Contrast Mechanisms in Scanning Helium Atom Microscopy

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Scanning helium atom microscopy (SHeM) [1] is emerging as a valuable tool for imaging delicate surfaces, with a wide range of potential applications. The technique involves producing a helium microprobe by collimation or diffractive focussing of a molecular beam from a free-jet supersonic source, followed by raster-scanning the resulting beam over a sample. Atoms scattered into a particular direction are collected and passed to an ultra-high sensitivity detector for counting, prior to assembling the resulting image.

The nature of the helium atom-surface scattering process [2] means a number of unusual contrast mechanisms are possible. These include (i) diffuse or topological contrast due to diffuse scattering from the local structure; (ii) Debye-Waller or chemical contrast due to inelastic interactions with the surface; and (iii) reflective, diffractive and interference contrast due to elastic scattering.

We will give an overview of the SHeM technique and the implementation we have developed in Cambridge, U.K., in collaboration with the University of Newcastle, Australia. We will discuss the prospects for further development of the technique, particularly in terms of resolution and imaging rate. Recent applications will be reviewed, along with progress in observing and understanding the origins of each of the above forms of contrast.

References:
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[2] D. Farias and K.-H. Rieder, Rep. Prog. Phys. 61, 1575 (1998).