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From Z to A:
Z-contrast’s Guide to the Atomic World

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In this presentation I will trace the development of Z-contrast STEM using the HAADF detector from the first early attempts in the Cavendish Laboratory, Cambridge, through to today [1,2]. Although incoherent imaging with the electron microscope is accepted today, it was not always, and formed the source of much controversy. With an understanding of the role of the detector, imparting transverse incoherence [3], and phonons, imparting longitudinal incoherence [4], with the surprising Bloch state filtering effect that avoids dynamical effects [5,6], the technique began to gain acceptance. With increasing resolution, and especially aberration correction [7], not only did HAADF imaging improve dramatically, so did STEM bright field phase contrast imaging, and also EELS sensitivity. Incoherent imaging has revealed many new insights into materials, uncovering numerous surprises concerning grain boundaries in ceramics, light emitting nanoparticles and the origin of colossal ionic conductivity in strained YSZ multilayers. We could even follow point defect diffusion inside materials and see the reason for giant piezoelectricity in epitaxial ceramic thin films. We can even fabricate entirely new materials such as monolayer Mo, molene.

STEM has transformed from mostly a curiosity to a mainstream tool in materials research. But there remains plenty to do [8], and new developments such as ptychography and field free microscopy seem to provide even more exciting prospects for materials science in the future.

References:

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