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Reciprocity Relations in Transmission Electron Microscopy: A Rigorous Derivation

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Abstract

A concise derivation of the principle of reciprocity applied to realistic transmission electron microscopy setups is presented making use of the multislice formalism. The equivalence of images acquired in conventional and scanning mode is thereby rigorously shown. The conditions for the applicability of the found reciprocity relations is discussed. Furthermore the positions of apertures in relation to the corresponding lenses are considered, a subject which scarcely has been addressed in previous publications.

Keywords: Principle of Reciprocity, TEM, CTEM, STEM, Multislice

1. Introduction

In transmission electron microscopy (TEM) the principle of reciprocity and derived relations are frequently invoked to substantiate the equivalence of seemingly very different modes of image formation. First generally formulated by von Laue (von Laue, 1948) and popularly introduced into electron microscopy by Cowley (Cowley, 1969), reciprocity is able to relate conventional direct image formation using an extended incoherent source with the image intensity gained from scanning a focused electron probe and using an extended detector. It was thus utilised to reveal the intrinsic spatial incoherence of scanning TEM

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