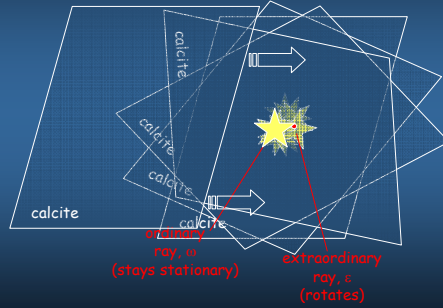


# Chapter 6

## Uniaxial Optics

We've talked about minerals as magicians - now let's prove it!



..... 점 위에 Calcite를 회전시킬

움직이지 않는 점

Ordinary ray =  $\omega$  ray

진동 벡터 // (001)면 → C축(z축, optic axis)에 수직으로 진동 (항상 동일 환경에서 진동)

$n(\omega) = 1.658$   
어떠한 상황에서도 일정

Fig 6-7 Bloos, Optical Crystallography, MSA

움직이지 않는 점

Extraordinary ray =  $\epsilon$  ray

진동 벡터  $\perp \omega$  ray → C축(z축, optic axis)을 포함하는 면에서 진동 (001)면과 교차

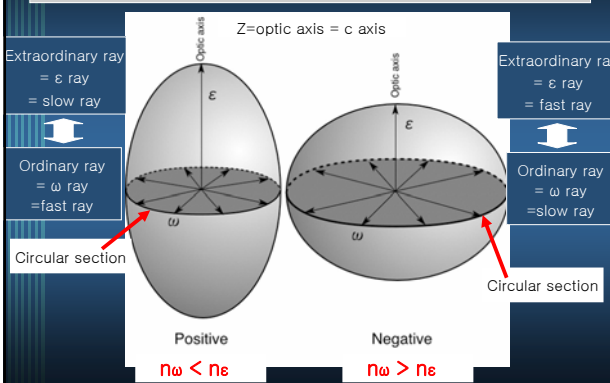
$n(\epsilon) = 1.486 \sim 1.658$   
입사방향에 따라 변화

$\therefore \delta = 0 \sim 0.172$

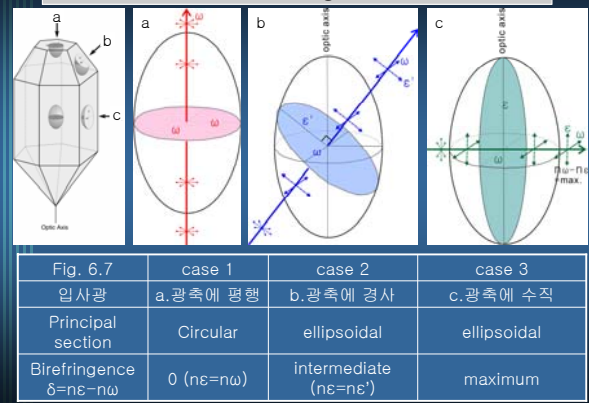
### Crystallographic considerations

- ◎ Fig 6.2 참고
- ◎ All uniaxial minerals are hexagonal or tetragonal habit
- ◎ Property : 결정축(c 축, z축=optic axis)에 대해 대칭도가 높다.
  - ◎ (001)면 내의 모든 방향으로 일정한 화학 결합 존재
  - ◎ (001)면 끼리의 결합은 다른 강도의 결합 존재

### Uniaxial indicatrix

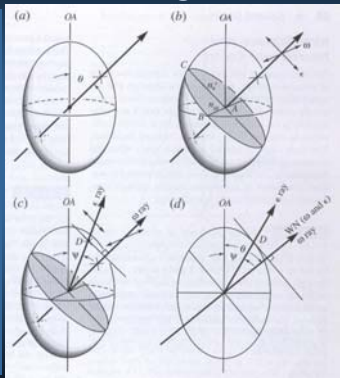


### Cross-sections through the indicatrix



.....Use of the indicatrix(Fig. 6.5).....

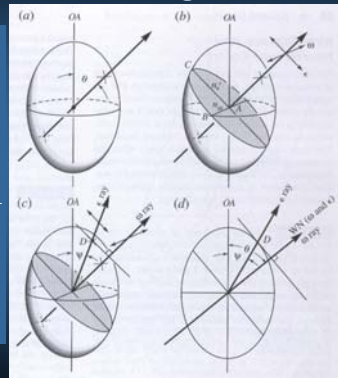
1. Wave normal 작도
2. Wave normal의 수직 단면 작도 ( $n_\epsilon, n_\omega$ 의 축을 갖는 타원 작도됨)
3. 두 광선의 진동 방향 // 타원의 축의 방향



.....Use of the indicatrix(Fig. 6.5).....

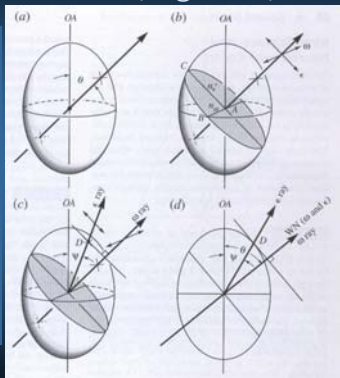
- $\theta$  를 알 경우  $n_\epsilon$ ?
- $\theta$  = angle between ordinary ray(=wave normal) and optic axis(식 6.1)

$$n_\epsilon = \frac{n_\omega}{\left[1 + \left(\frac{n_\omega^2}{n_\epsilon^2} - 1\right) \sin^2 \theta\right]^{1/2}}$$



.....Use of the indicatrix(Fig. 6.5).....

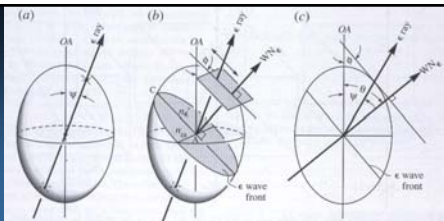
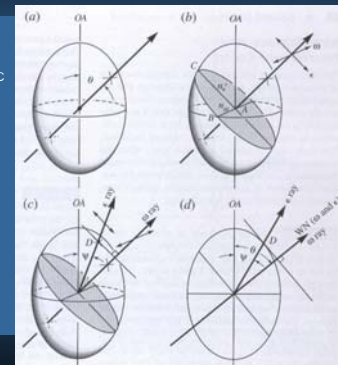
- Extraordinary ray의 direction
  - ordinary ray에 수직이고 AC에 평행인 타원체의 점선 작도
  - 점점(D)과 타원의 중심(A)을 연결한 직선 (Fig. 6.5c, d)



.....Use of the indicatrix(Fig. 6.5).....

- $\psi$ ?
- $\psi$  = angle between extraordinary ray and optic axis(식 6.2)

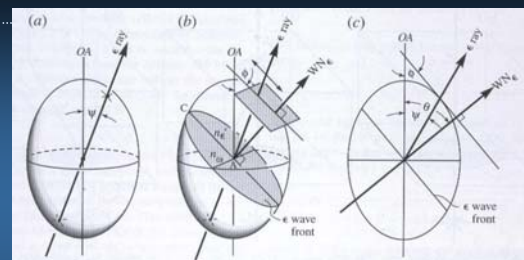
$$\tan \psi = \frac{n_\omega^2}{n_\epsilon^2} \tan \theta$$



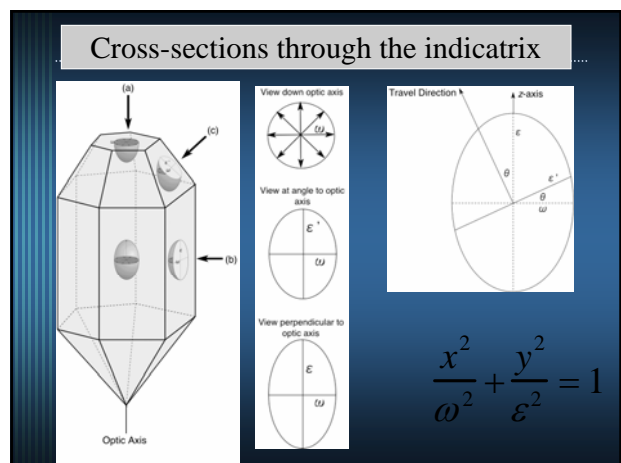
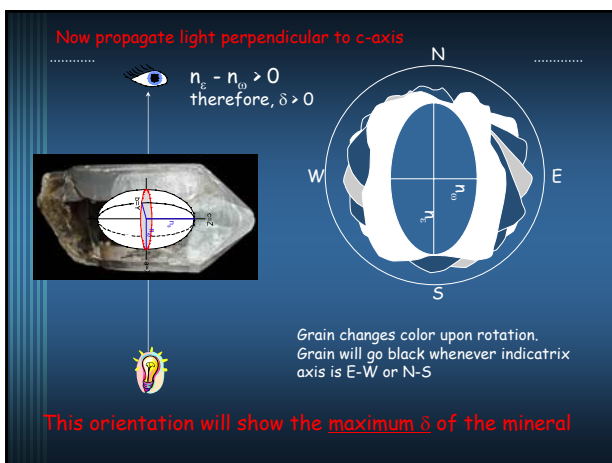
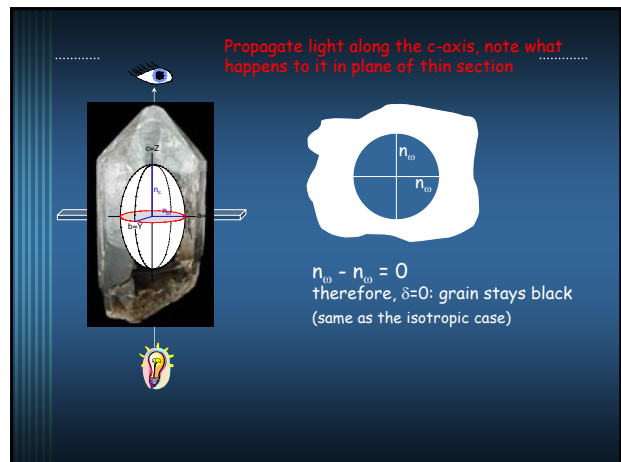
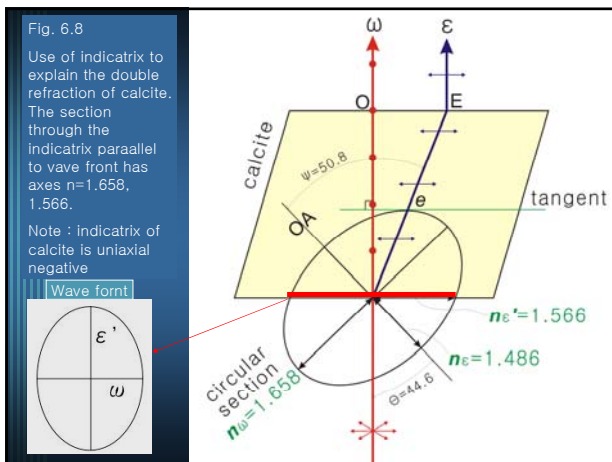
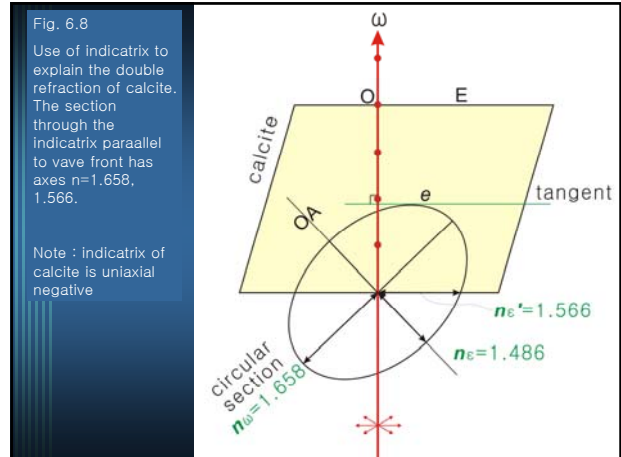
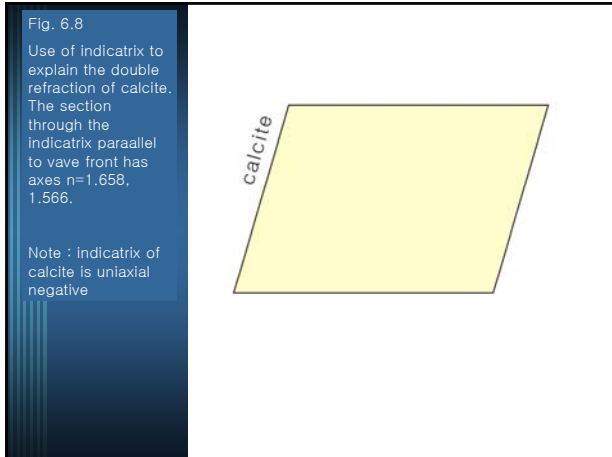
- 만일 extraordinary ray(ER)의 진행방향이 wave normal 대선에 작도되었을 경우, 다음과 같이 wave normal, direction, 진동방향, 굴절률이 확립됨.
- 각도  $\psi$  를 이루어 타원체의 중심을 관통하는 ER 작도(Fig. 6.6a)
- 타원체와 ER이 만나는 점에 접면 작도(Fig. 6.6b).  $\phi$  : 광축과 접면 사잇각.
- 식 6.2로부터 유도( $90 - \phi = \theta$ )

$$\tan(90 - \phi) = \frac{n_\epsilon^2}{n_\omega^2} \tan \psi$$

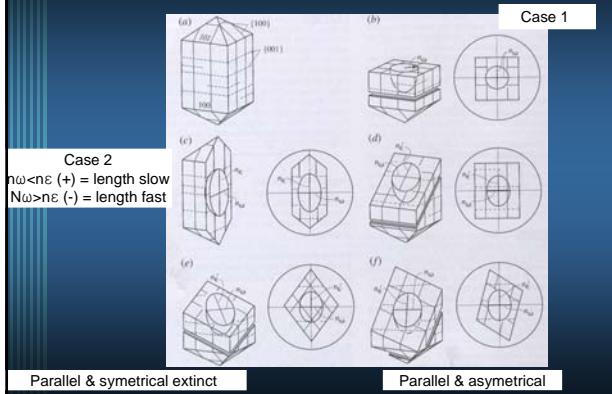
식 6.3



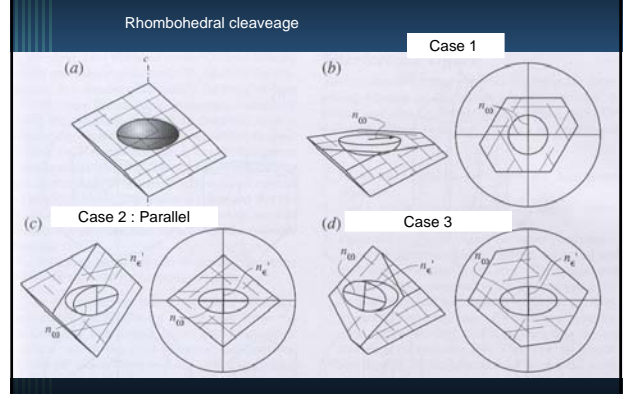
- 접면에 평행한 Indicatrix의 중심을 관통하는 단면(principal section)을 작도 (Fig. 6.6b) : 이 단면(타원)의 축의 길이가 각 광선의 굴절률임
- Section(AC)//ER의 진동방향



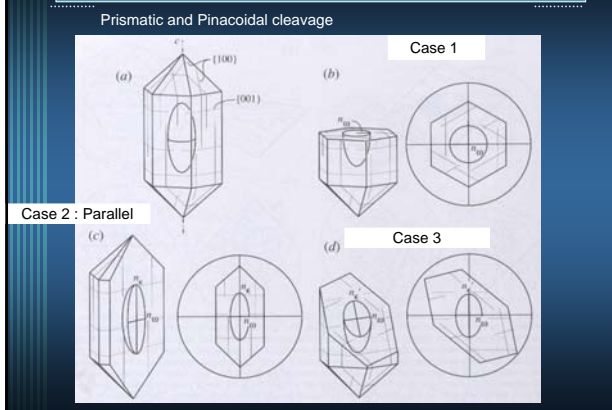
### Extinction of Tetragonal Mineral(Fig. 6.10)



### Extinction of Hexagonal(Fig. 6.11)



### Extinction of Hexagonal(Fig. 6.12)



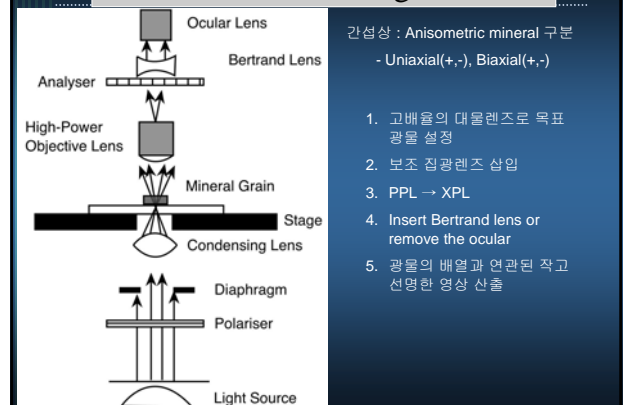
### Pleochroism

- ◎ Pleochroic formula:
  - Tourmaline:
    - $\epsilon$  = dark green to bluish
    - $\omega$  = colorless to tan
- ◎ Can determine this as just described by isolating first  $\omega$  and then  $\epsilon$  E-W and observing the color
- ◎ 최저 간섭색일때와 최대 간섭색일때의 경우에 따라서 광물의 다색성을 정함
- ◎ Strong and weak pleochroism

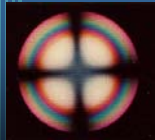
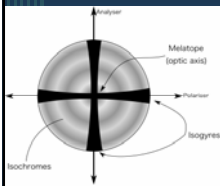
### Pleochroism 결정 방법

- ◎ Lowest order interference color을 갖는 광물 찾기(XPL; Fig. 6.10b, 11b, 12b)
- ◎ 광물의 색 관찰(PPL) : 스테이지 회전해도 색의 변화가 거의 없음
- ◎ Highest order interference color을 갖는 광물 찾기(XPL; Fig. 6.10c, 11c, 12c)
- ◎ 광물의 색 관찰(PPL) : 색의 변화가 급격함, 최대 색 또는 최저색중 하나는 위의 색과 동일

### Interference Figure

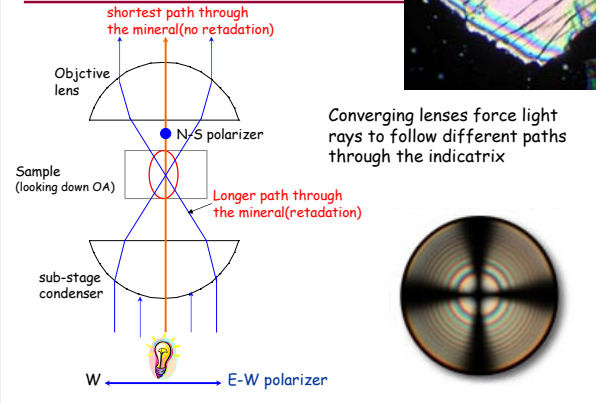


## Uniaxial Interference Figure.....

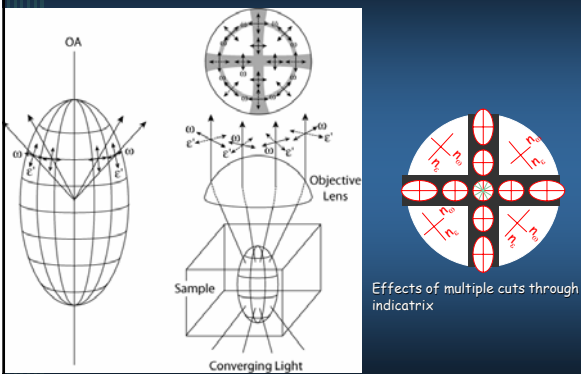


- Circles of *isochromes* : function of thickness and birefringence
- Note vibration directions:
  - $\omega$  tangential
  - $\varepsilon'$  radial & variable magnitude
- Black cross (*isogyres*) results from locations of extinction directions : corresponding to the vibration directions of lower and upper polarizer
- Center of cross (*melatope*) represents optic axis
- Approx 30° inclination of OA will put it at margin of field of view

## Formation of Isochromes



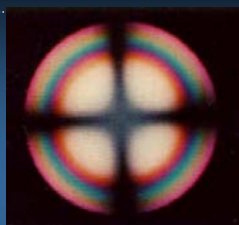
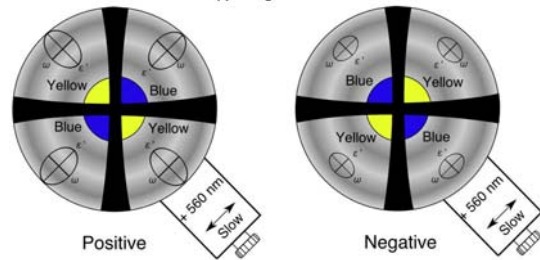
## Formation of Isogyres



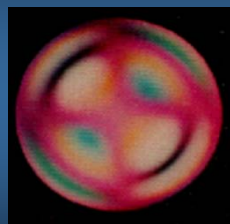
## Optic sign determination

Look for 1st order grey close to centre of figure. Insert sensitive tint plate. Colour changes to blue or yellow.

**BURP**  
**Blue Upper Right Positive**



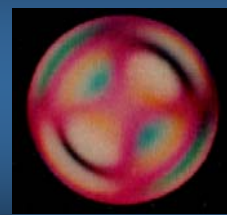
(+) OA Figure without plate



(+) OA Figure with plate  
Yellow in NW is (+)



(-) OA Figure without plate  
(same as (+) figure)



(-) OA Figure with plate  
Blue in NW is (-)

