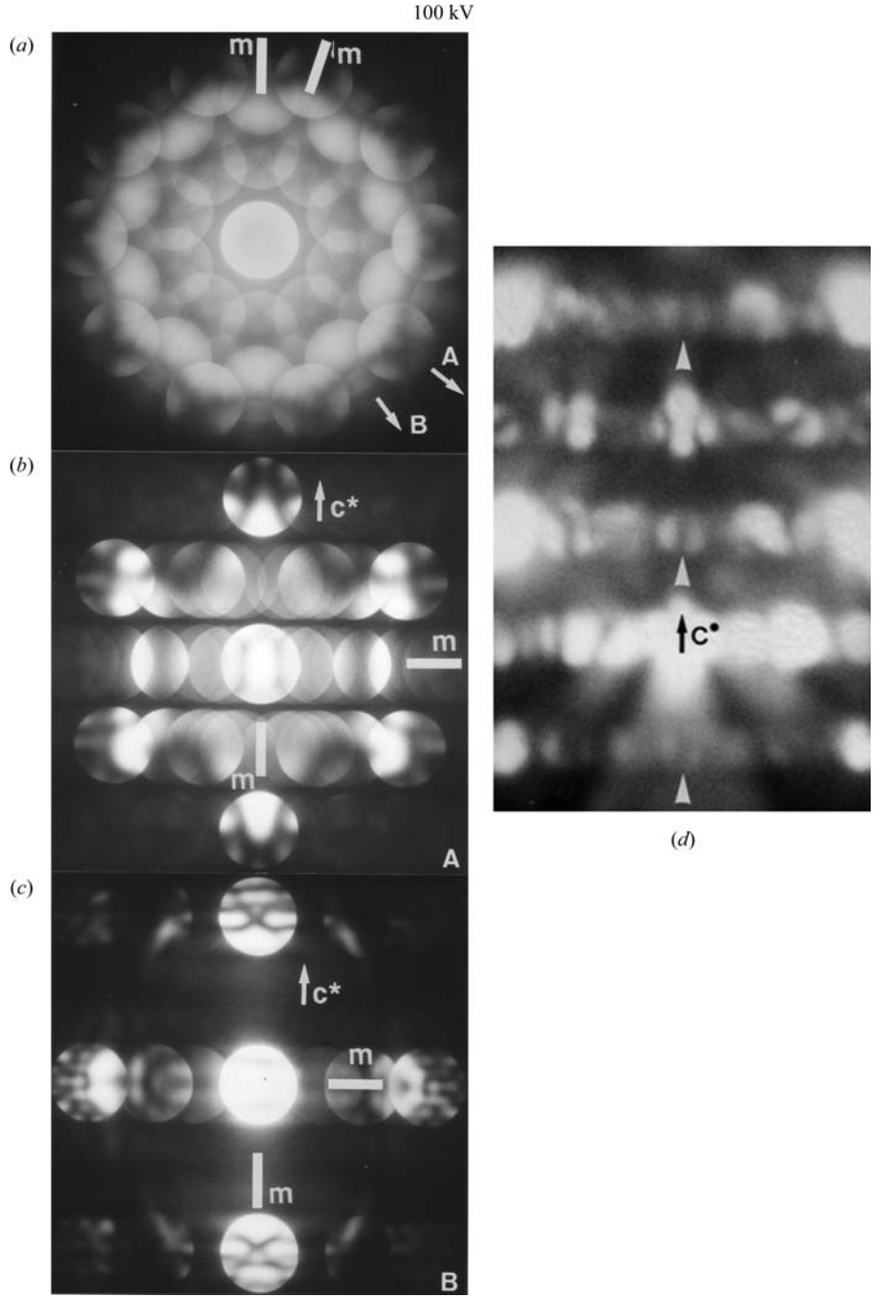

Fig. 2.5.3.27. CBED patterns of metastable $Al_{70}Ni_{20}Fe_{10}$ taken from a 3 nm diameter area. (*a*) Electron incidence along the decagonal axis: symmetry 10*mm*. (*b*) Electron incidence along direction A indicated in (*a*): symmetry 2*mm*. (*c*) Electron incidence along direction B indicated in (*a*): symmetry 2*mm*. (*d*) Reflections 00*l* (*l* = odd) show dynamical extinction lines. This alloy is determined to have the centrosymmetric space group $P10_5/mmc$.

twofold rotation axis is equivalent to the vertical mirror plane in the projection approximation. Figs. 2.5.3.26(*b*) and (*c*) were taken with beam incidences A and B, respectively, as denoted in Fig. 2.5.3.26(*a*). Mirror symmetry perpendicular to the *c* axis is seen in Fig. 2.5.3.26(*b*) and (*c*). Since the mirror symmetry requires a twofold rotation axis or a mirror plane perpendicular to the *c* axis, point groups 52 and $\overline{1}0m2$ remain as possibilities. Fig. 2.5.3.26(*c*) exhibits symmetry 2*mm*. Mirror symmetry parallel to the *c* axis requires the existence of a mirror plane parallel to the axis (a twofold rotation axis is not possible because the fivefold rotation axis already exists.). Since the mirror plane does not exist in point group 52 but does exist in $\overline{1}0m2$, the point group of the alloy is determined to be $\overline{1}0m2$. Examination of the ordinary diffraction patterns of the alloy revealed that the lattice type is primitive with a periodicity of 0.4 nm in the *c* direction and no dynamical extinction was observed. Thus, the space group of $Al_{70}Ni_{15}Fe_{15}$ was determined to be $P\overline{1}0m2$ (Saito *et al.*, 1992) by full use of the potential of CBED. This is the first quasicrystal with a noncentrosymmetric space group. High-resolution electron-microscope images revealed that the quasicrystal is composed of specific pentagonal atom clusters 2 nm in diameter (Tanaka *et al.*, 1993). Dark-field microscopy revealed the existence of inversion domains with an antiphase shift of *c*/2, the polarity being perpendicular to the *c* direction (Tsuda *et al.*, 1993).

Quasicrystals of $Al_{70}Ni_{10+x}Fe_{20-x}$ ($0 \leq x \leq 10$) were investigated by CBED and transmission electron microscopy (Tanaka *et al.*, 1993). The change in space group takes place at $x = 7.5$ upon a sudden decrease of the size of the inversion domains or a rapid mixing of the atom clusters with positive and negative polarities. As a result, the average structure becomes centrosymmetric. A CBED pattern of $Al_{70}Ni_{20}Fe_{10}$ taken at an incidence along the *c* axis shows tenfold rotation symmetry (Fig. 2.5.3.27*a*). CBED patterns taken at incidences A and B (shown in Fig. 2.5.3.27*a*) exhibit two mirror symmetries parallel and perpendicular to the *c* axis (Figs. 2.5.3.27*b* and *c*). Thus, the point group of this phase is