Lecture Notes - Optics 7: Biaxial Minerals

- The interference figure obtained for a biaxial mineral depends on the orientation of the mineral with respect to the microscope stage. Four types of interference figure are commonly considered:

  (a) **BxA** figure - the **acute bisectrix** (a line that bisects the acute angle between the two optic axes) is vertical (perpendicular to the plane of the microscope stage). The acute bisectrix is the γ vibration direction for positive minerals, the α vibration direction for negative minerals.

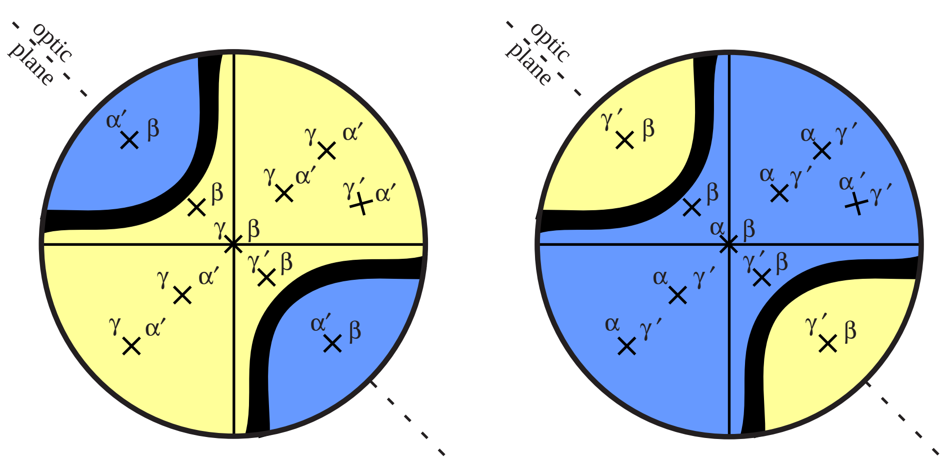
  (b) **BxO** figure - the **obtuse bisectrix** (a line that bisects the obtuse angle between the two optic axes) is vertical. The obtuse bisectrix is the α vibration direction for positive minerals, the γ vibration direction for negative minerals.

  (c) **O.A.** figure - one of the two **optic axes** is vertical (an optic axis figure).

  (d) **O.N.** figure - the β vibration direction is vertical. The **optic axial plane** (O.A.P.) is horizontal (an optic normal figure). This figure is also called a flash figure.

  The Birnie video tape discusses these and other biaxial interference figures and shows examples of them.

- The distribution of interference colors observed in a BxA figure can be understood by considering the refractive indices and vibration directions expected for the conoscopic incident light. Imagine that at each point in the figure a small crystal exists with its acute bisectrix inclined in a vertical plane extending from the point to the center of figure. The degree of inclination from the vertical increases with the radial distance from the center of the figure. The refractive indices and vibration directions at each point are given by the (horizontal) cross section of the indicatrix for the inclined bisectrix (see figure).



biaxial (-) biaxial (+)

- Where one of the two vibration directions is E-W, the retardation is zero. The distribution of these points produces two black, curved **isogyres**. The point of maximum curvature for the isogyre is called the **melatope**. Retardation increases in all directions away from the melatope. If the birefringence of the mineral is large, the interference figure will show **isochromes** arranged concentrically about the melatopes. Each melatope is the point of emergence of an optic axis. The trace of the **optic axial plane** (O.A.P.), a symmetry plane, passes through the two melatopes.

- Interference figures for biaxial minerals are more varied than those of uniaxial minerals and can be difficult to interpret. However, if a careful choice of mineral grain is made (on the basis of retardation), interpretation is straightforward. Always look for a mineral grain with the **minimum** retardation. It's interference figure should be a nearly centered optic axis figure. The optic sign may be determined from the optic axis figure by inserting the quartz accessory plate when the centered isogyre is concave to the NE. If there is addition to the retardation in the NE (constructive interference), the mineral is positive. The **2V** may be estimated from an optic axis figure based on the curvature of the centered isogyre (see handout). **2V** may also be estimated from the separation of the melatopes in a BxA figure (Tobi's Method).

- For minerals with a **2V** greater than 65° both isogyres in a BxA figure will leave the field of view during rotation of the stage. **Do not** attempt to determine the optic sign using an interference figure in which the isogyres leave the field of view. In these cases you may easily confuse a BxA figure and a BxO figure. You will determine the wrong sign using the normal procedure on a BxO figure. The maximum observable separation of the isogyres depends on the numerical apature (n.a.) of the objective lens and the β refractive index of the mineral. The 65° **2V** limit applies to a n.a. of 0.85 and a β of 1.6. Smaller n.a. values and larger β values will lead to smaller observable maximum **2V** values (see Table 7.1 in Nesse).

- Three principal refractive indices must be determined for biaxial minerals. Grains showing the **maximum** retardation and giving an optic normal (flash) figure may be used to determine $\mathbf{n}_\alpha$ and $\mathbf{n}_\gamma$. Grains showing the **minimum** retardation and giving an optic axis figure may be used to determine $\mathbf{n}_\beta$. Once the proper grains are identified, the procedures are identical to those used for uniaxial minerals. By measuring a set of extinction angles for a crystal mounted on a spindle stage, a computer program developed by Donald Bloss may be used to determine **2V** immediately and to identify the spindle and stage positions required to measure (*i.e.* to orient E-W) the $\mathbf{n}_\alpha$, $\mathbf{n}_\beta$, and $\mathbf{n}_\gamma$ indices.