Advancements in Atom Scattering Techniques for Characterizing 2D Materials

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The characterization of two-dimensional (2D) materials presents an experimental challenge due to their unique properties and nanoscale thickness. Traditional techniques, such as charged beam approaches and X-rays, typically penetrate into the bulk, limiting their surface sensitivity. However, atom scattering, as a purely surface-sensitive technique, holds significant potential for studying 2D materials. In atom scattering, atoms scatter off the valence electrons at the surface, with a classical turning point of ~3Å, precluding any penetration into the bulk[1]. Modern atom scattering is advancing in two primary direction: improved energy resolution and improved spatial resolution.

Recently the Cambridge atom scattering facility has completed a major upgrade, leading to the immanent launch of the 2nd generation He-3 Spin Echo spectrometer with an order of magnitude increase in resolution relative to the 1st generation instrument. Spin-Echo enables measurements of dynamics on 2D materials[2] and characterization of surface excitations, enhancing our ability to probe the properties and behavior of 2D materials.

In parallel, Scanning Helium Microscopy (SHeM)[3] has emerged as a powerful technique for studying microscopic samples, addressing a primary limitation of traditional atom scattering: the requirement for large single crystal samples. SHeM allows for detailed investigations on a smaller scale, facilitating the examination of 2D materials at the microscopic level.

The first successful demonstration of Micro Atom diffraction using SHeM will be presented[4], both on a test sample of LiF and on exfoliated $MoS2$. These advancements in atom scattering and SHeM provide researchers with new tools to study the unique properties and surface dynamics of 2D materials, overcoming the experimental challenges associated with their characterisation.

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