International Tables for Crystallography (2006). Vol. C, Figure 2.7.3.5, p. 119.

$\Delta\omega_{180} = \theta(V') - \theta(V) - \Delta\varphi$, from which both $\Delta\varphi$ and the difference in Bragg angles can be found. The interplanar spacing difference is given by $d(V') - d(V) = [\theta(V) - \theta(V')]\bar{d} \cot\theta$, $\bar{d}$ being the mean interplanar spacing of V and V'. In practice, series of topographs are taken with azimuthal angles $\psi = 0$, 90, 180, and 270°, so that the two components needed to specify the misorientation vector between the Bragg-plane normals of V and V' can be determined. The Du Mond diagram shows that in this slightly dispersive experiment the range of overlap of the U band with any V band can be restricted by reducing the angular range or wavelength range of rays incident on U. Such reduction can be achieved by use of a small source S far distant from U, such as a synchrotron source. It can also be achieved by methods described in Subsection 2.7.4.2. As regards spatial resolution on double-crystal topographs, relations analogous to those for single-crystal topographs apply. If the reference crystal U unavoidably contains some defects, their images on F can deliberately be made diffuse compared with images of defects in V by making the UV distance relatively large. In a nearly dispersion-free arrangement, if the $K\alpha_1$ wavelength is being reflected, then so too will the $K\alpha_2$ if S is sufficiently widely extended in the incidence plane, as is usually necessary to image a usefully large area of V. If the distance VF cannot be made sufficiently small to reduce to a tolerable value the resolution loss due to simultaneous registration of the α_1 and α_2 images, then a source S of small apparent size, together with a collimating slit before U, will be needed. In order to obtain imaging of a large area of V, a linear scanning motion to and fro at an angle to SU in the plane of incidence must be performed by the source and collimator relative to the double-crystal camera. Whether it is the source and collimator or the camera that physically move depends upon their relative portability. When the source is a standard sealed-off X-ray tube, it is not difficult to arrange for it to execute the motion (Milne, 1971).

In some applications, it may occur that the specimen is so deformed that only a narrow strip of its surface will reflect at each ω setting. Then, a sequence of images can be superimposed on a single film, changing ω by a small step between each exposure. The 'zebra' patterns so obtained define contours of equal 'effective misorientation', the latter term describing the combined effect of variations in tilt $\Delta\varphi$ and of Bragg-angle changes due to variations in interplanar spacing (Renninger, 1965; Jacobs & Hart, 1977).

Double-crystal topography employing the parallel setting was developed independently by Bond & Andrus (1952) and by Bonse & Kappler (1958), and used by the former workers for studying reflections from surfaces of natural quartz crystals, and by the latter for detecting the strain fields surrounding outcrops of single dislocations at the surfaces of germanium crystals. Since then, the method has been much refined and widely applied. The detection of relative changes in interplanar spacing with a sensitivity of 10^{-8} is achievable using high-angle reflections and very perfect crystals. These developments have been reviewed by Hart (1968, 1981).

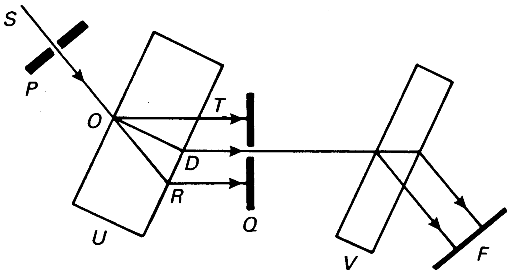

Fig. 2.7.3.5. Transmission double-crystal topography in + − setting with spatial limitation of beam leaving reference crystal.

Transmitted Bragg reflection (*i.e.* the Laue case) can be used for either or both crystals U and V, in both the + + and + − settings, if desired. When the reference crystal U is used in transmission, a technique due to Chikawa & Austerman (1968), shown in Fig. 2.7.3.5, can be employed if U is relatively thick and, preferably, not highly absorbing of the radiation used. This technique exploits a property of diffraction by ideally perfect crystals, that, for waves satisfying the Bragg condition exactly, the energy-flow vector (Poynting vector) within the energy-flow triangle (the triangle ORT in Figs. 2.7.2.2 and 2.7.2.3) is parallel to the Bragg planes. (In fact, the energy-flow vectors swing through the triangle ORT as the range of Bragg reflection is swept by the incident wave vector, $\mathbf{K}_0$.) Placing a slit Q as shown in Fig. 2.7.3.5 so as to transmit only those diffracted rays emerging from RT whose energy-flow direction in the crystal ran parallel, or nearly parallel, to the Bragg plane OD has the effect of selecting out from all diffracted rays only those that have zero or very small angular deviation from the exact Bragg condition. The slit Q thus provides an angularly narrower beam for studying the specimen crystal V than would be obtained if all diffracted rays from U were allowed to fall on V. The specimen is shown here in the + − setting, and also oriented to transmit its diffracted beam to the film F. This specimen arrangement is a likely embodiment of the technique but is incidental to the principle of employing *spatial* selection of transmitted diffraction rays to gain *angular* selection, a technique first used by Authier (1961). A practical limitation of this technique arises from angular spreading due to Fraunhofer diffraction by the slit Q: use of too fine an opening of Q will defeat the aim of securing an extremely angularly narrow beam for probing the specimen crystal.

2.7.4. Developments with synchrotron radiation

2.7.4.1. *White-radiation topography*

The generation and properties of synchrotron X-rays are discussed by Arndt in Subsection 4.2.1.5. For reference, his list of important attributes of synchrotron radiation is here repeated as follows: (1) high intensity, (2) continuous spectrum, (3) narrow angular collimation, (4) small source size, (5) polarization, (6) regularly pulsed time structure, and (7) computability of properties. All these items influence the design and scope of X-ray topographic experiments with synchrotron radiation, in some cases profoundly. The high intensity of continuous radiation delivered in comparison with the output of standard X-ray tubes, and hence the rapidity with which X-ray topographs could be produced, was the first attribute to attract attention, through the pioneer experiments of Tuomi, Naukkarinen & Rabe (1974), and of Hart (1975*a*). They used the simple diffraction geometry of the Ramachandran (Fig. 2.7.1.2) and Schulz (Fig.2.7.1.1) methods, respectively. [Since in the transmission-specimen case a multiplicity of Laue images can be recorded, it is usual to regard this work as a revival of the Guinier & Tennevin (1949) technique.] Subsequent developments in synchrotron X-ray topography have been reviewed by Tanner (1977) and by Kuriyama, Boettinger & Cohen (1982), and described in several chapters in Tanner & Bowen (1980). Some developments of methods and apparatus that have been stimulated by the advent of synchrotron-radiation sources will be described in this and in the following Subsection 2.7.4.2, the division illustrating two recognizable streams of development, the first exploiting the speed and relative instrumental simplicity

references