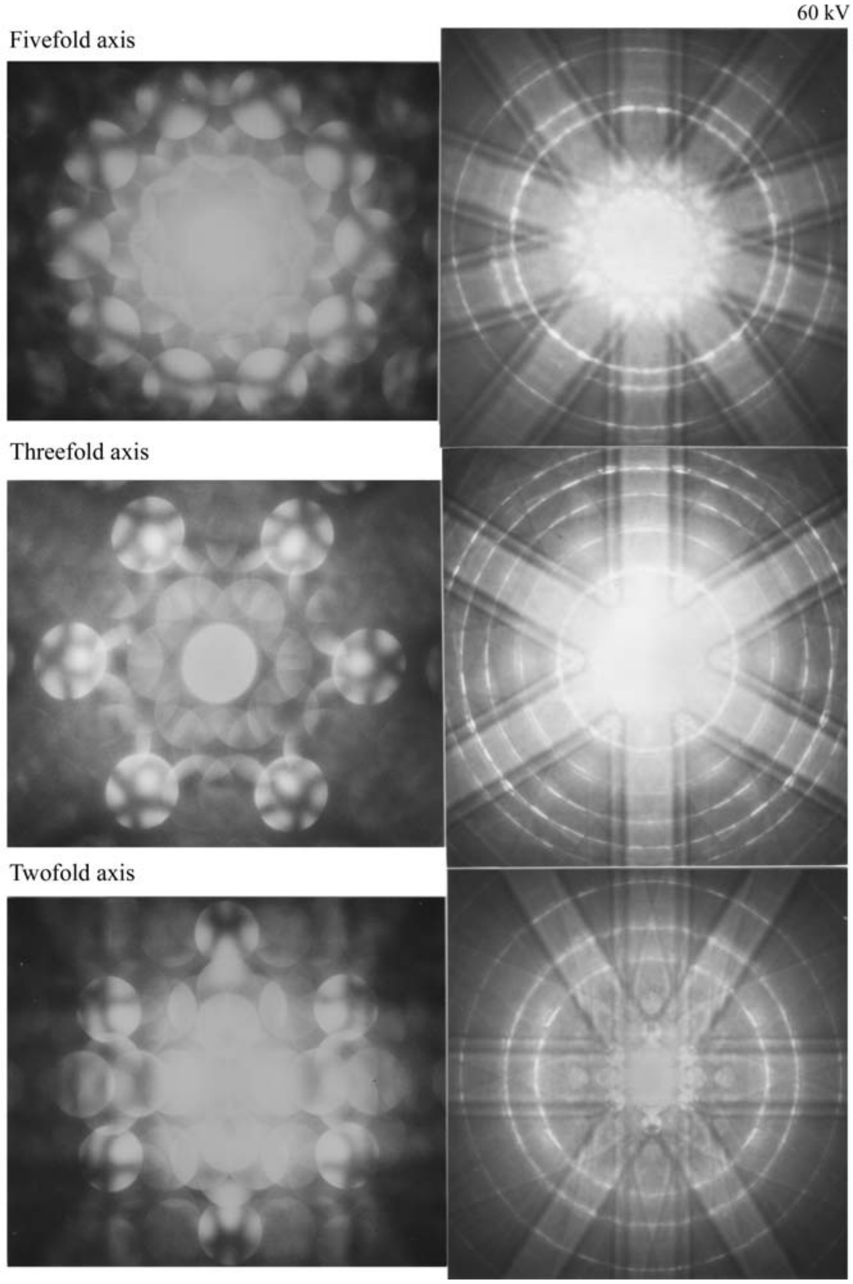


Fig. 2.5.3.24. Three pairs of ZOLZ [(*a*), (*c*) and (*e*)] and HOLZ [(*b*), (*d*) and (*f*)] CBED patterns taken at 60 kV from an area of $Al_{74}Mn_{20}Si_6$ about 3 nm in diameter and about 10 nm thick (Tanaka, Terauchi, Suzuki *et al.*, 1987). Symmetries are (*a*) 10*mm*, (*b*) 5*m*, (*c*) 6*mm*, (*d*) 3*m*, (*e*) 2*mm* and (*f*) 2*mm*.

Fig. 2.5.3.23(*b*) shows a CBED pattern corresponding to Fig. 2.5.3.23(*a*), taken from a specimen area 3 nm in diameter. The excitation errors of two *Umweganregung* paths *a* and *b* are the same at this electron incidence. The reflections 0001, $000\bar{1}$, $200\bar{1}$ and $\bar{2}001$ indicated by white arrowheads show no intensity. Dynamical extinction does not appear as a line in the present case because the width of the extinction line exceeds the disc size of the reflections. Fig. 2.5.3.23(*c*) shows a CBED pattern taken at an incidence slightly tilted toward the $b^*$ axis from that for Fig. 2.5.3.23(*b*) or the [001] zone-axis incidence. The excitation errors are no longer the same for the two *Umweganregung* paths. Thus, it is seen that the kinematically forbidden reflections indicated by white arrowheads have intensities due to incomplete cancellation of waves coming through different paths, which is an additional proof of the dynamical extinction.

### 2.5.3.5. *Symmetry determination of quasicrystals*

#### 2.5.3.5.1. *Icosahedral quasicrystals*

Penrose (1974) demonstrated that a two-dimensional plane can be tiled with thin and fat rhombi to give a pattern with local fivefold rotational symmetries but with no translational symmetry. Mackay (1982) extended the tiling to three dimensions using acute and obtuse rhombohedra, which also resulted in the acquisition of local fivefold rotational symmetries and in a lack of translational symmetry. The three-dimensional space-filling method was later completed by Ogawa (1985). These studies, however, remained a matter of design or geometrical amusement until Shechtman *et al.* (1984) discovered an icosahedral symmetry presumably with long-range structural order in an alloy of $Al_6Mn$ (nominal composition) using electron diffraction. Since then, the term quasicrystalline order, a new class of structural order with no translational symmetry but long-range structural order, has been coined. Levine & Steinhardt (1984) showed that the quasilattice produces sharp diffraction patterns and succeeded in reproducing almost exactly the diffraction pattern obtained by Shechtman *et al*. (1984) using the Fourier transform of a quasi-periodic icosahedral lattice. When analysing X-ray and electron-diffraction data for a quasicrystal, the diffraction peaks can be successfully indexed by six independent vectors pointing to the vertices of an icosahedron. It was then found that the icosahedral quasicrystal can be described in terms of a regular crystal in six