAIRSTEP program at Lamar University sponsored by NSF – STEP program with the award # DUE 0757057.