Summary of optical properties

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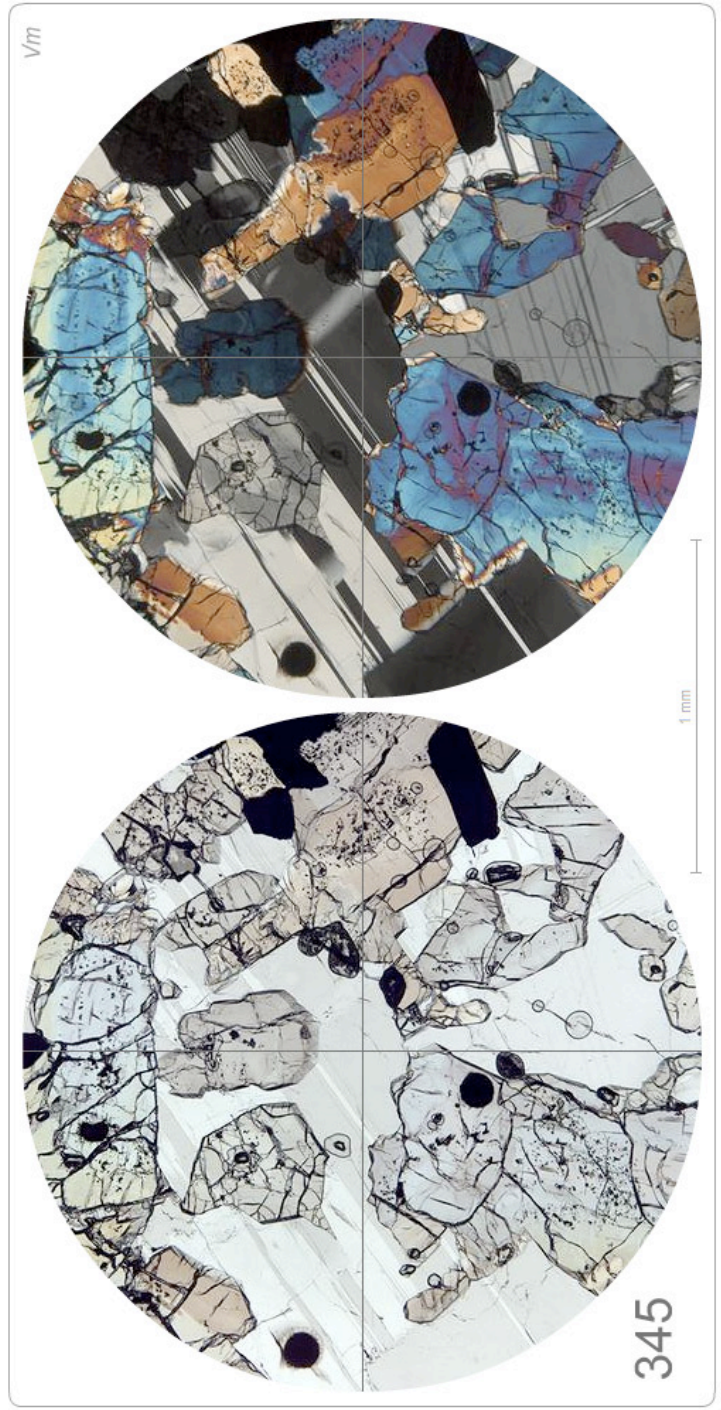


Appolo12:
Credits: Open University Virtual Microscope Project

ISOTROPIC, UNIAXIAL OR BIAXIAL?

- Mineral is:
  - **Isotropic** if all grains are extinct under crossed polars during 360° rotation.
  - **Uniaxial** if it gives a uniaxial interference figure (crossed or straight lines with Bertrand lens).
  - **Biaxial** if it gives a biaxial interference figure (curves with Bertrand lens).

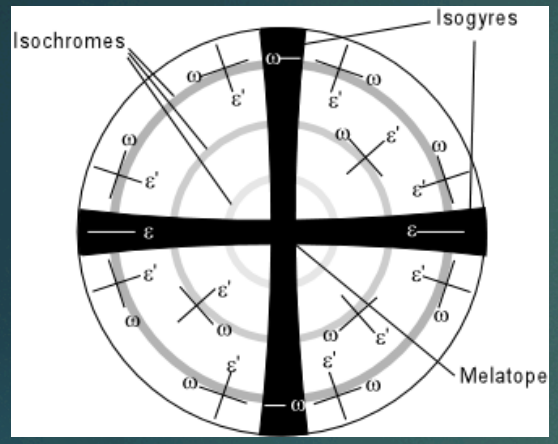
BIREFRINGENCE

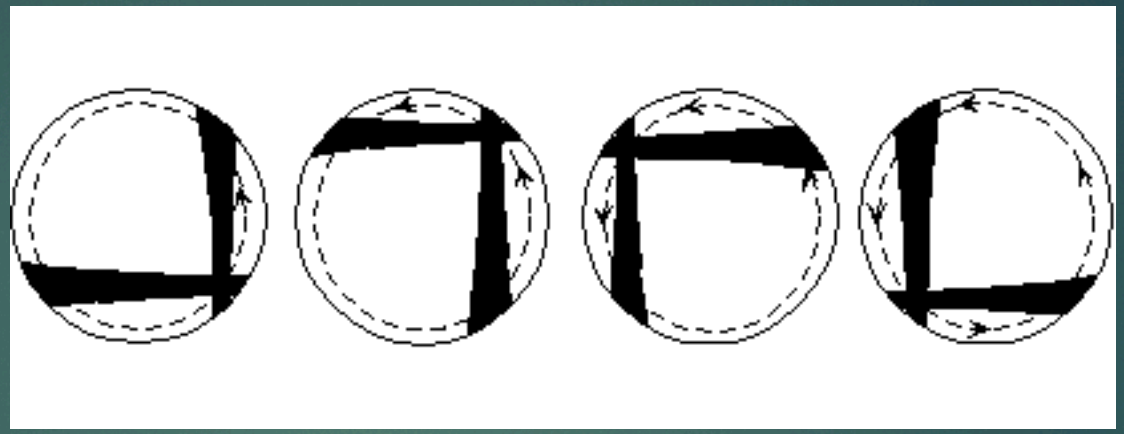
- **Estimation of Birefringence** - in thin section with a given thickness of minerals (0.03 mm), birefringence is estimated using interference color chart.

- Note that only absolute birefringence is diagnostic:
  - $|\omega - \varepsilon|$ for uniaxial minerals
  - $(\gamma - \alpha)$ for biaxial minerals

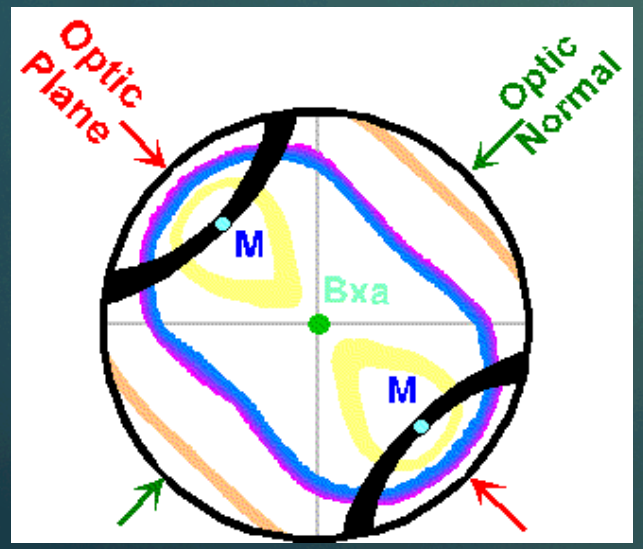
INTERFERENCE FIGURES

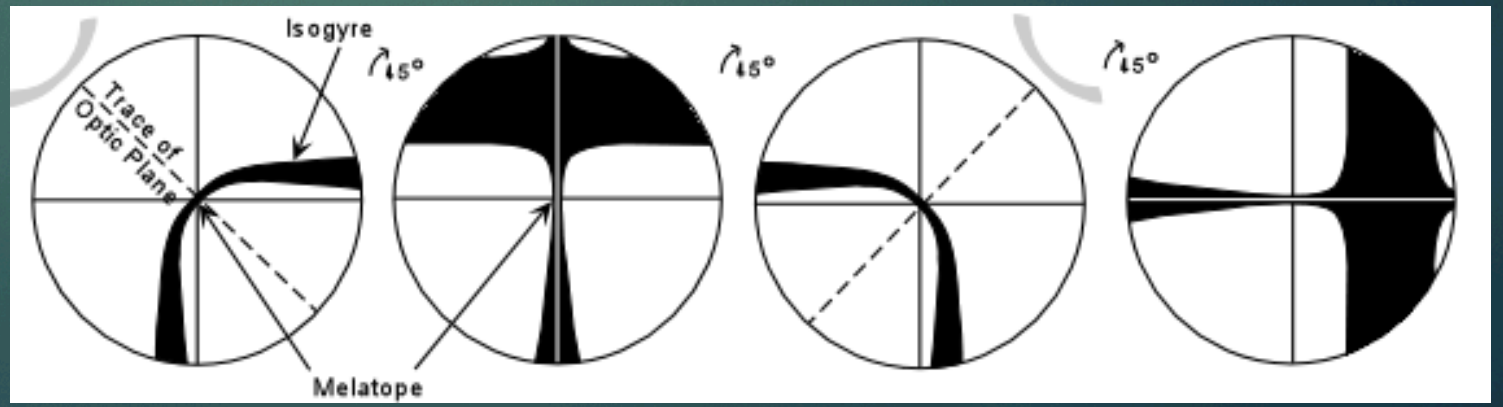
- **Uniaxial mineral:** cross or line





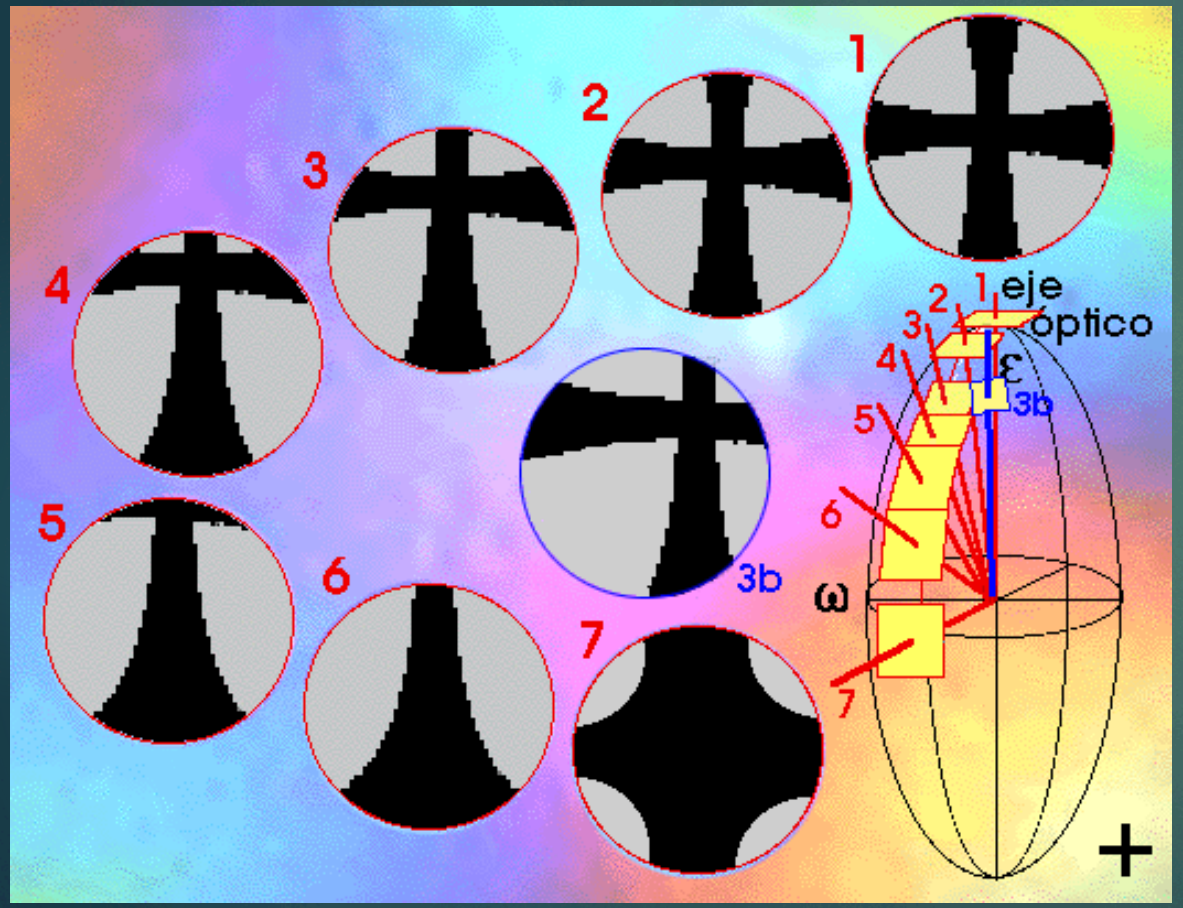
- **Biaxial mineral:** one or 2 curves



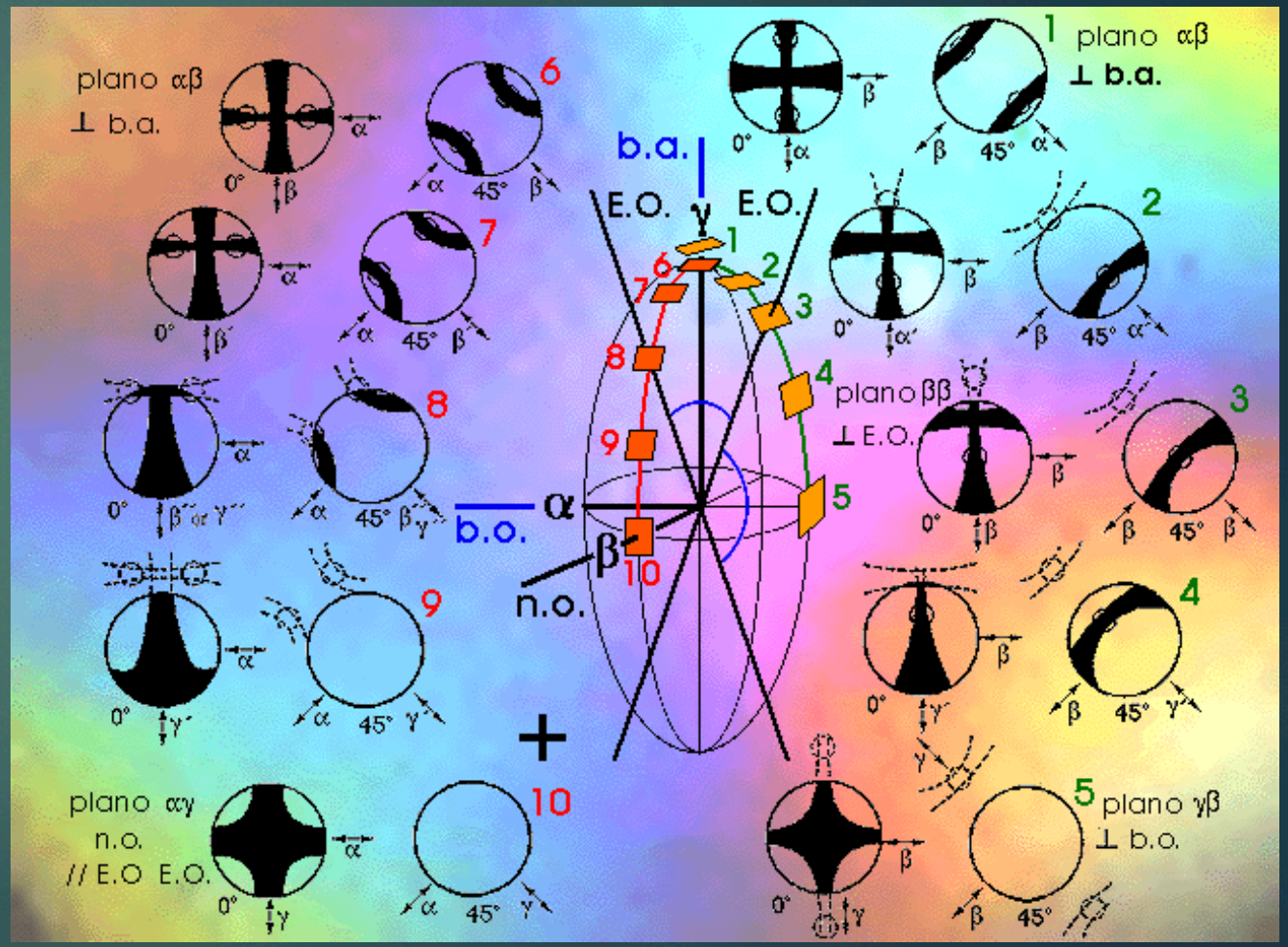


INTERFERENCE FIGURES

- **Section parallel to c: Flash figure**



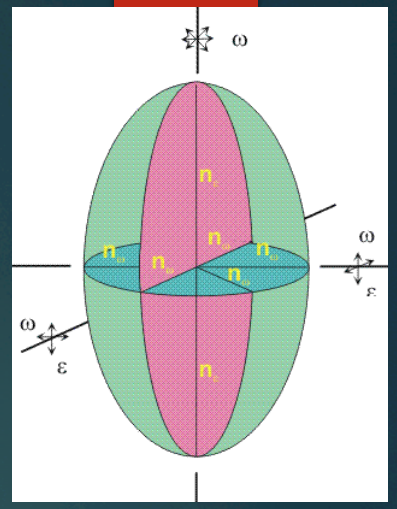
Uniaxial

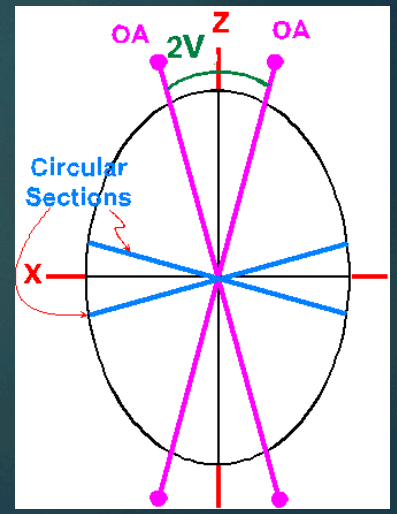


Biaxial

OPTIC SIGN

- from uniaxial centered or near centered interference figure for uniaxial minerals.
  - Positive if blue in NW-SE quadrants
- from biaxial BX_A or OA centered or near centered interference figure.
  - Melatopes in NW-SE quadrants: positive if blue inside the isogyres





2V

- for <u>biaxial minerals only</u>, estimated with BX_A or centered OA figure

RELIEF

- From comparison with surrounding minerals or cement in which the crystals are mounted (**Becke line method**), or with oil in immersion method.

- Constant for isotropic minerals or for circular section of the optical indicatrix:
  - Uniaxial mineral: basal section – $\Phi = \omega$
  - Biaxial mineral: section perpendicalar to OA - $\Phi = \beta$

PLEOCHROISM

- **Absorption color** - if present, may be observable in isotropic, uniaxial, and biaxial minerals with analyzer **not inserted**. (i.e., color seen in transmitted light)

- **Uniaxial minerals may have pleochroic** formula: ω = color1, ε = color2. If optic axis is perpendicular to the stage i.e. we are looking at the basal section), only one color will be observed.

- **Biaxial minerals may have pleochroic** formula α = color1, β = color2, γ = color3, but only 2 colors will be observed in any one grain, unless the optic axis is perpendicular to stage - then only one color.

In transmitted light!!!!!!

SIGN OF ELONGATION

- **Uniaxial minerals:** when elongated (long direction parallel to the C axis):
  - 1) Turn the mineral on the stage such as the direction of elongation is NE-SW
  - 2) insert the gypsum plate: + if the interference color increases
- **Biaxial minerals:**
  - 1) Position the long direction parallel to N-S
  - 2) Turn the stage clockwise until the mineral go extinct
  - 3) turn the stage clockwise by 45°
  - 4) insert the gypsum plate: + if the interference color increases ⇔ **the long direction is parallel to γ**

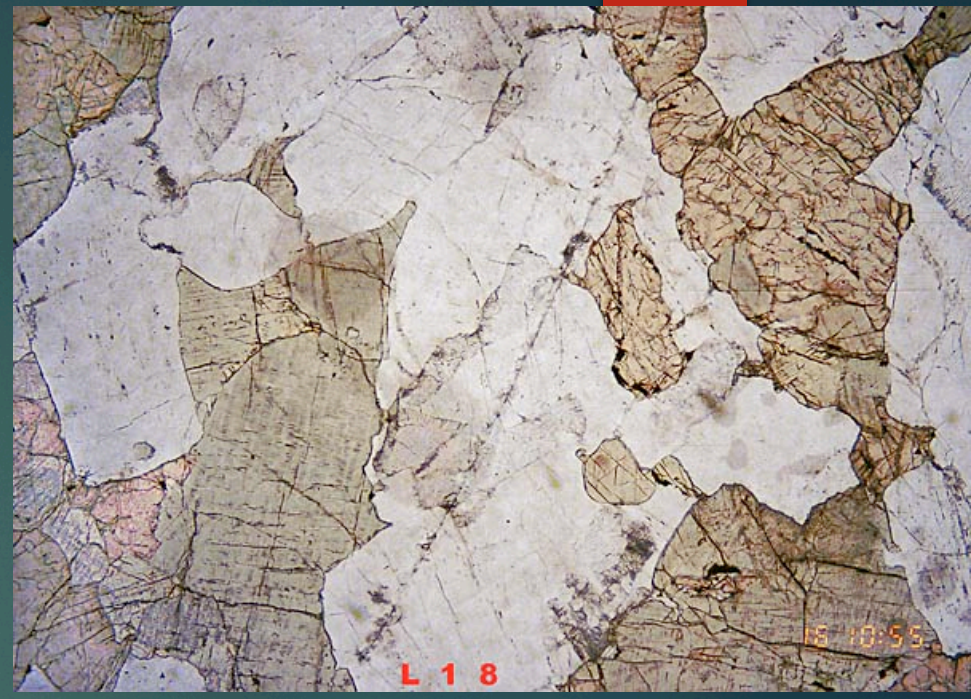
EXTINCTION ANGLE

- **Uniaxial minerals:**
  - Parallel extinction on prismatic section (parallel to c-axis)
  - Symmetrical extinction for all other faces if the cleavage intersect)

- **Biaxial minerals:**
  - Orthorhombic crystal: same as uniaxial minerals: parallel and symmetrical extinction
  - Monoclinic and triclinic crystals: inclined and asymmetrical extinction
  - Extinction angle: maximal acute angle

OTHER OPTICS PROPERTIES

- **Zoning**
- **Twinning**
- **Exsolution lamellae**
- **Undulatory extinction**



Thin section of gabbro with twinned plagioclases and exsolution lamellae of two pyroxenes.

NEXT WEEK

- **Reflected light optics – Chapter 8**