Matter-wave diffraction from a periodic array of half planes

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We report on reflection and diffraction of beams of He and D2 from square-wave gratings of 400-μm period and strip widths ranging from 10 to 200 μm at grazing incidence conditions. In each case, we observe fully resolved matter-wave diffraction patterns including the specular reflection and diffracted beams up to the ±2nd diffraction order. With decreasing strip width the observed diffraction efficiencies exhibit a transformation from the known regime of quantum reflection from the grating strips to the regime of edge diffraction from a half-plane array. The latter is described by a single-parameter model developed previously to describe phenomena as diverse as quantum billiards, scattering of radio waves in urban areas, and reflection of matter-waves from micro-structures. Our data provide experimental confirmation of the widespread model. Moreover, our results demonstrate that neither classical reflection nor quantum reflection is essential for reflective diffraction of matter-waves from a structured solid, but it can result exclusively from half-plane edge diffraction.