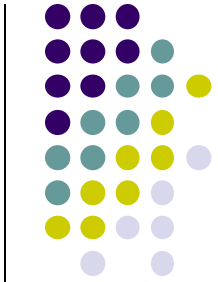
Q

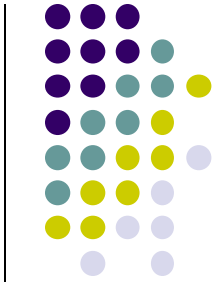
Corneal Optics



- What is the refractive index (*n*) of the cornea?

A

Corneal Optics



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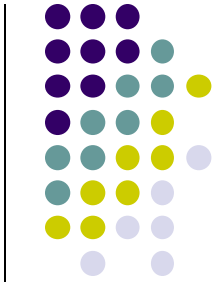

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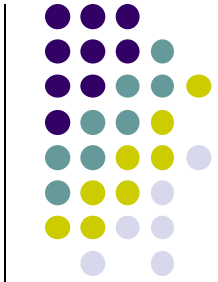

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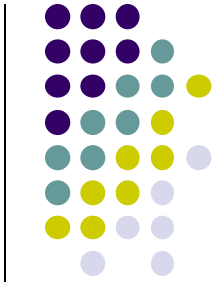

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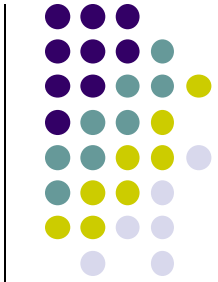

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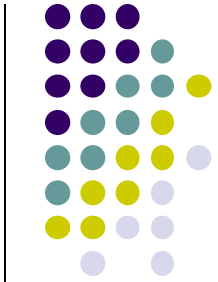

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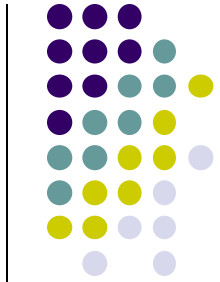

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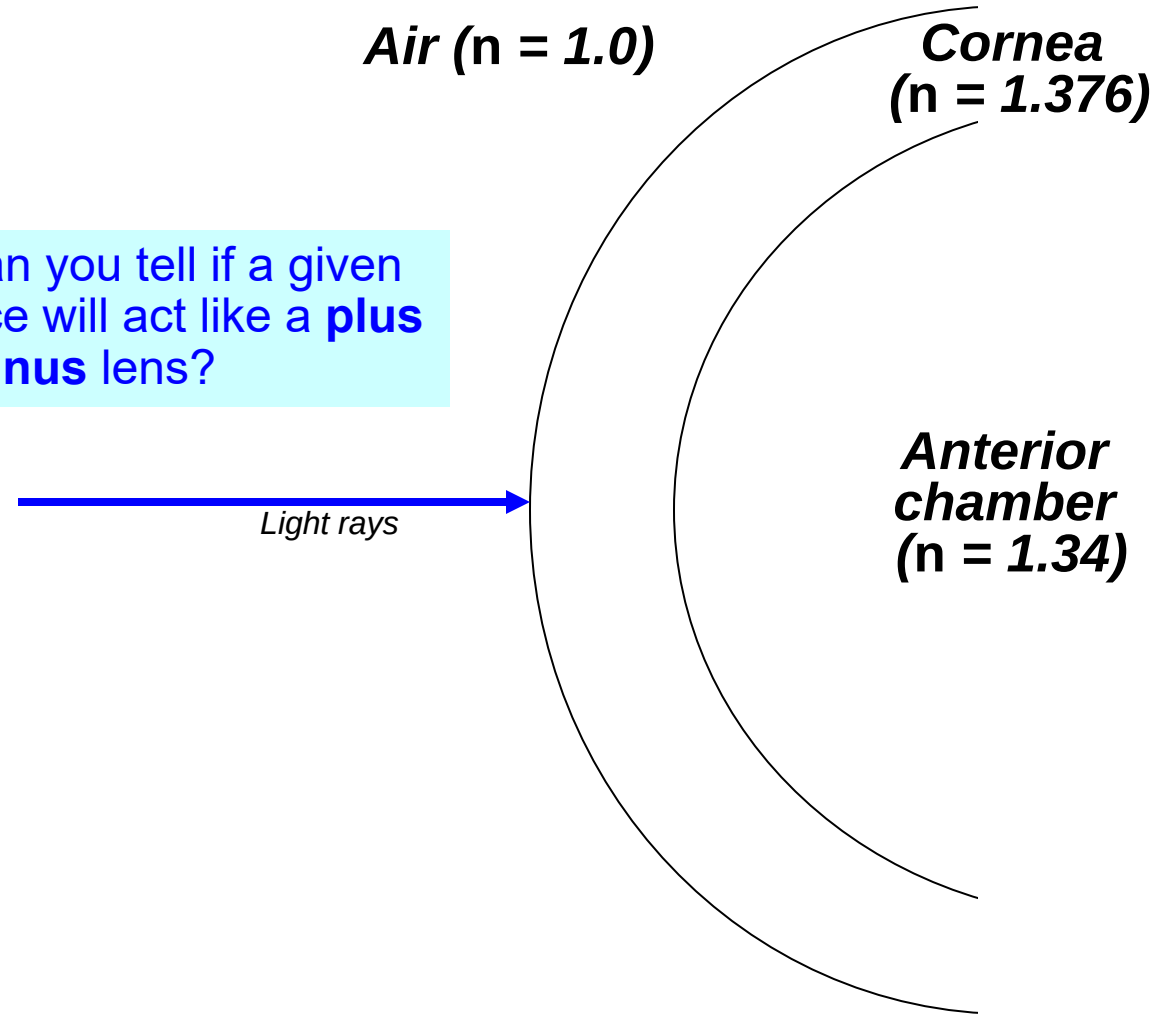
The math is demonstrated on the following slides.

Corneal Optics

How can you tell if a given interface will act like a **plus** vs a **minus** lens?



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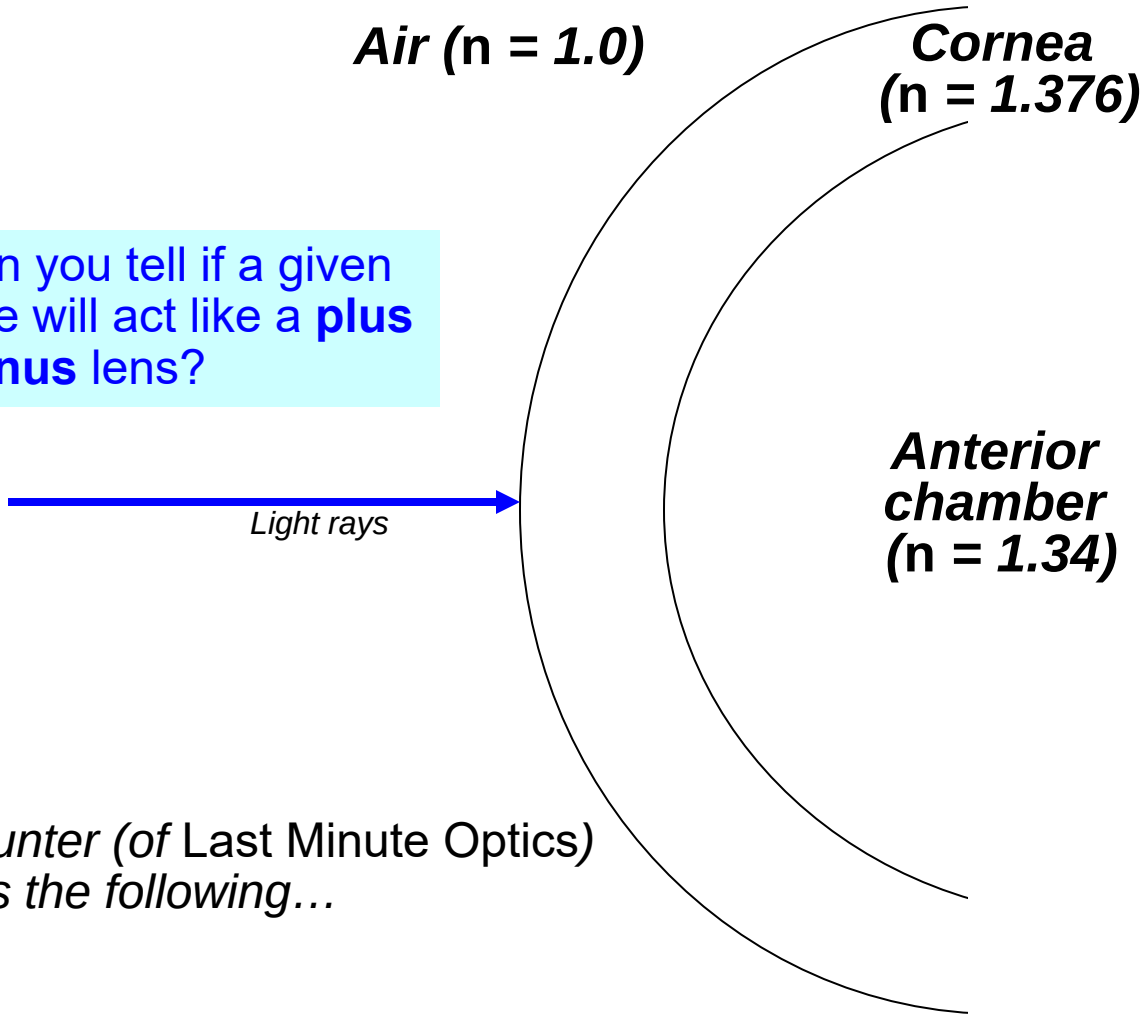

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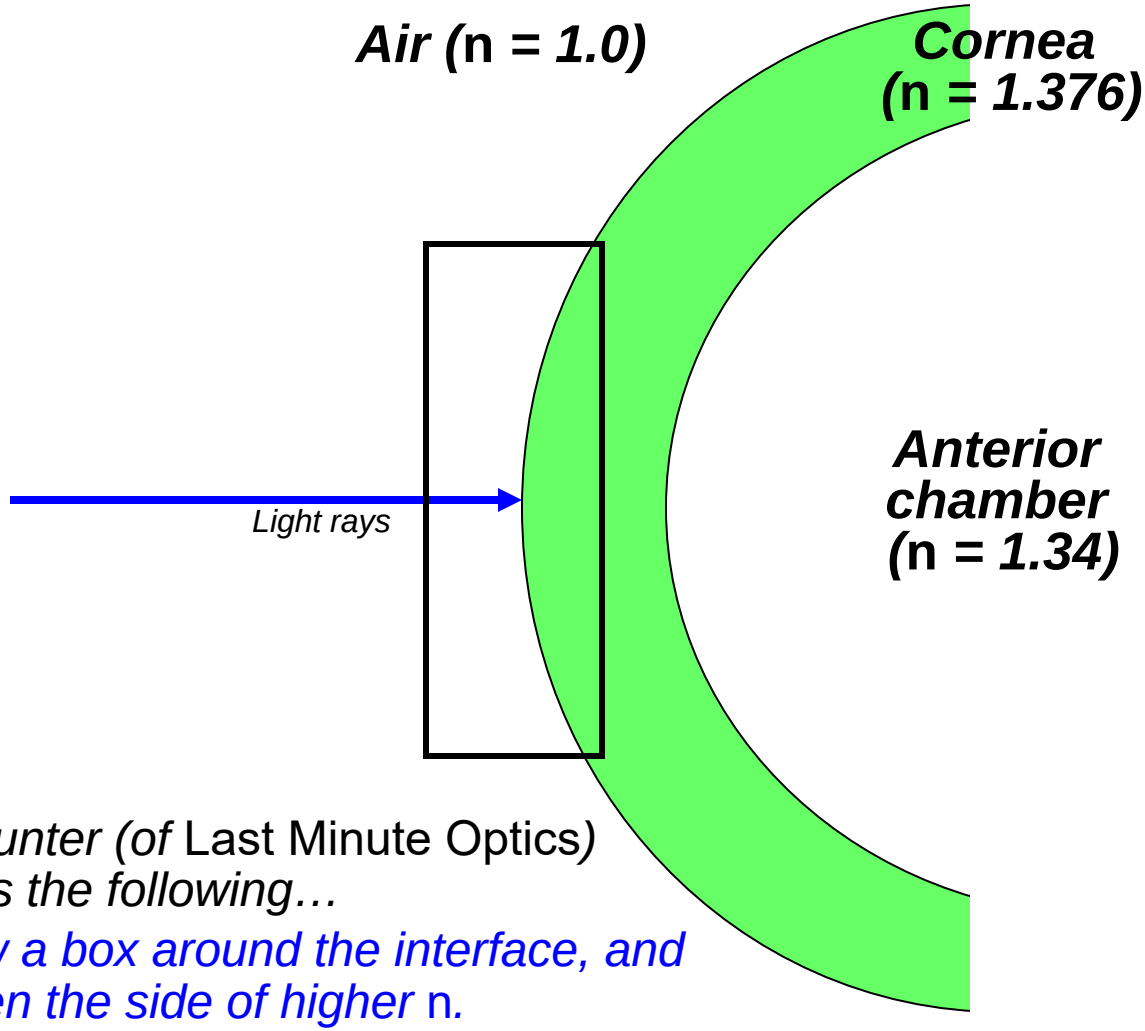

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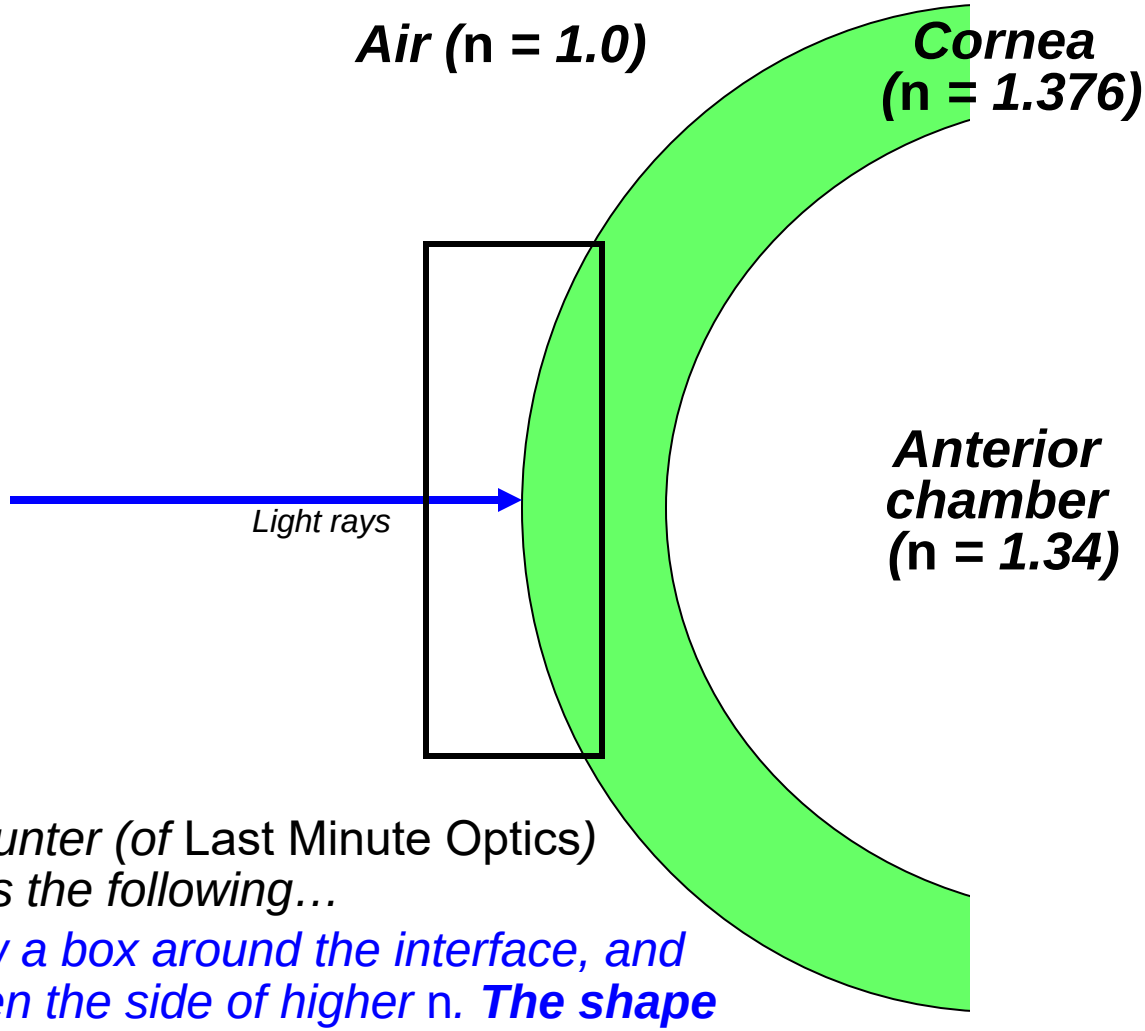
Corneal Optics



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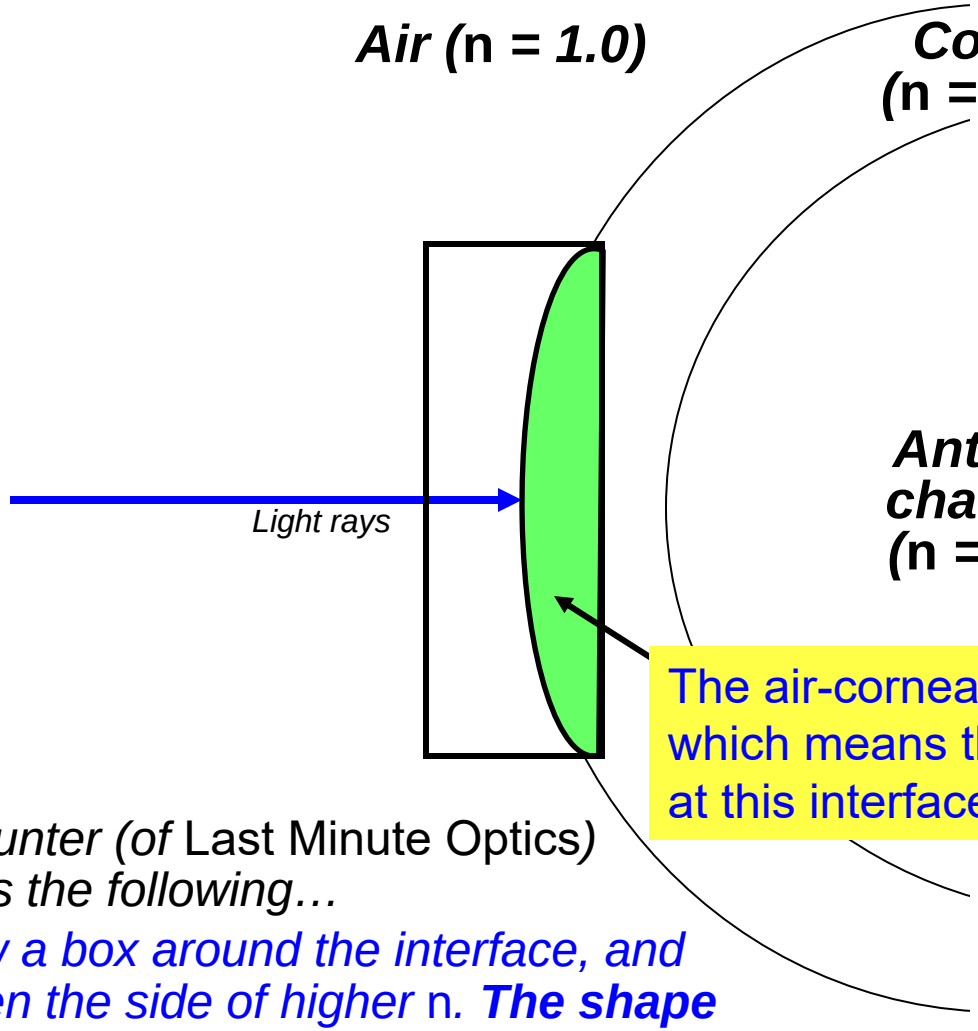
Corneal Optics



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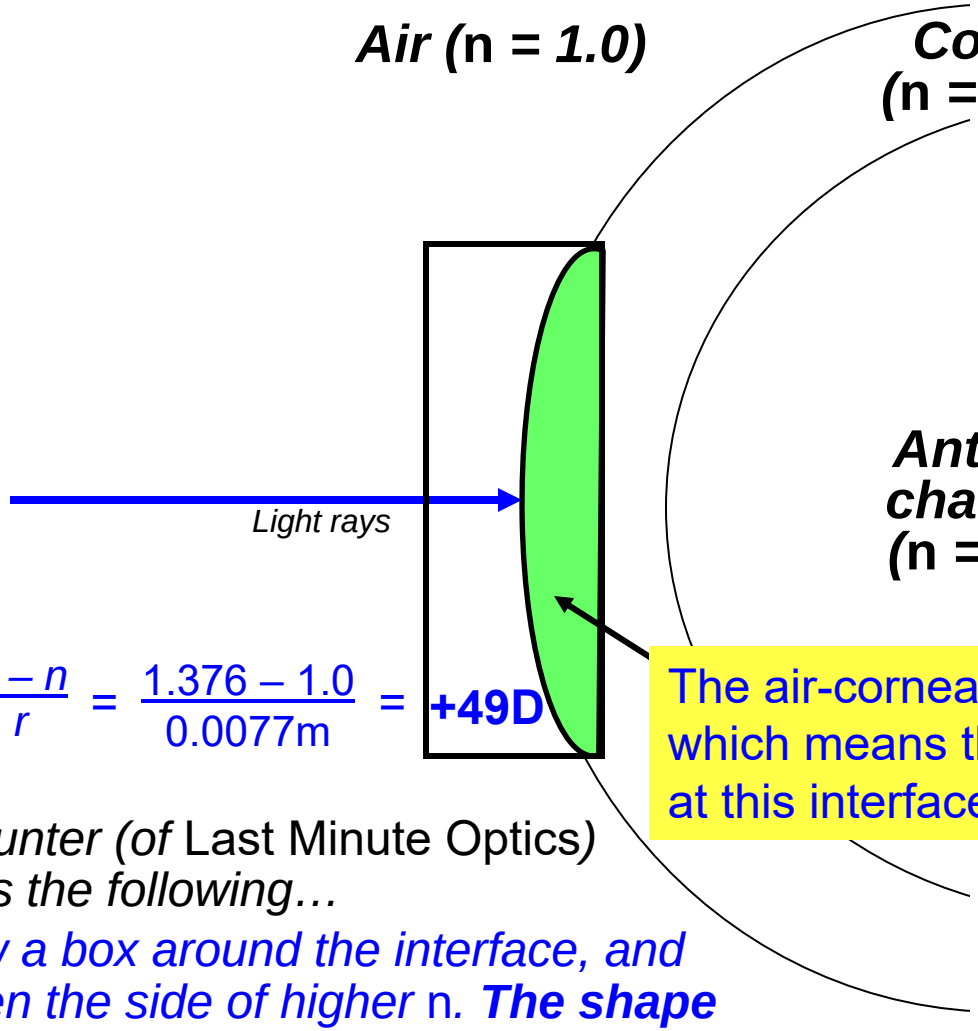

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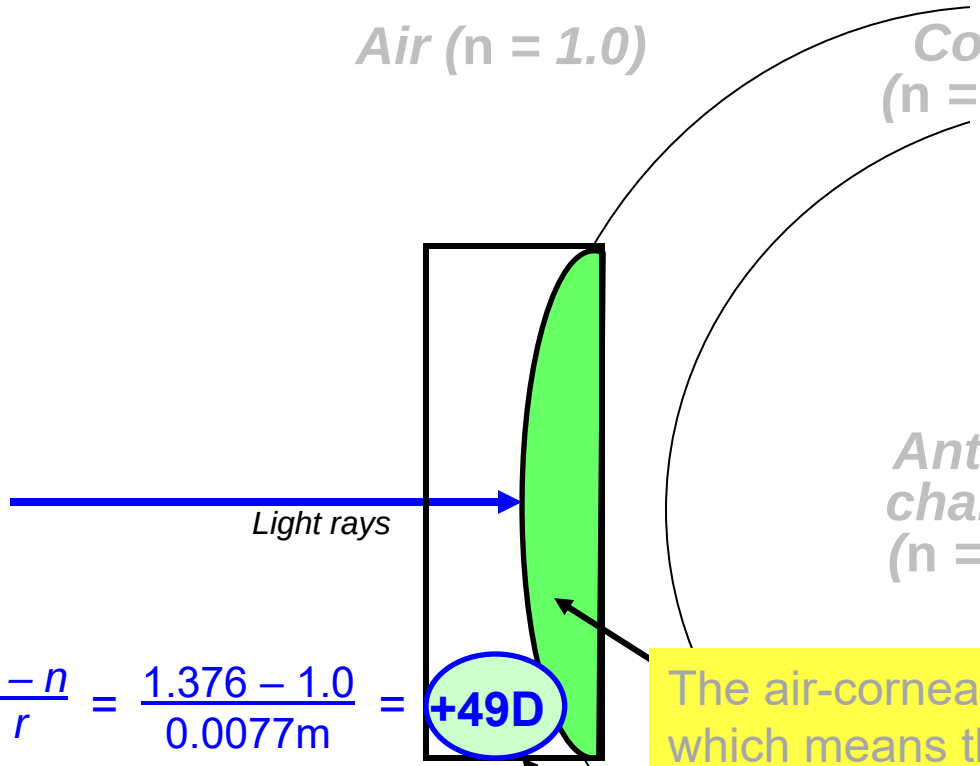

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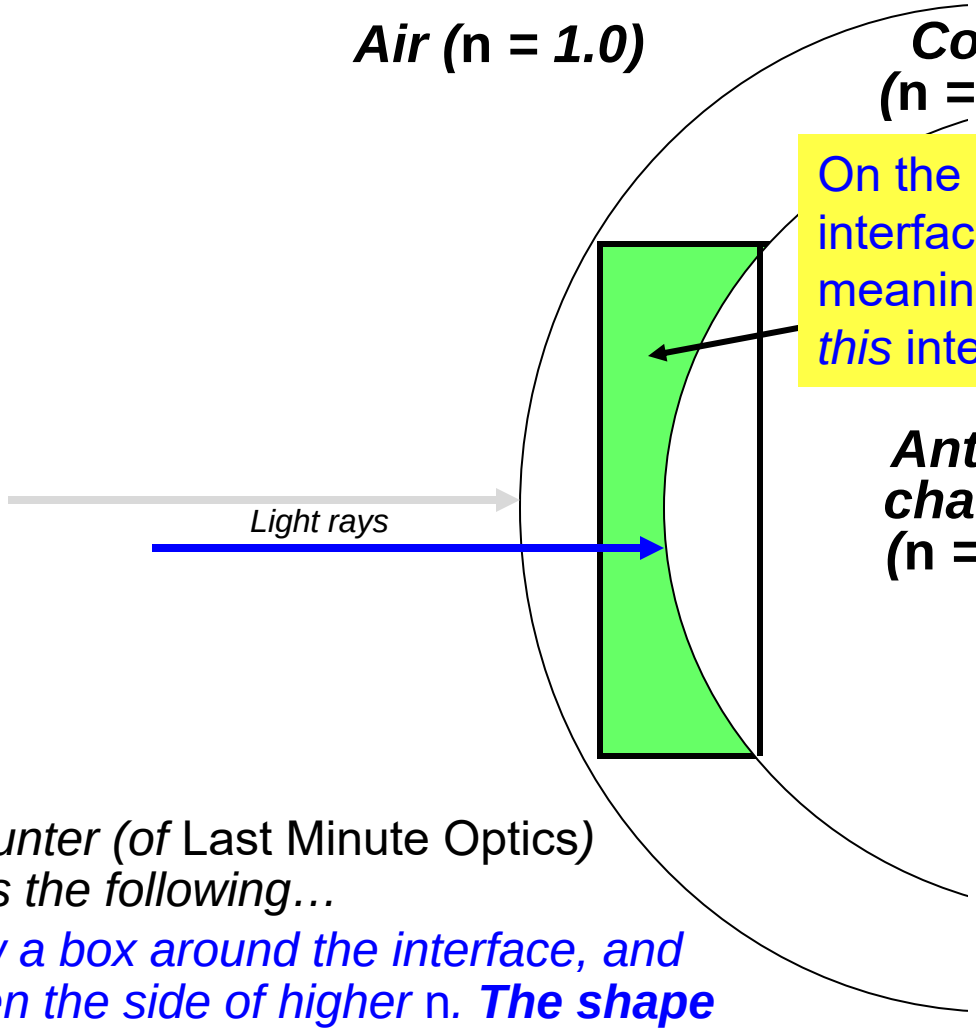

On the other hand, the cornea-aqueous interface looks like a **minus** lens, meaning ***divergence*** will be added at *this* interface

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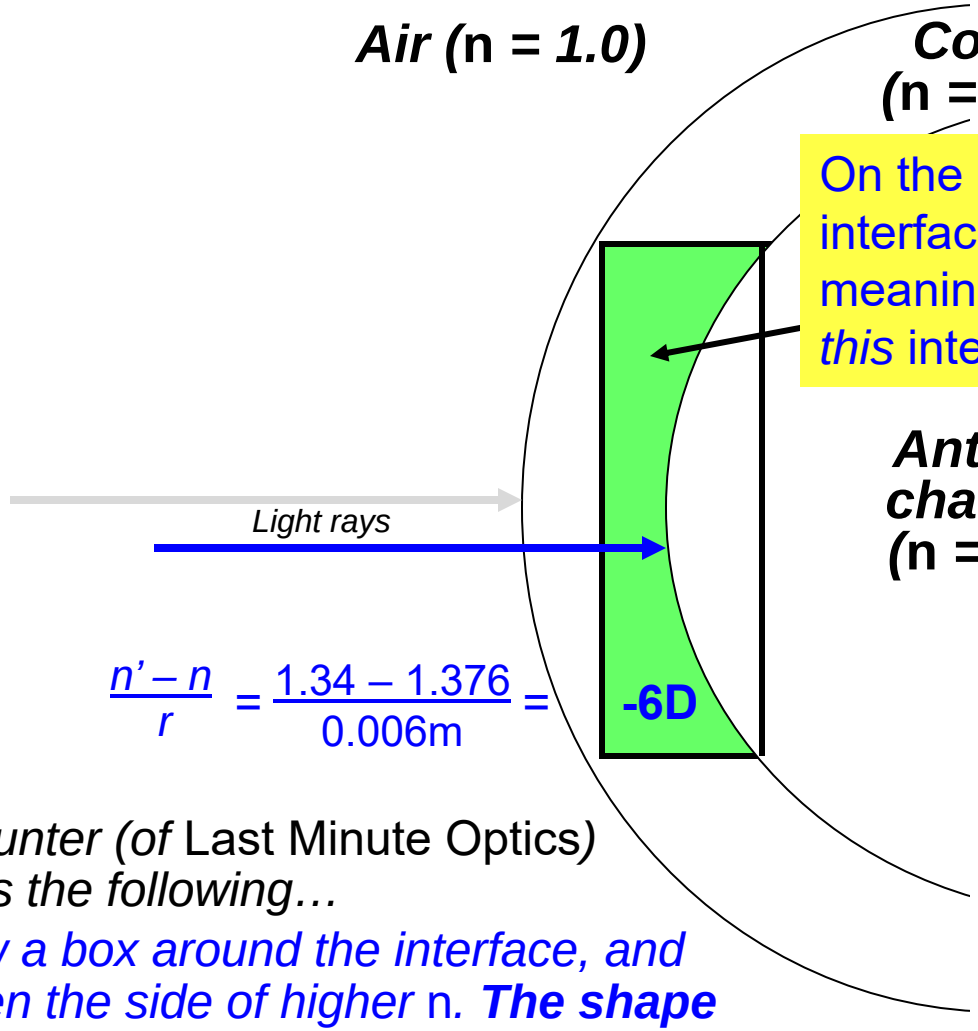

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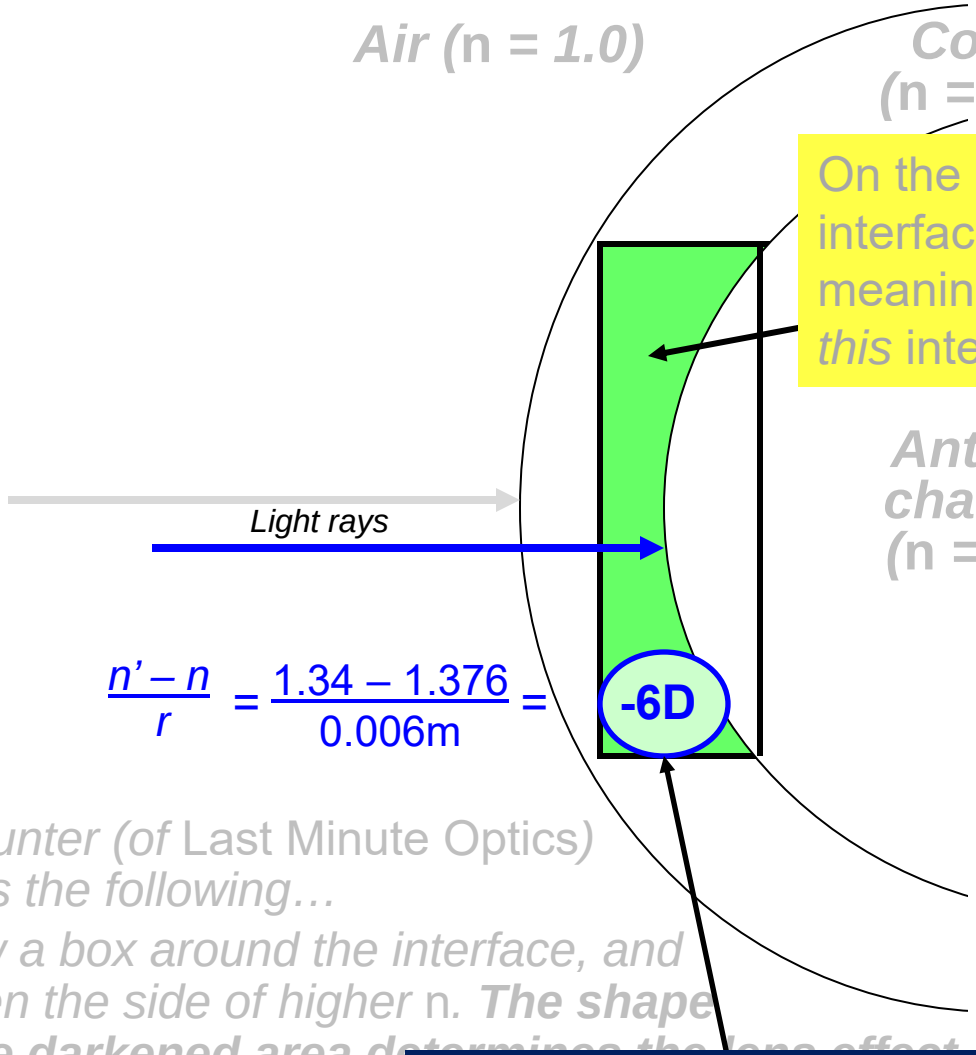

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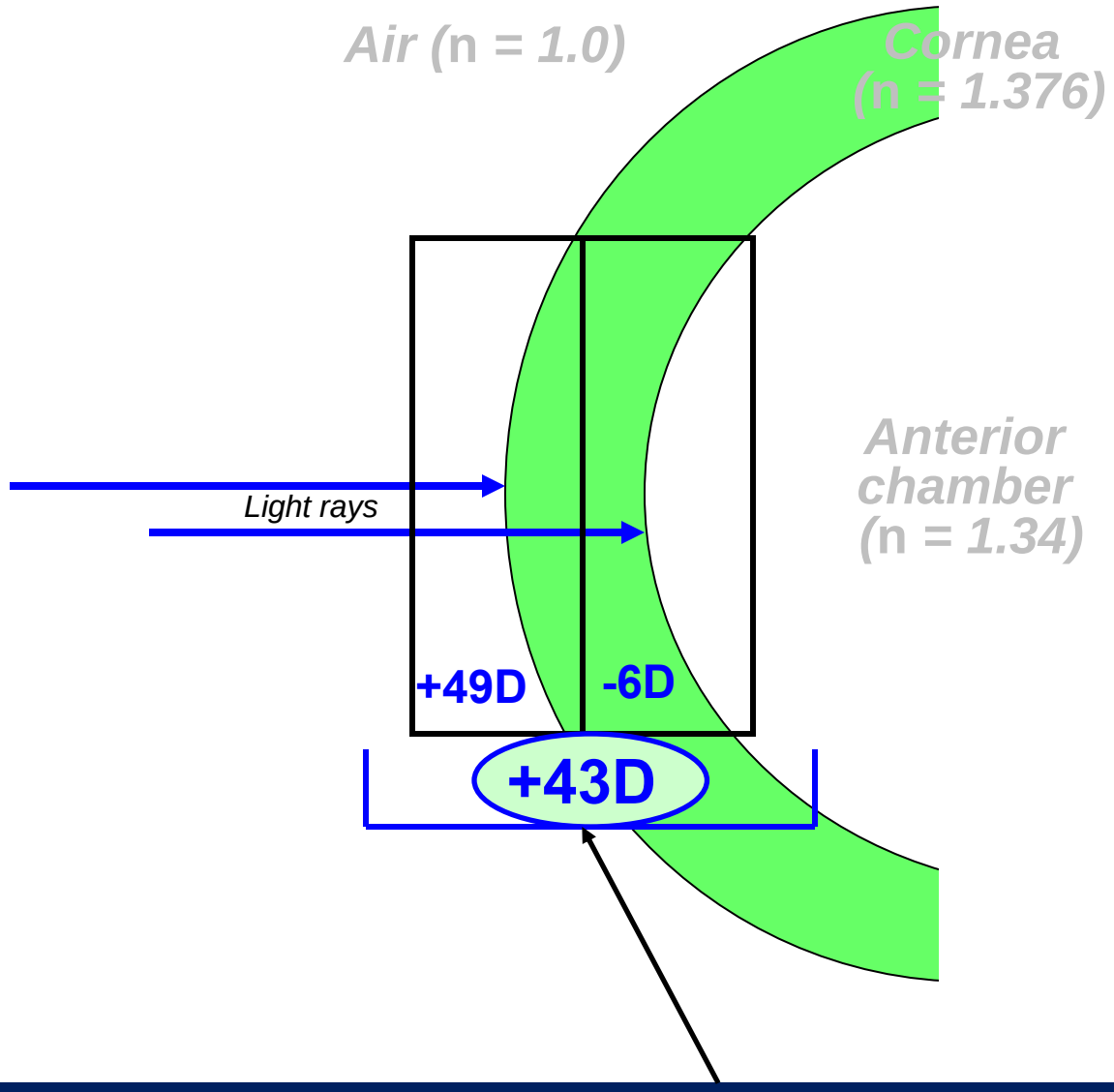
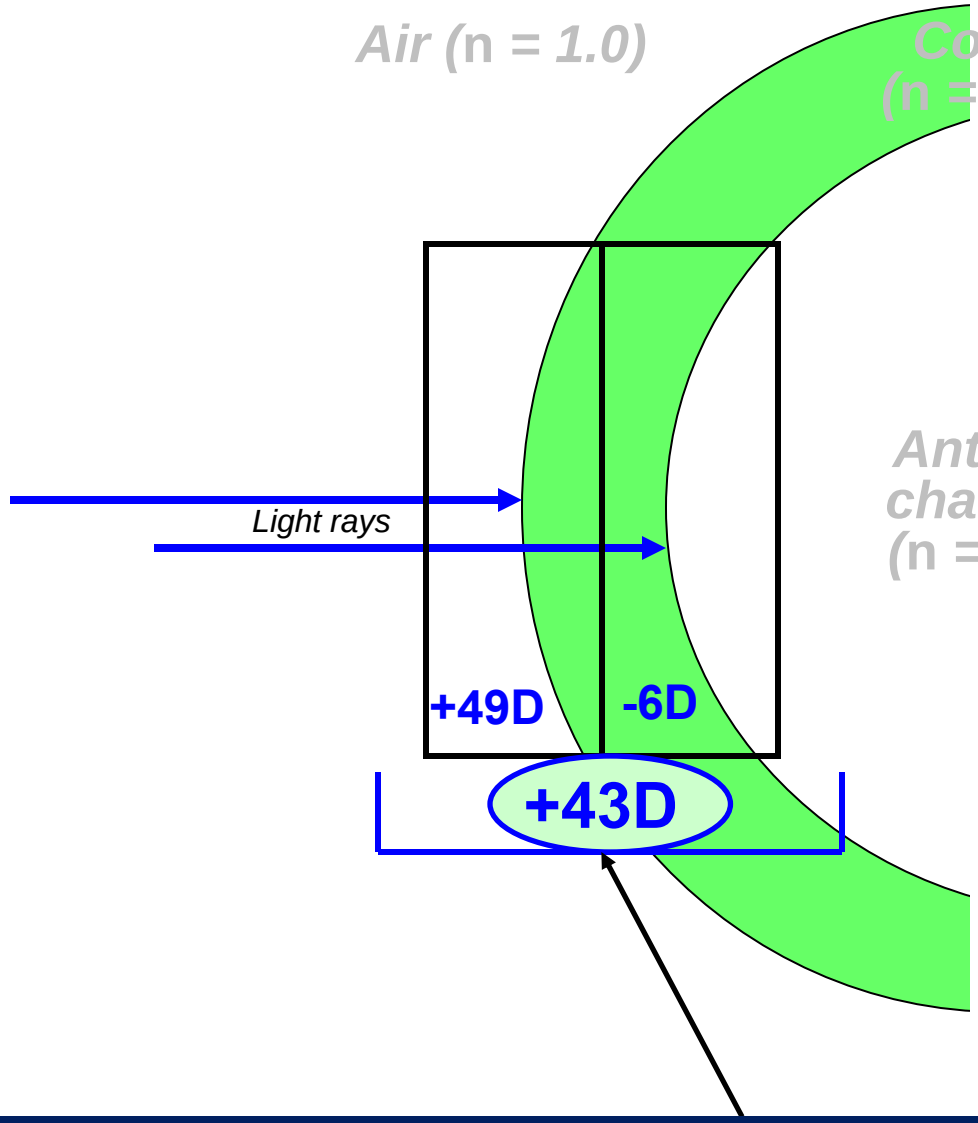


The net result across the cornea is an **overall power of about 43D**

Corneal Optics



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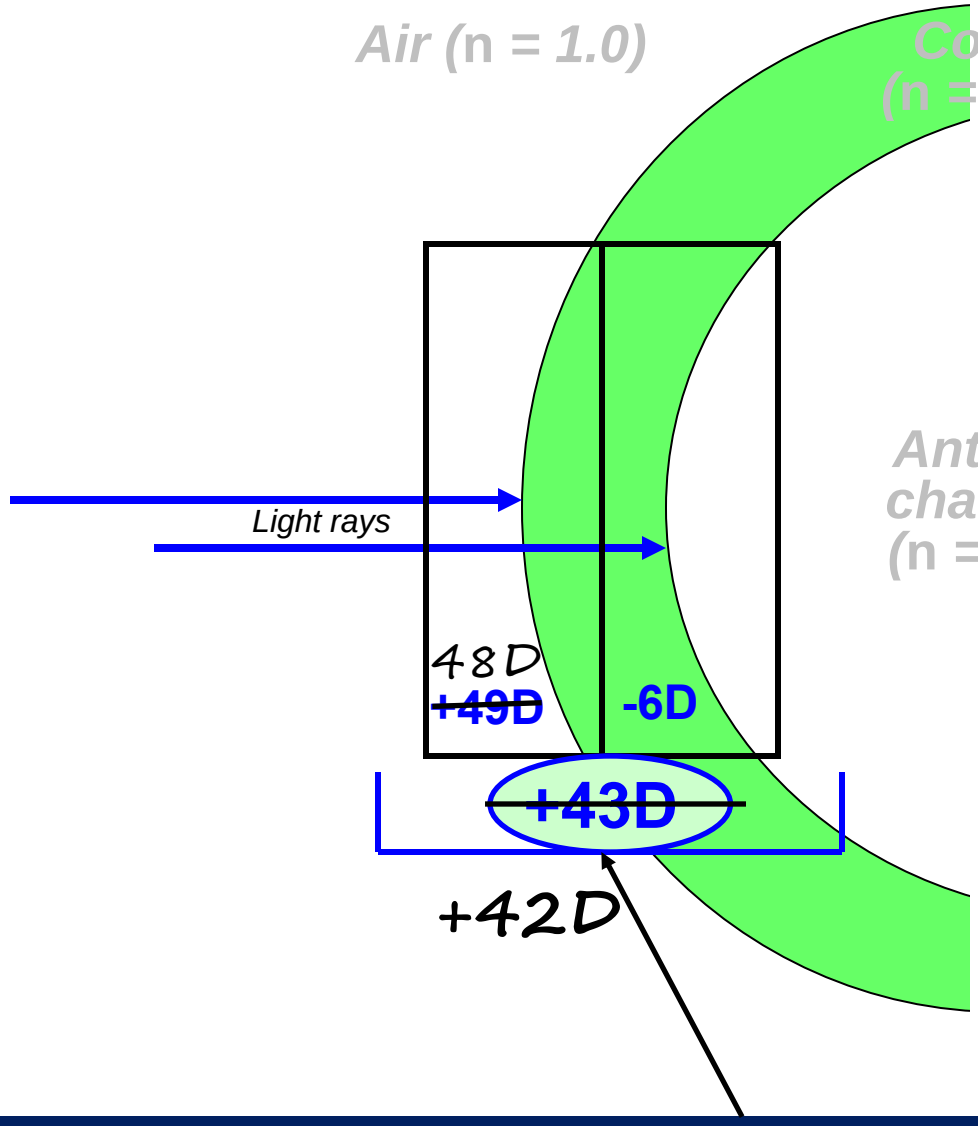

Note: The BCSC *Clinical Optics* book uses these numbers. However… The *Refractive Surgery* book assumes an anterior-corneal power of **48D**, which in turn results in an overall corneal power of **42D**. So don't be confused if you see these numbers.

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Corneal Optics

I used n_{cornea} = *1.376* for those corneal calculations.
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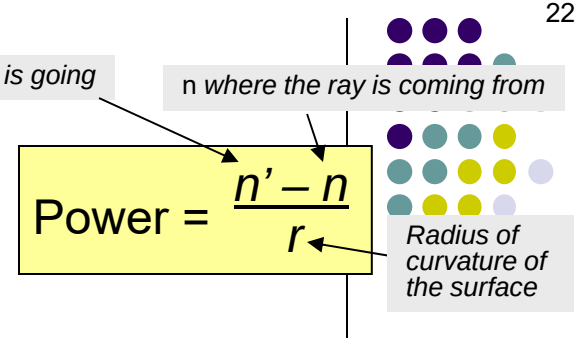

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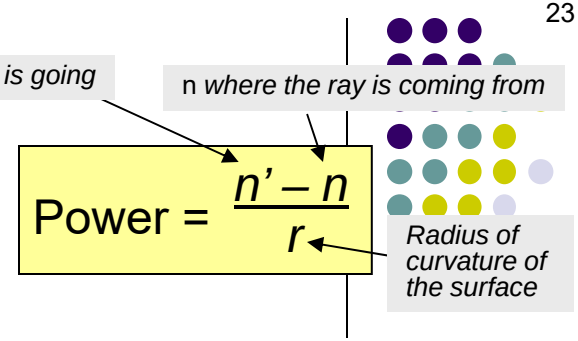

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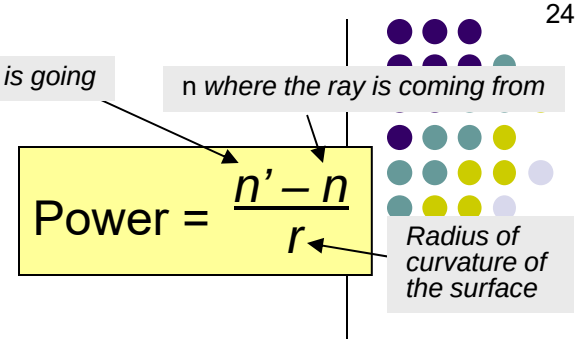

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n *of air*

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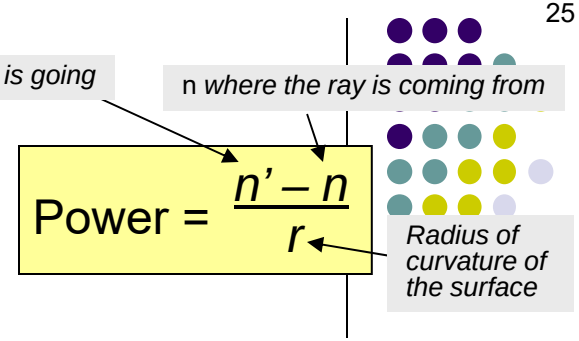
Corneal Optics



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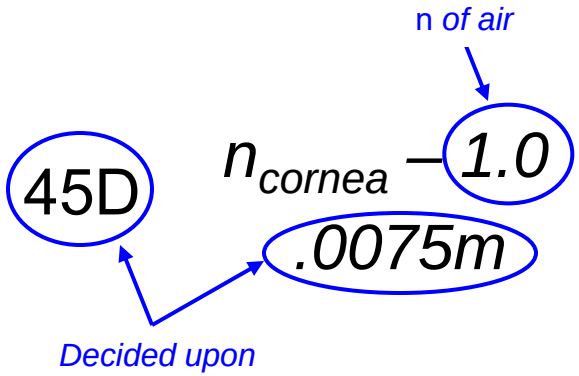

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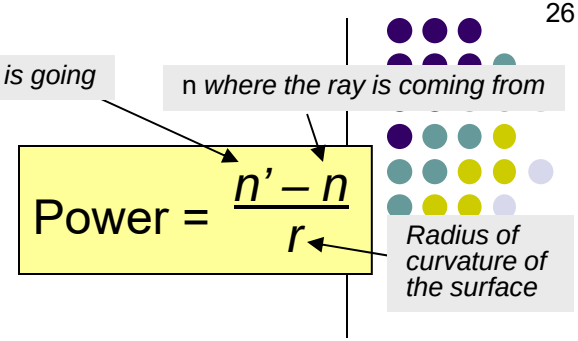

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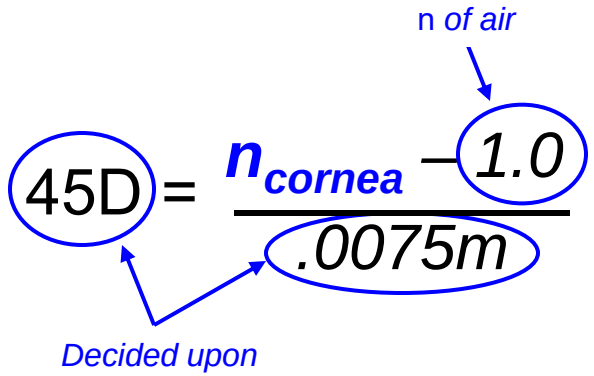

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Corneal Optics

n *where the ray is going*

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Decided upon

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Thus, assigning the cornea a single n *of 1.3375 accounts for both its anterior (plus) and posterior (minus) effects, greatly simplifying calculations of net corneal power. However, 1.3375 does* **not** *accurately represent the 'true' refractive effect that corneal tissue has on light. In short, it is a* **convenient fiction.**

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n *of air*

$$D_{cornea} = \frac{1.3333 - 1.0}{.0075m}$$

Decided upon

$$D_{cornea} = 44.44$$

Thus, assigning the cornea a single n *of 1.3375 accounts for both its anterior (plus) and posterior (minus) effects, greatly simplifying calculations of net corneal power. However, 1.3375 does* **not** *accurately represent the 'true' refractive effect that corneal tissue has on light. In short, it is a* **convenient fiction.**

Corneal Optics

n *where the ray is going*

n *where the ray is coming from*

$$\text{Power} = \frac{n' - n}{r}$$

Radius of curvature of the surface

I used $n_{cornea} = 1.376$ for those corneal calculations.
So why is the cornea said to have an* n *of* 1.3375*?

Determination of the **true** *corneal power requires measurement of the posterior corneal curvature—a technically difficult and time-consuming task back in the day.*

$$\text{Power} = \frac{1.376 - 1.0}{r_{Anterior}} + \frac{1.34 - 1.376}{r_{Posterior}}$$

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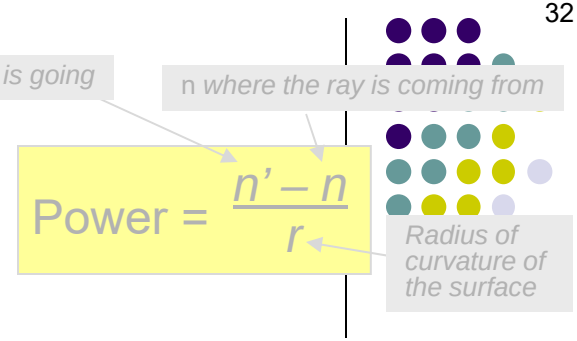

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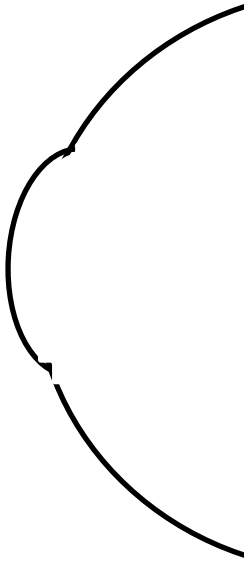
Q

- *What one word best describes the overall shape of the cornea?*



A

Corneal Optics

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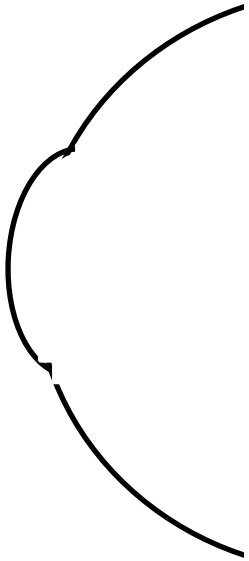

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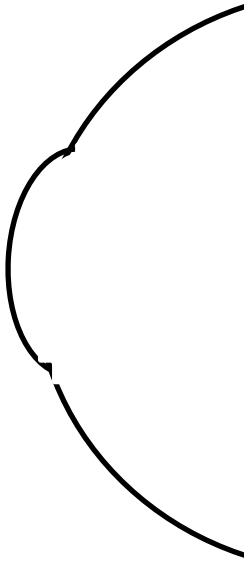

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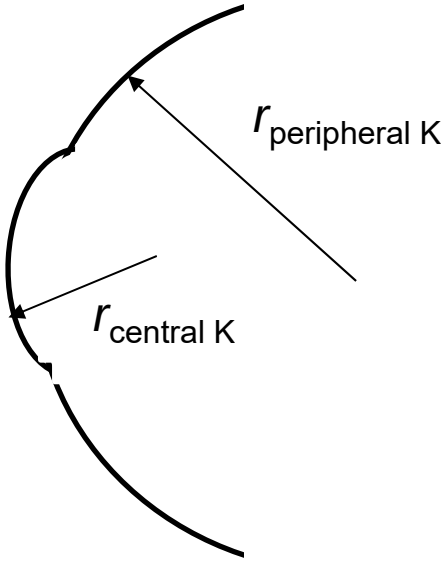

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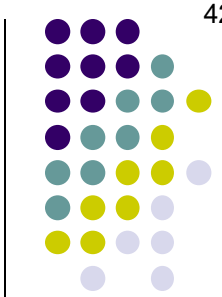
Corneal Optics



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Under what (quite common) circumstance might one encounter an oblate cornea?

Q/A

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Under what (quite common) circumstance might one encounter an oblate cornea?
In an eye that is s/p keratorefractive surgery for myopia

Q

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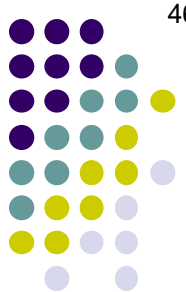

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What if the entire cornea has the same steepness/radius of curvature--what word describes **that** *shape?*

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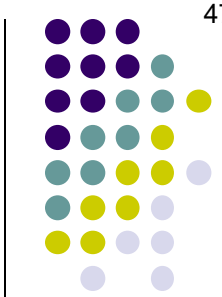

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Spherical

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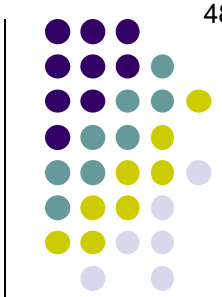

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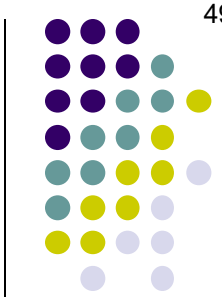
Spherical

Does the human cornea ever take on a spherical shape?

A

Corneal Optics



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Spherical

Does the human cornea ever take on a spherical shape?
Essentially never

Q

Corneal Optics

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What term quantifies the degree of difference between the curvature of the central cornea vs that of the corneal periphery?

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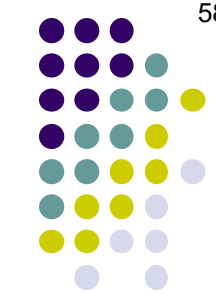

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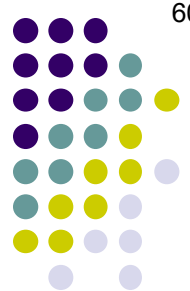
It has none—it is a dimensionless number

Q

Corneal Optics



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What is the average Q factor/value for the human cornea?

A

Corneal Optics

- *What one word best describes the overall shape of the cornea?* **Prolate**
- *What does* prolate *indicate about the cornea steepe curvatu*

What term quantifies the degree of difference between the curvature of the central cornea vs that of the corneal periphery?
The **Q factor** (aka **Q value**)

Q factor can be divided into three groups: Q<0, Q=0, and Q>0. What is the significance of these groups?
*Q<0 means…*the central cornea is steeper than the peripheral (ie, the cornea is **prolate**)
*Q=0 means…*the central and peripheral cornea have the same steepness/radius of curvature (ie, the cornea's overall shape is **spherical**)
*Q>0 means…*the central cornea is flatter than the peripheral (ie, the cornea is **oblate**)

If the opposite re heral--what word descri
Oblate

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What is the average Q factor/value for the human cornea?
-0.26

Q

Corneal Optics

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Spherical

In one word, what property of the cornea does the Q factor quantify?

A

Corneal Optics

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asphericity
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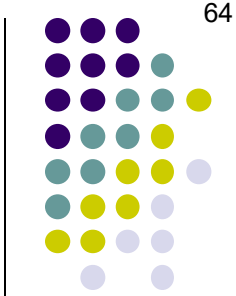
What if the entire cornea has the same steepness/radius of curvature--what word describes ***that*** *shape?*
Spherical

In one word, what property of the cornea does the Q factor quantify?
Corneal **asphericity** (in fact, it is often referred to as the 'asphericity Q factor')

Q

Corneal Optics



- *What one word best describes the overall shape of the cornea?* Prolate
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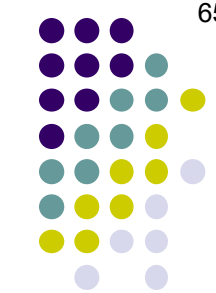
- *Is any portion of the cornea spherical?*

A

Corneal Optics



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Q

Corneal Optics

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On balance, and with respect to visual acuity, is the prolate nature of the human cornea a good thing?

A

Corneal Optics

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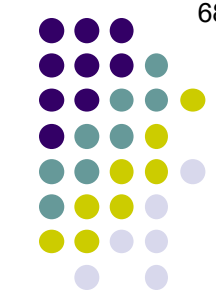
On balance, and with respect to visual acuity, is the prolate nature of the human cornea a good thing?
Yes, definitely

Q



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Corneal Optics

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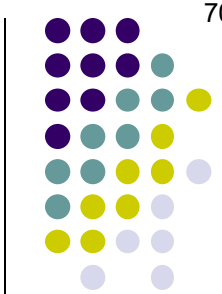
Q

Corneal Optics



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What is spherical aberration*?*

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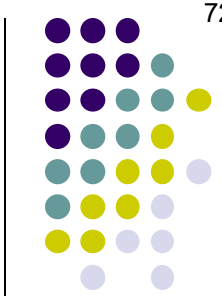
What is spherical aberration*?*
See slide-set **RS6** for a discussion of this important topic

Q

Corneal Optics



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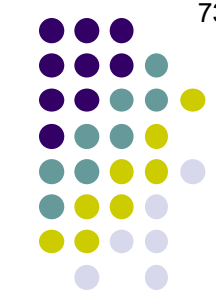
A

Corneal Optics



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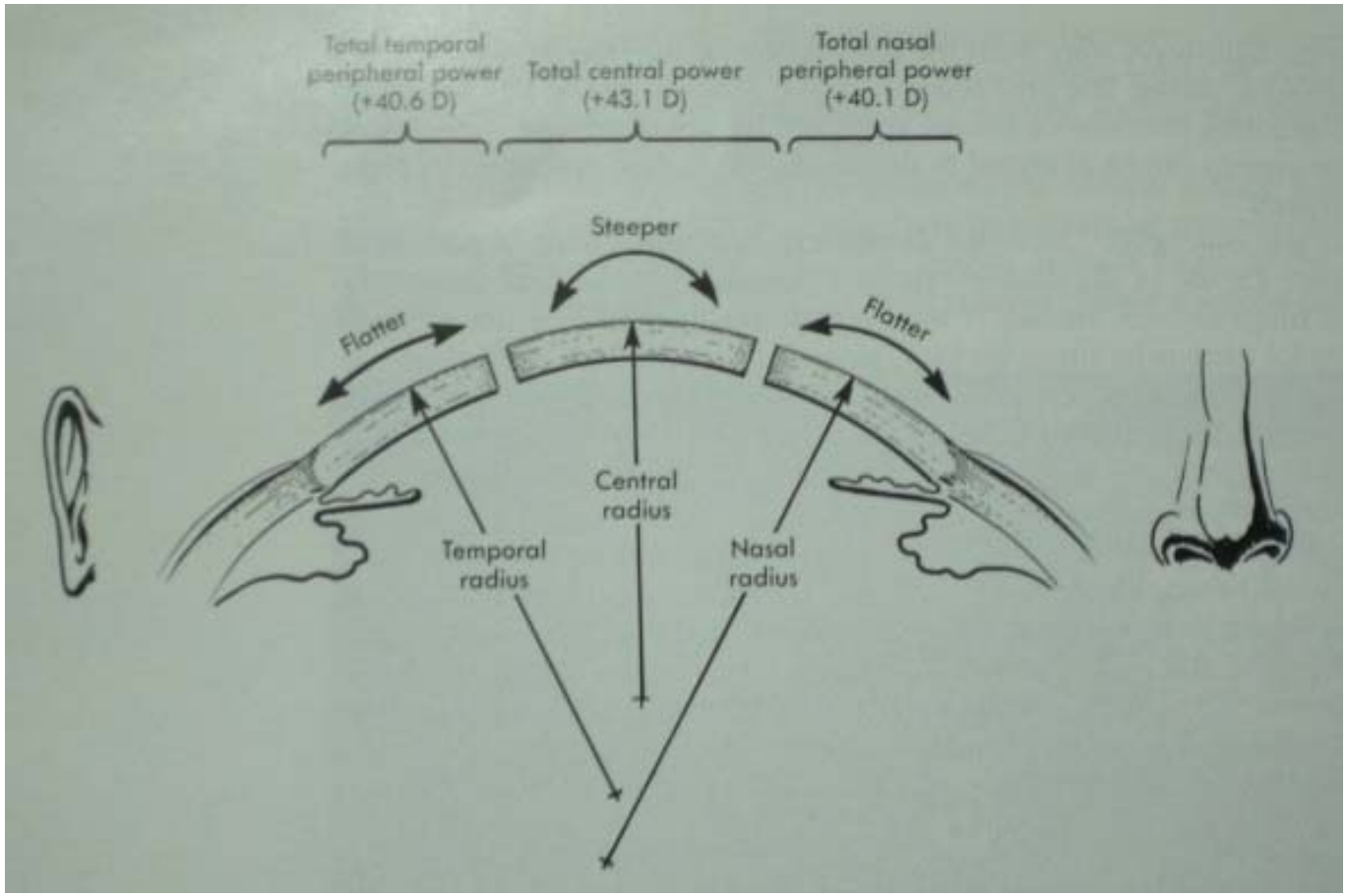
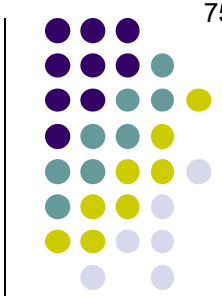
Corneal Optics



Power differential of central vs peripheral prolate cornea

Q

Corneal Optics



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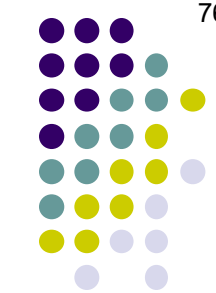
  - ***?***
  - ***?***
  - ***?***

A



- *What are the three categories of technology for determining central corneal power?*
  - Keratometry
  - Corneal topography
  - Corneal tomography

Q

Corneal Optics

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How does a keratometer work?

A

Corneal Optics

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How does a keratometer work?
By producing a reflection of an object of known size off the cornea (technically, off the tear film) from a known distance. By comparing the size of the resulting image to the size of the object, an estimate of corneal curvature can be calculated.

Q

Corneal Optics

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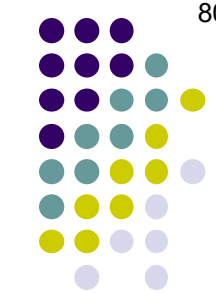
So it measures central corneal curvature/power directly?

A

Corneal Optics



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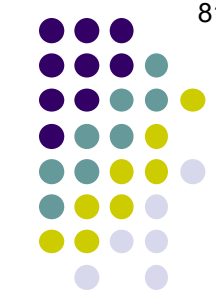
No. It assesses the rate of curvature at 4 points in the paracentral zone of the cornea; ie, along a circle 3-4 mm in diameter centered on the corneal apex. Then, based on the assumptions discussed earlier in this slide-set, the central power of the cornea is estimated.

Q



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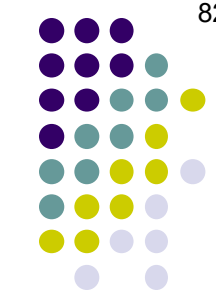
Does keratometry measure the curvature of the posterior *corneal surface?*

A



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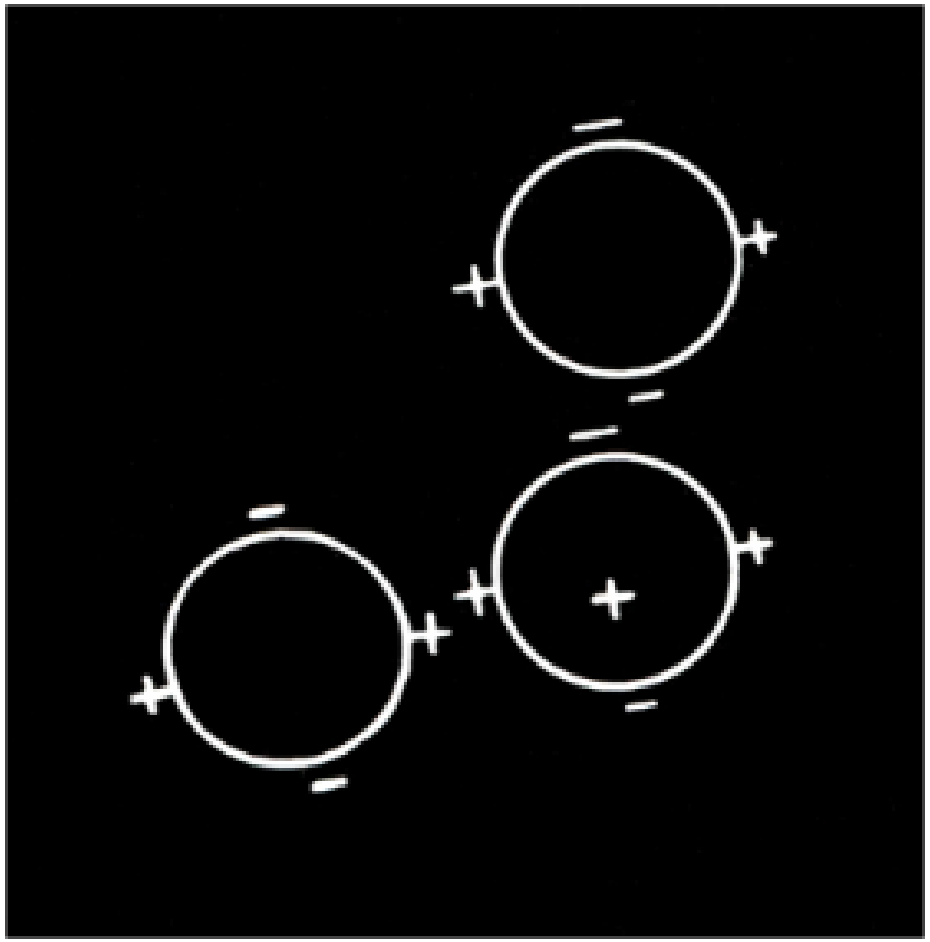
Does keratometry measure the curvature of the posterior *corneal surface?*
No

Corneal Optics

Keratometer (B&L type)

Corneal Optics



Keratometry image (B&L type)

Q

Corneal Optics

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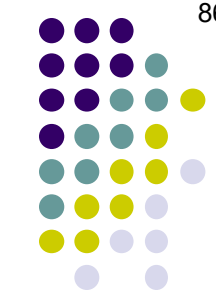
How does a corneal topographer work?

A

Corneal Optics



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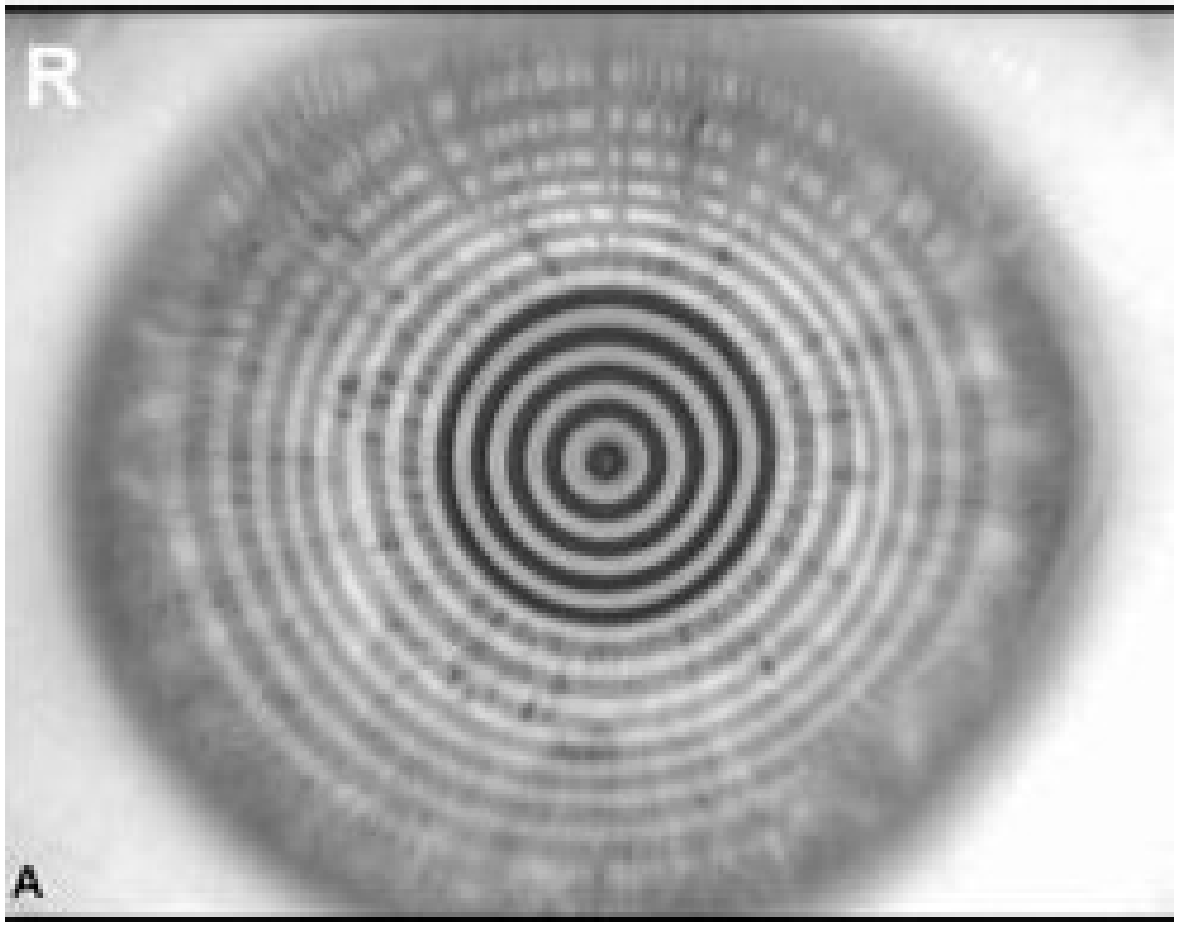
Corneal Optics

Corneal Placido-disk topography: Device

Corneal Optics



Corneal Placido-disk topography: Normal mires

A

Corneal Optics

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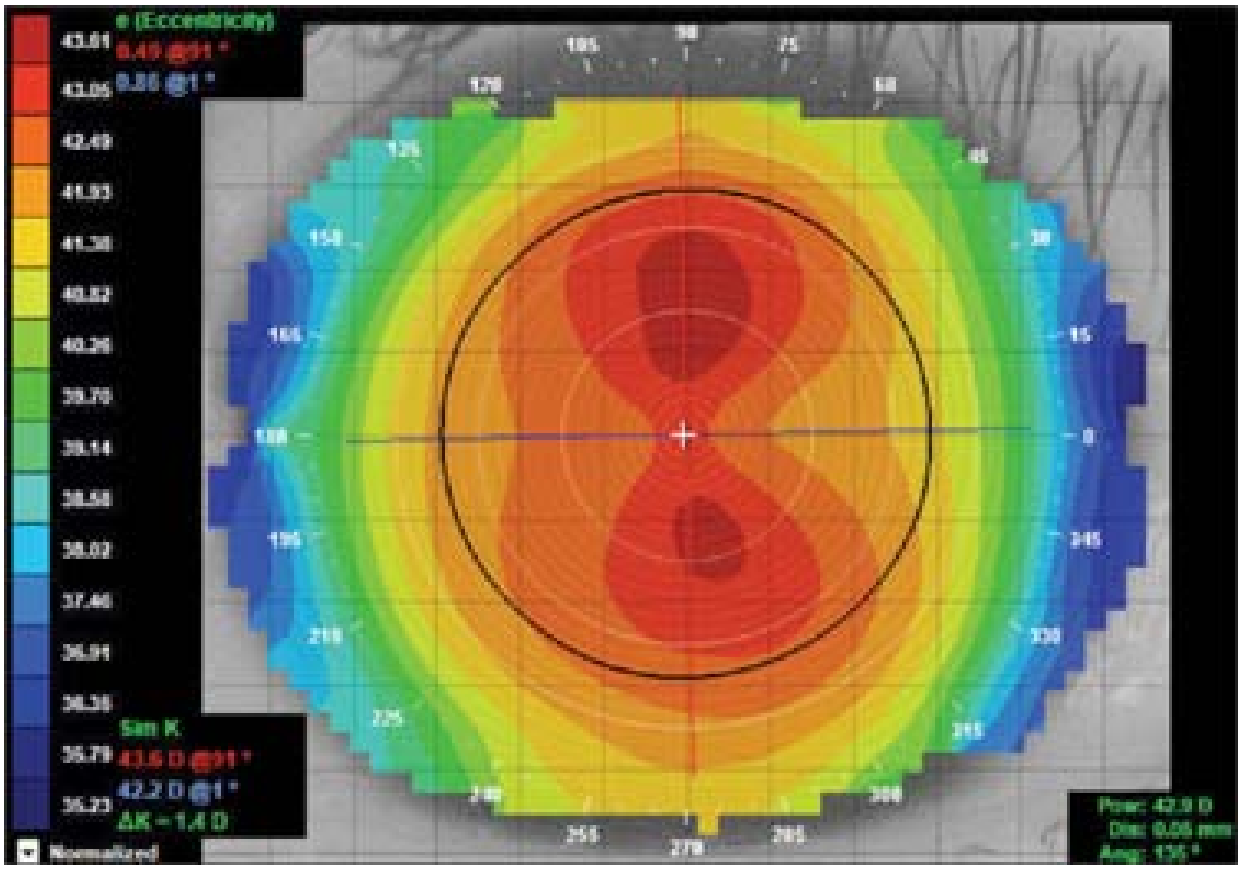
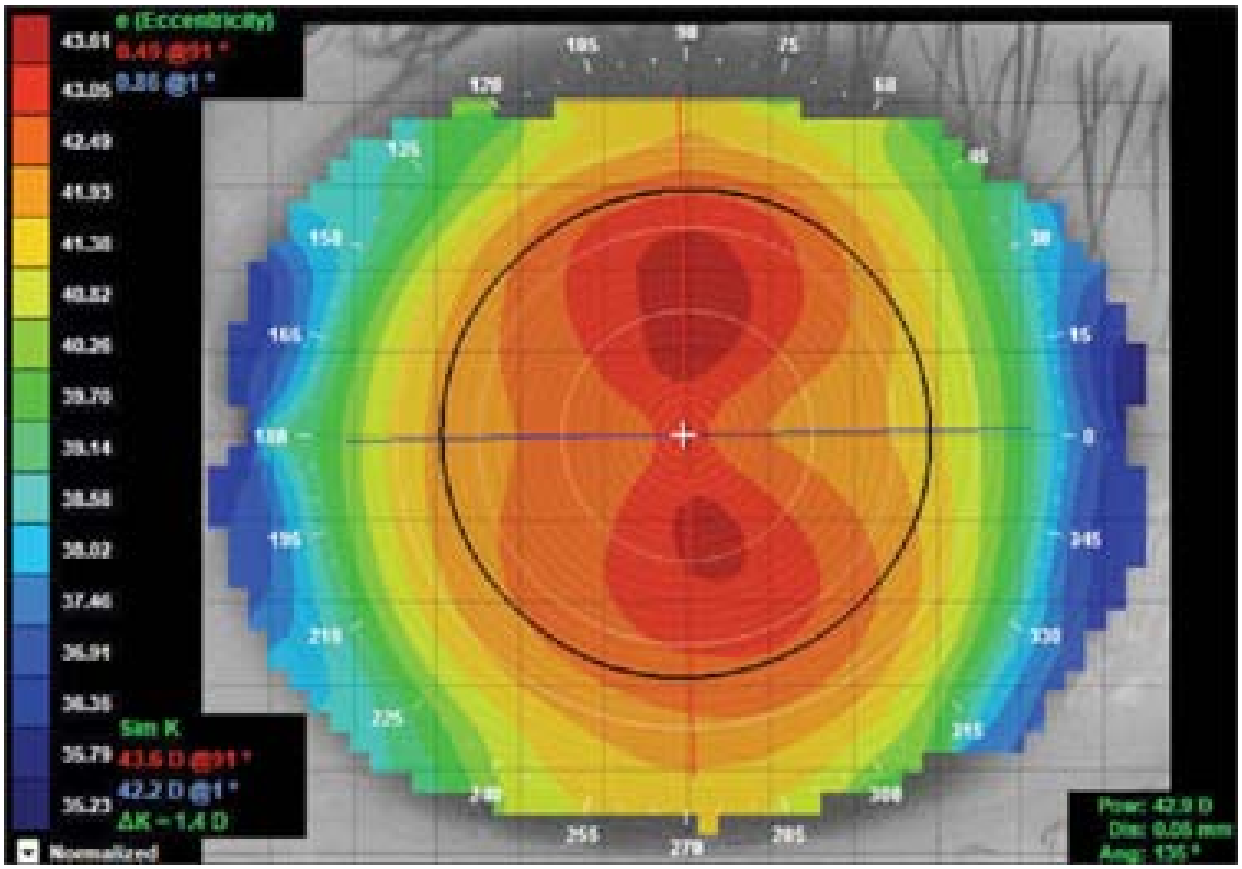
Corneal Optics



Corneal Placido-disk topography: Color map demonstrating…

Corneal Optics



Corneal Placido-disk topography: Color map demonstrating…with-the-rule astigmatism

Q

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In doing this, does corneal topography directly measure central corneal curvature/power?

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No. While it measures power *closer* to the central cornea than does a keratometer, topography still cannot directly measure central corneal curvature/power.

Q

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Does topography measure the curvature/power of the posterior *corneal surface?*

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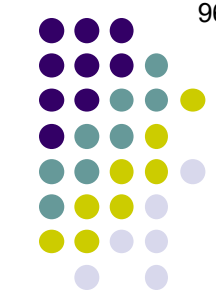
Does topography measure the curvature/power of the posterior *corneal surface?*
Not at all

Q



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Does topography, of itself, provide adequate information to perform keratorefractive surgery?

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Does topography, of itself, provide adequate information to perform keratorefractive surgery?
Provided it is interpreted properly, yes

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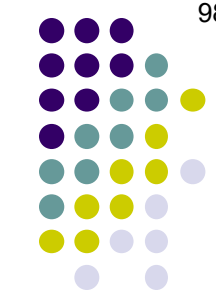
Corneal Optics



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Why this qualifier? How might interpretation be compromised?

rvature/power?
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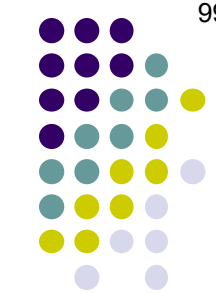

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The acquisition of topography data is susceptible to artifacts which can result in inaccurate mapping

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What sorts of artifacts interfere with interpretation of corneal topography?
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Does topography, of itself, provide adequate information to perform keratorefractive surgery?
Provided it is interpreted properly, yes

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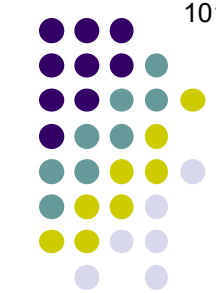
Corneal Optics



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How does a corneal topographer work?
Like keratometry, corneal topography is reflection-based. However, topographers reflect a set of concentric rings (collectively called a *Placido disk*) from the tear film, and a computer analyzes the distances between, and shapes of, the reflected rings. Based on this analysis, the topographer creates a color-coded 'map' depicting the curvature across the entire cornea.

Why this qualifier? How might interpretation be compromised?
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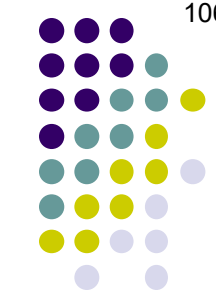

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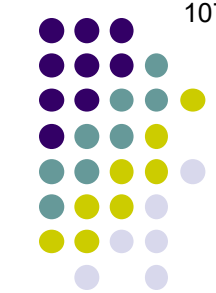

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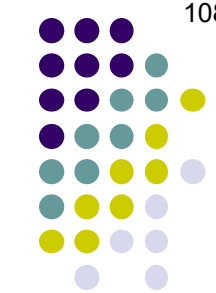

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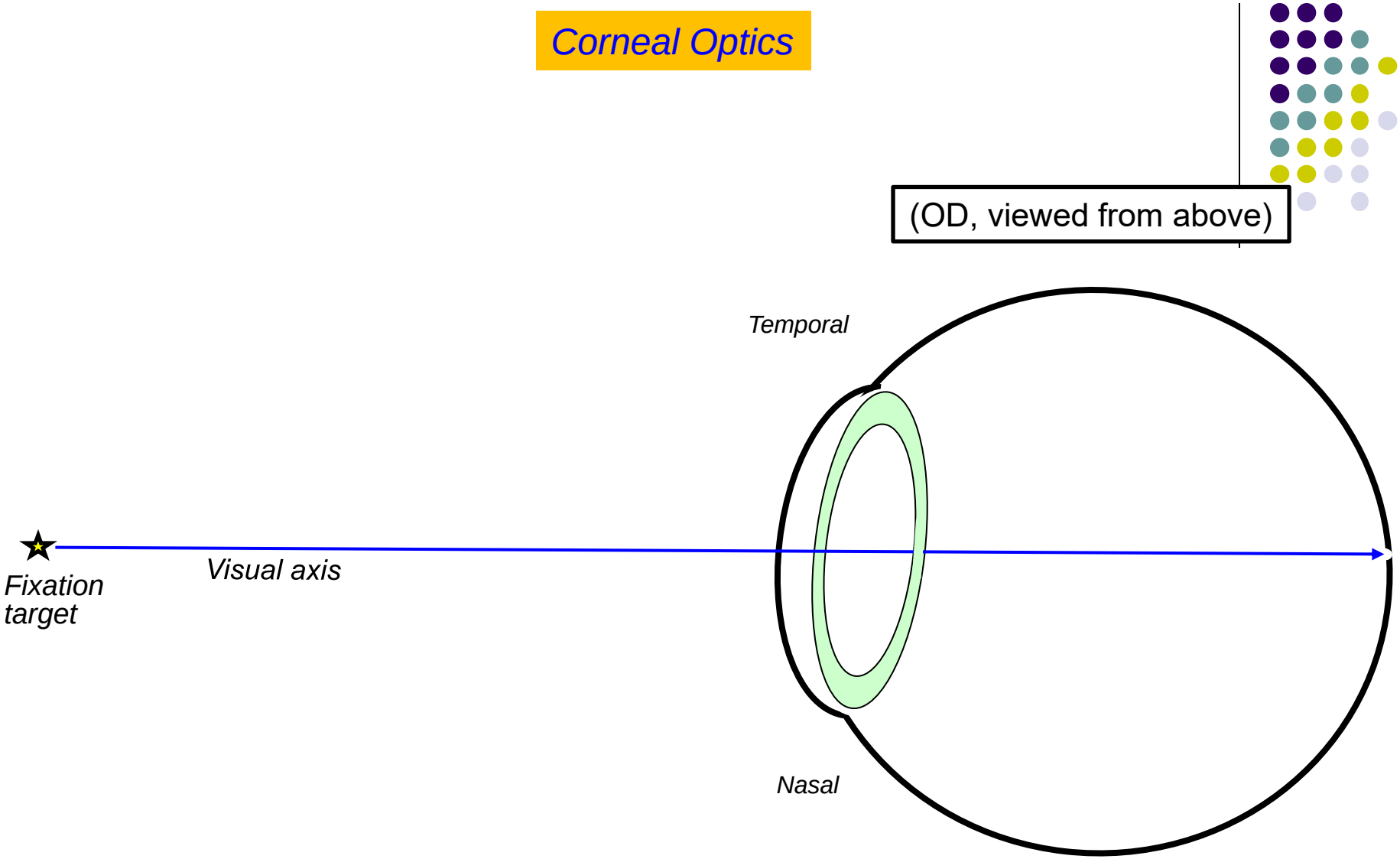

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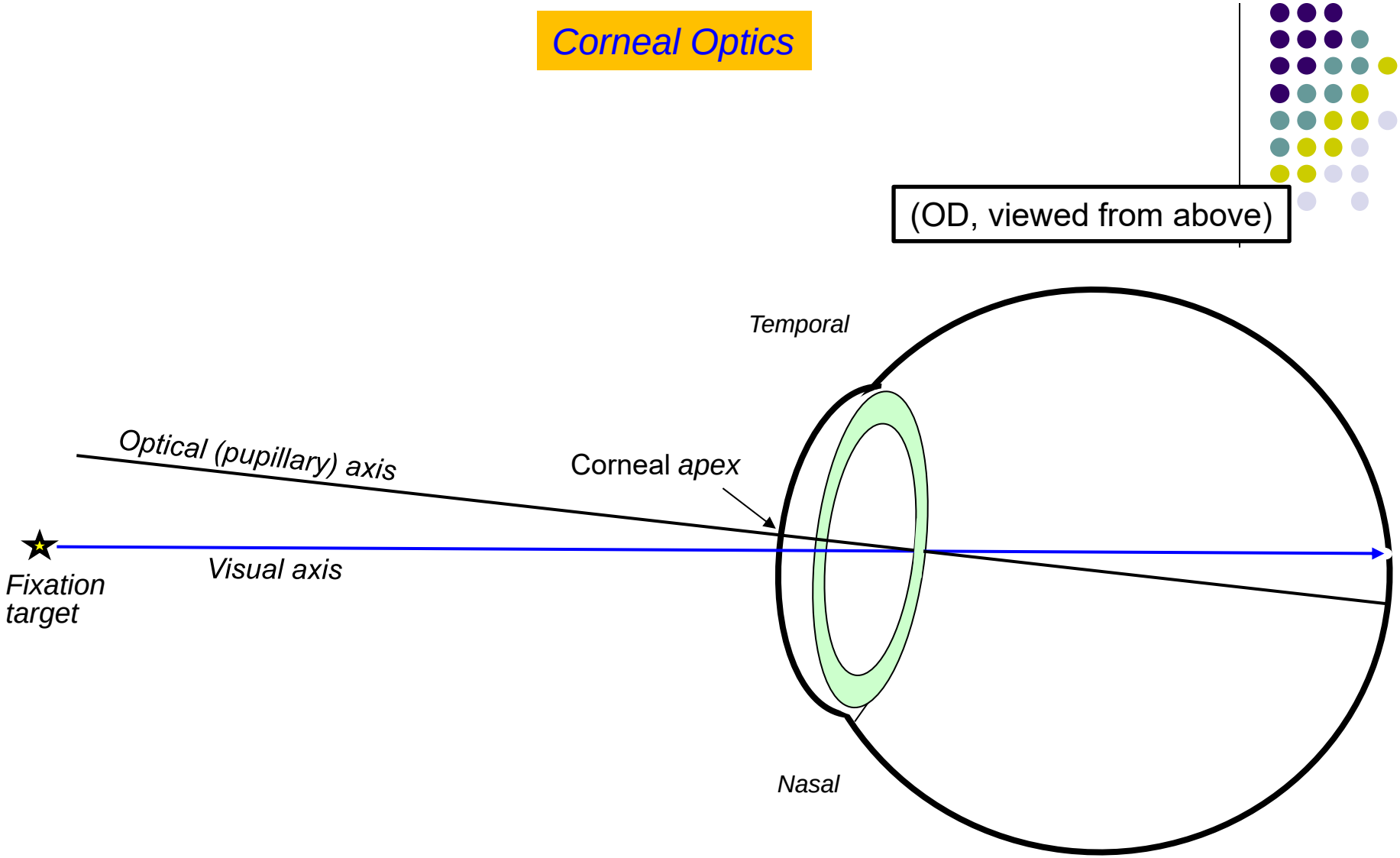

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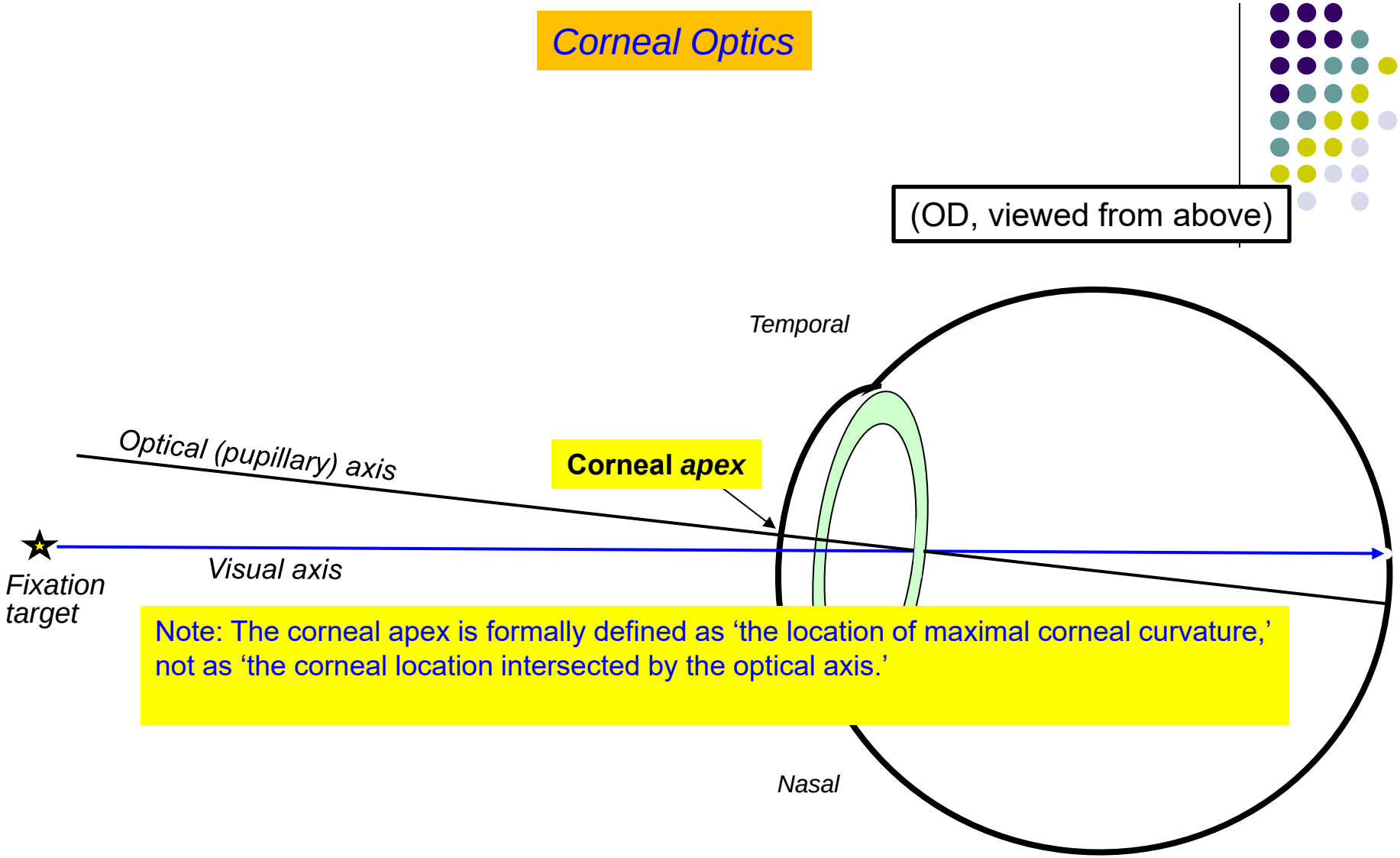
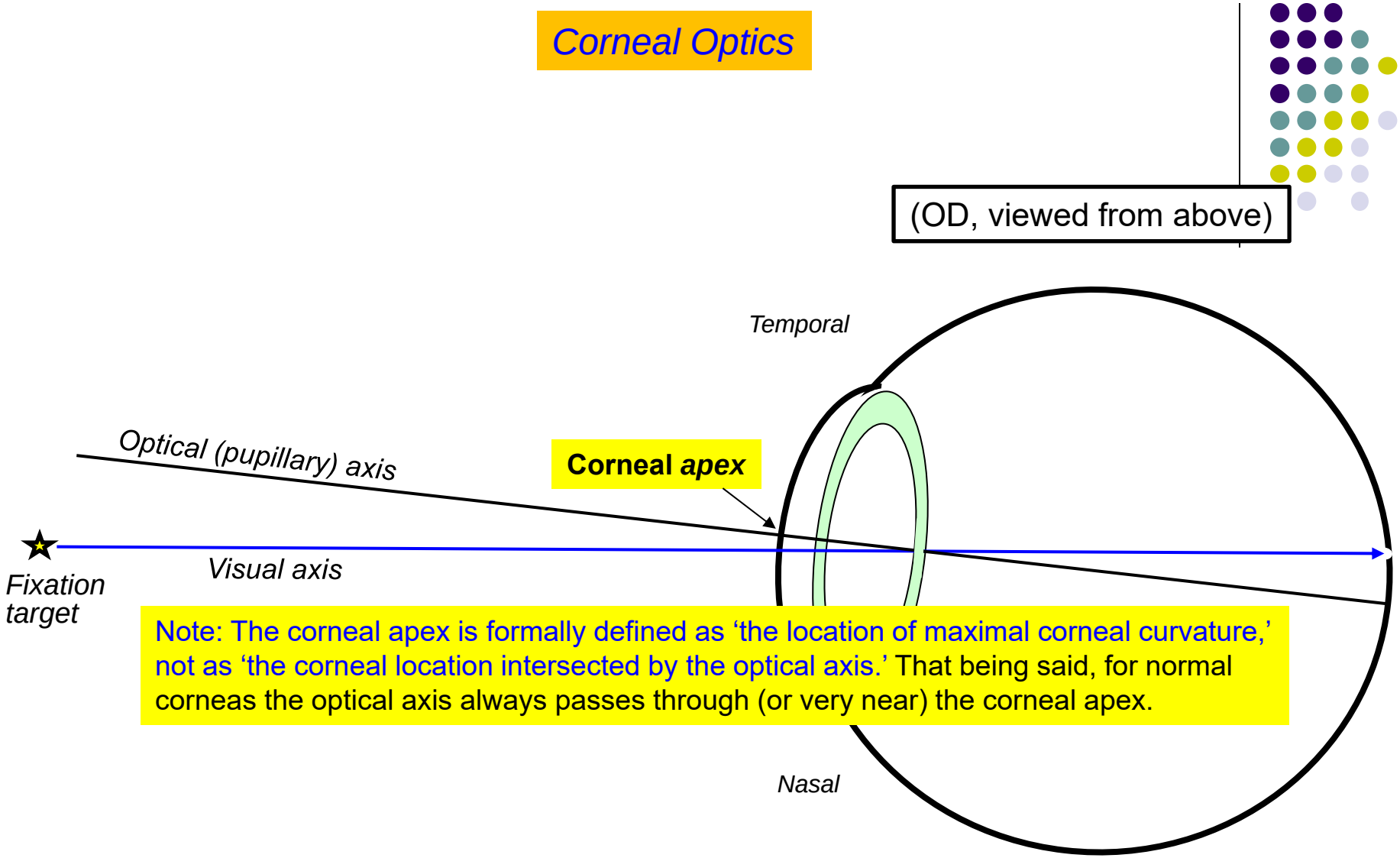


Note: The corneal apex is formally defined as ‘the location of maximal corneal curvature,’ not as ‘the corneal location intersected by the optical axis.’

Corneal Optics



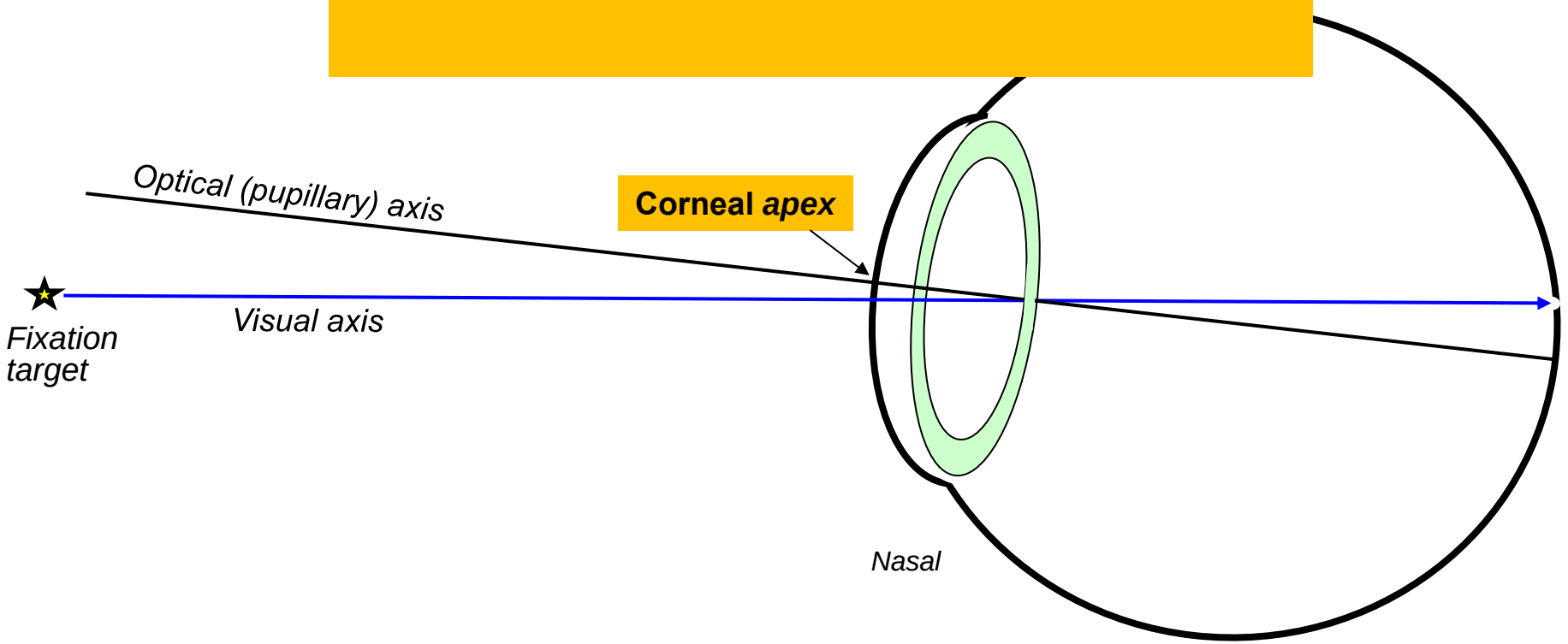
Note: The corneal apex is formally defined as 'the location of maximal corneal curvature,' not as 'the corneal location intersected by the optical axis.' That being said, for normal corneas the optical axis always passes through (or very near) the corneal apex.

Q

Corneal Optics

above)

How can one readily identify the corneal apex in the clinic?

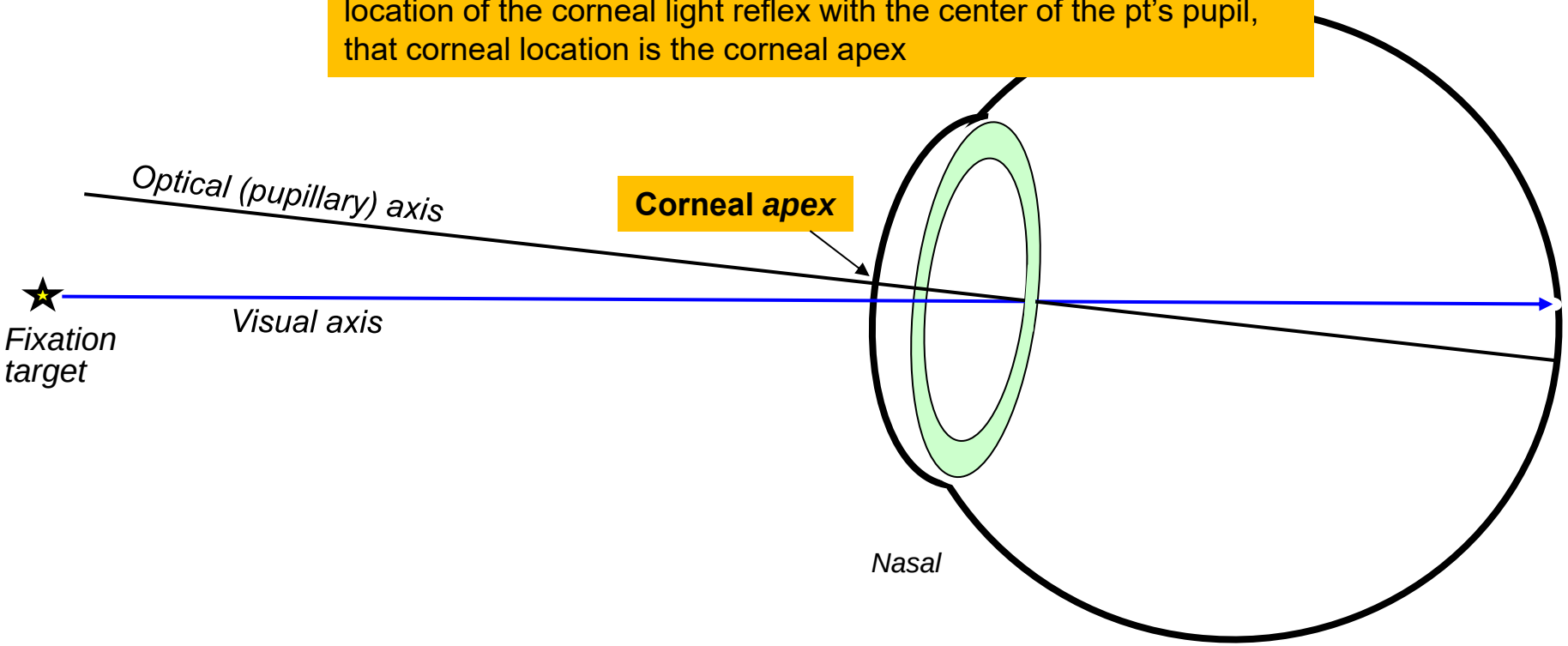


A

Corneal Optics

above)

How can one readily identify the corneal apex in the clinic?
When you align a light-source with your line of sight, then align the location of the corneal light reflex with the center of the pt's pupil, that corneal location is the corneal apex



Q

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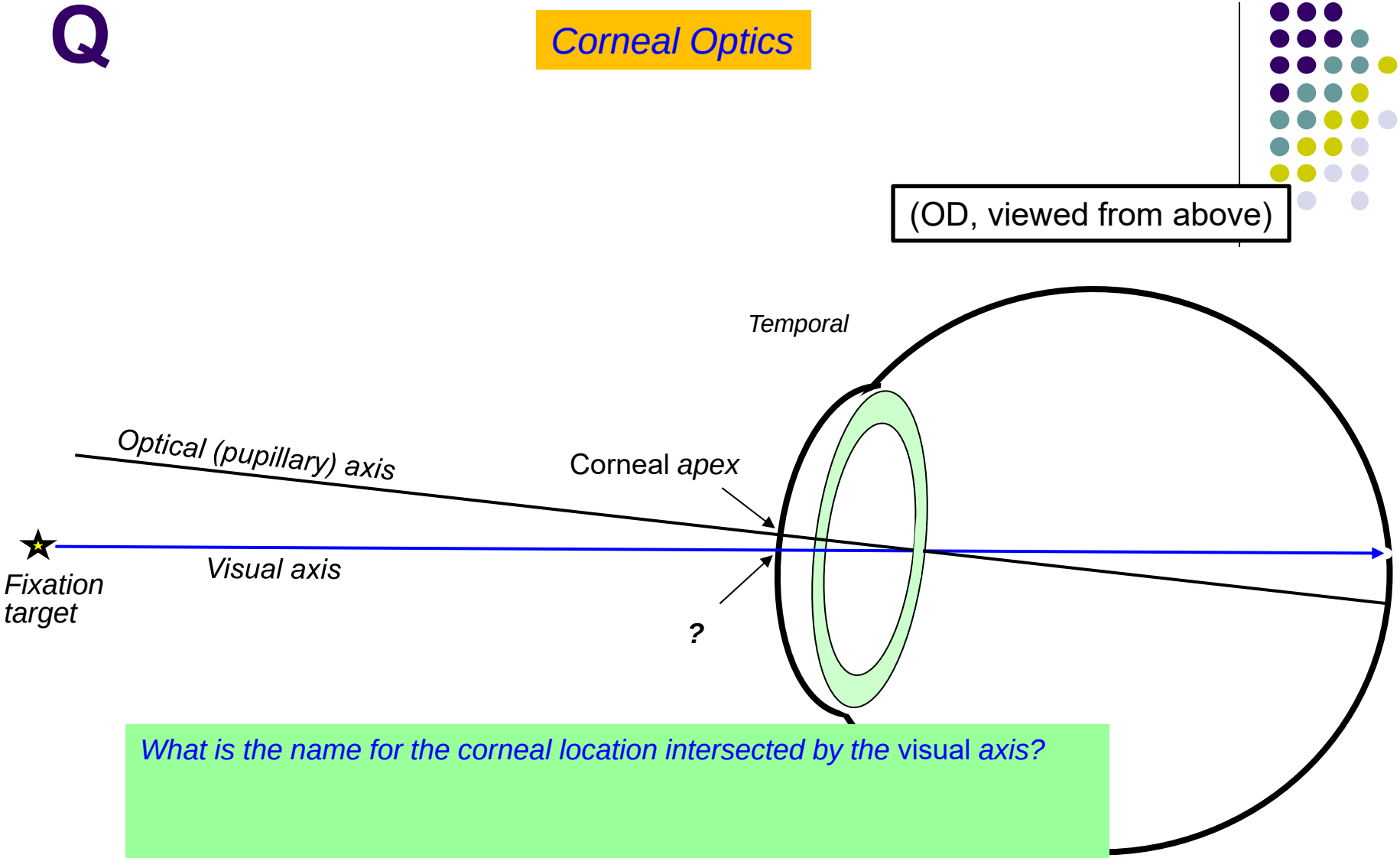
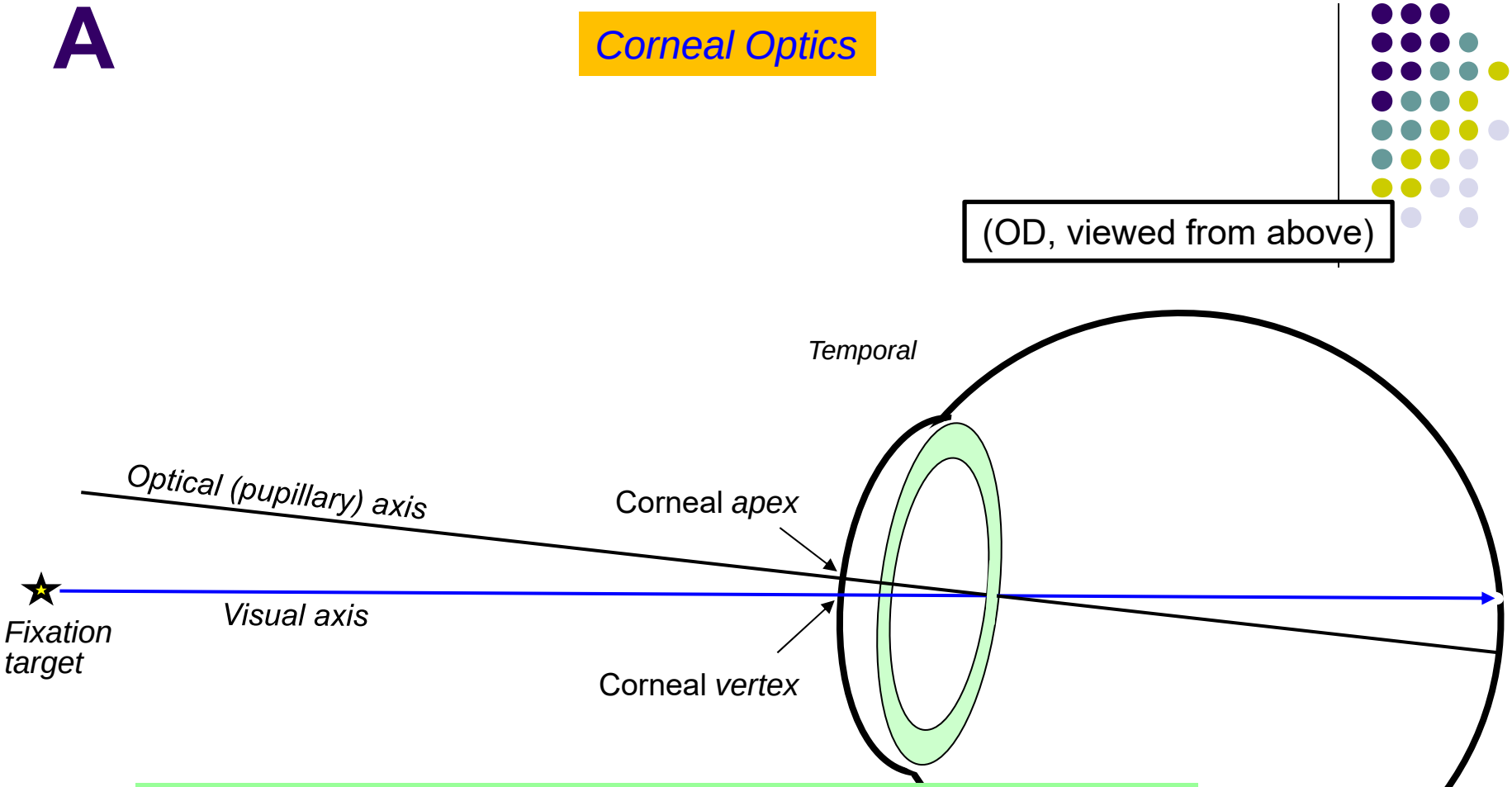


What is the name for the corneal location intersected by the visual *axis?*

A

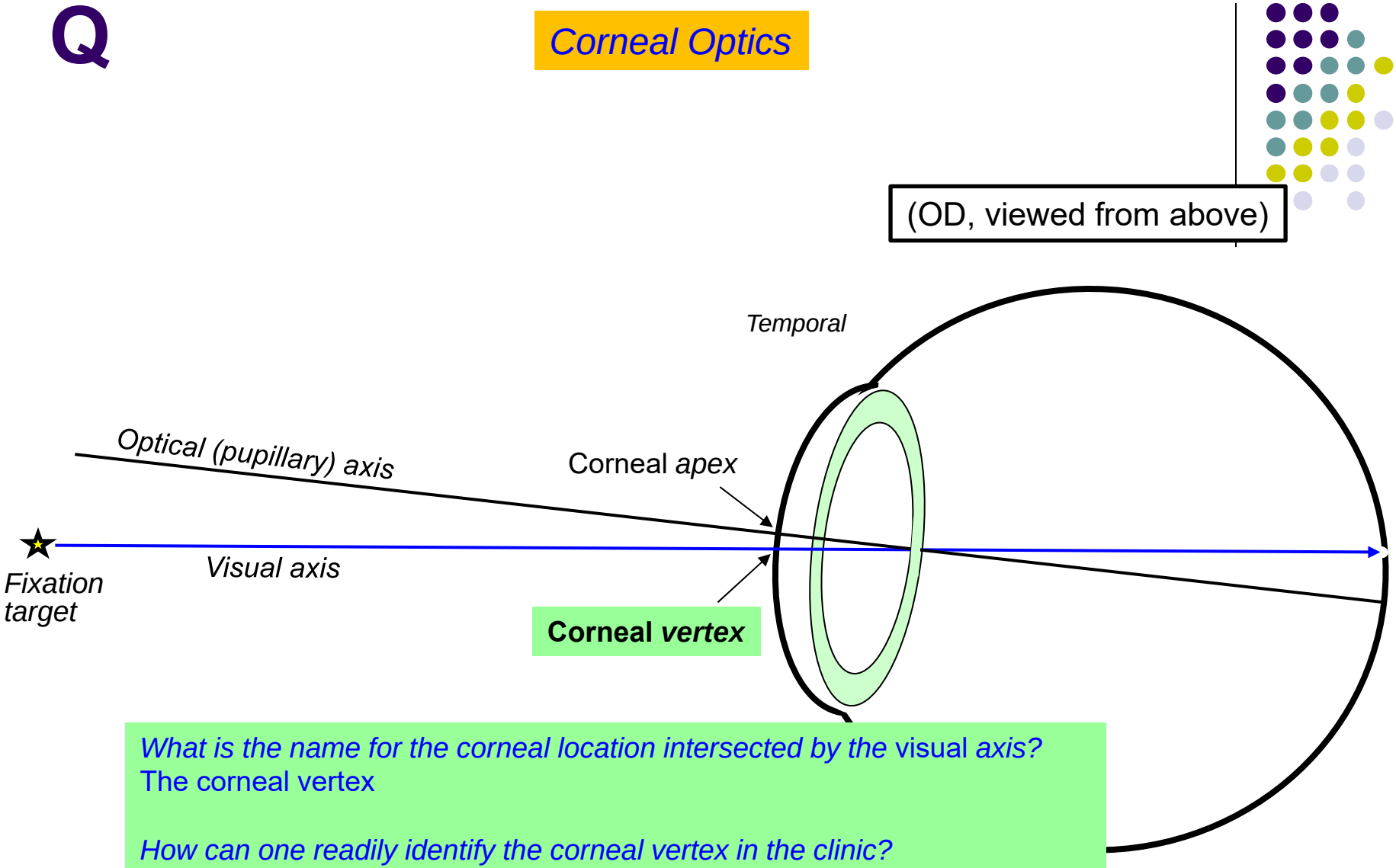
Corneal Optics



What is the name for the corneal location intersected by the visual *axis?*
The corneal vertex

Q

Corneal Optics



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A

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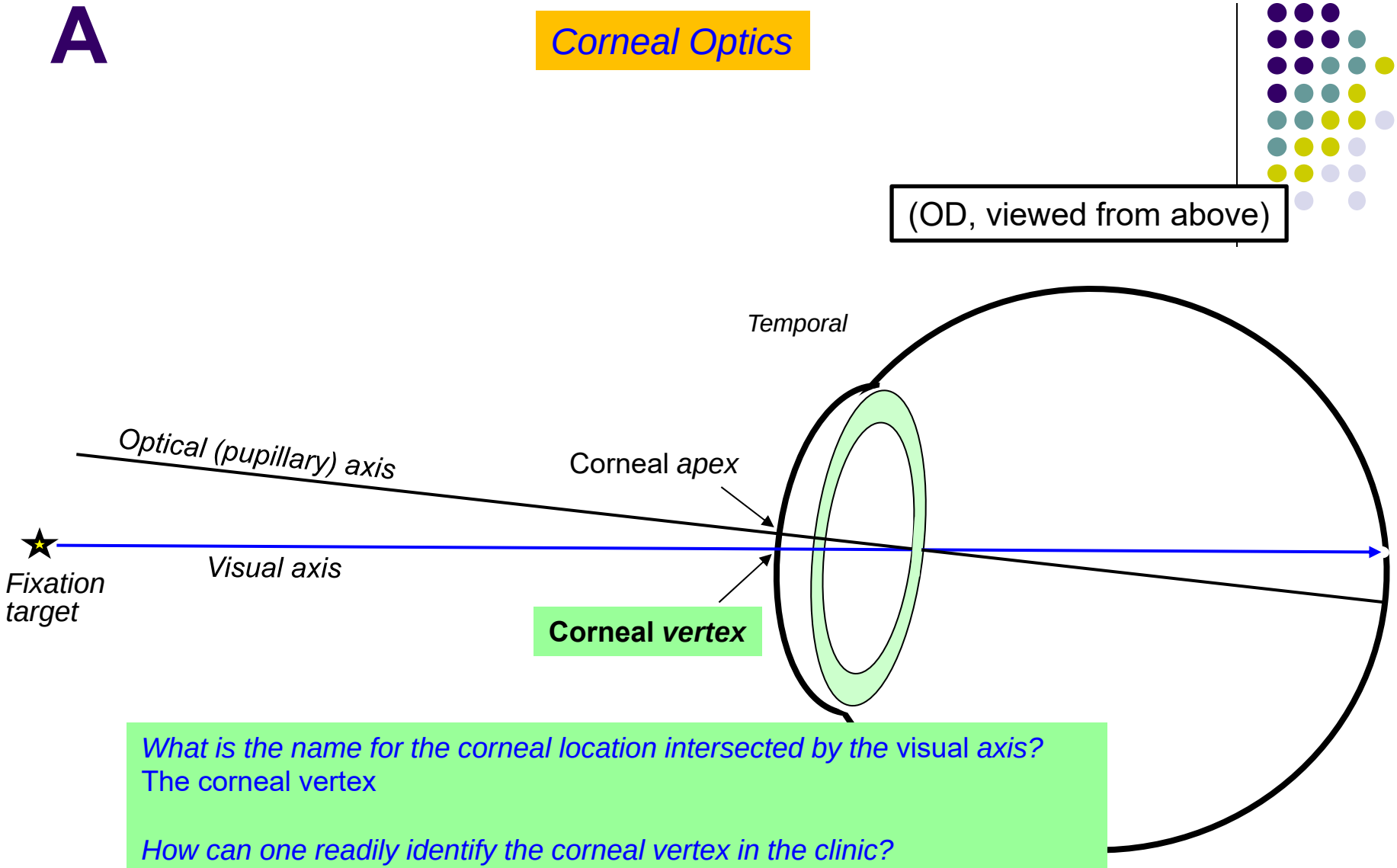


What is the name for the corneal location intersected by the visual *axis?*
The corneal vertex

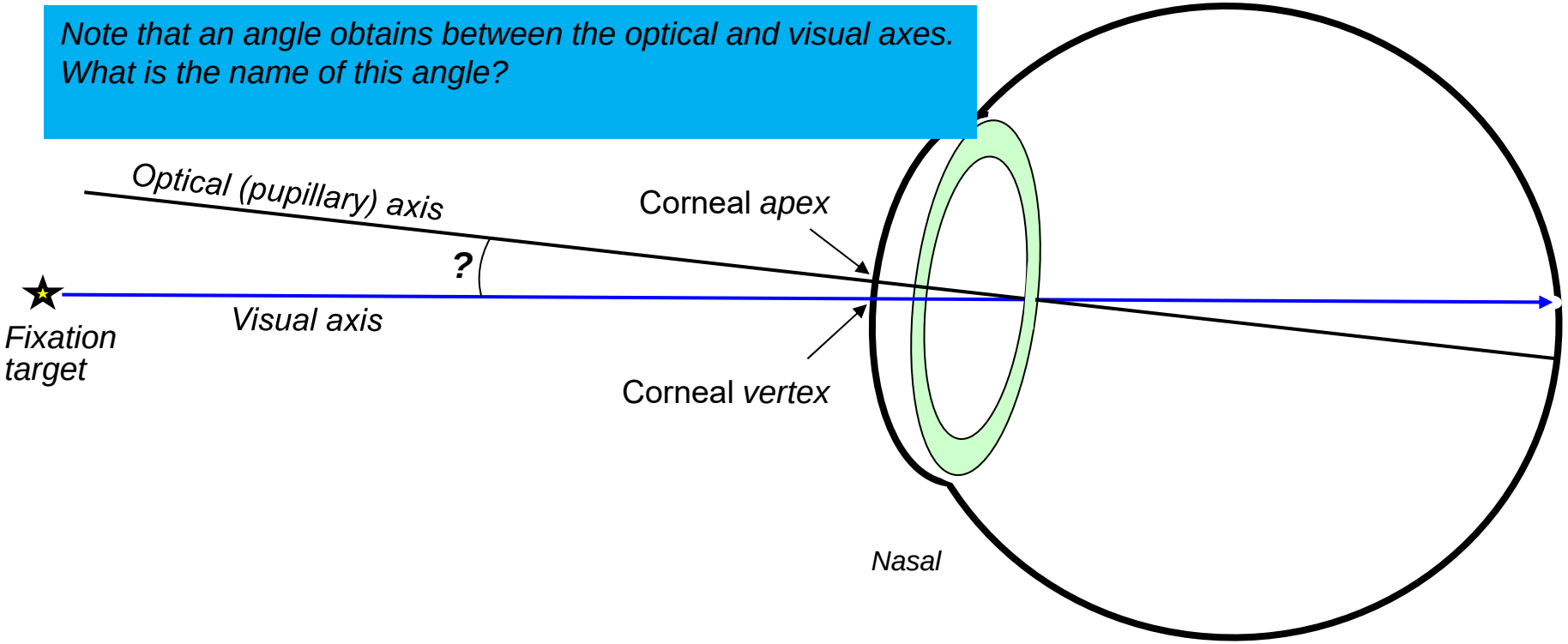
How can one readily identify the corneal vertex in the clinic?
When you align a light-source with your line of sight, then ask the pt to look at the light, the location of the corneal light reflex is the corneal vertex

Q

Corneal Optics

(OD, viewed from above)

Note that an angle obtains between the optical and visual axes. What is the name of this angle?



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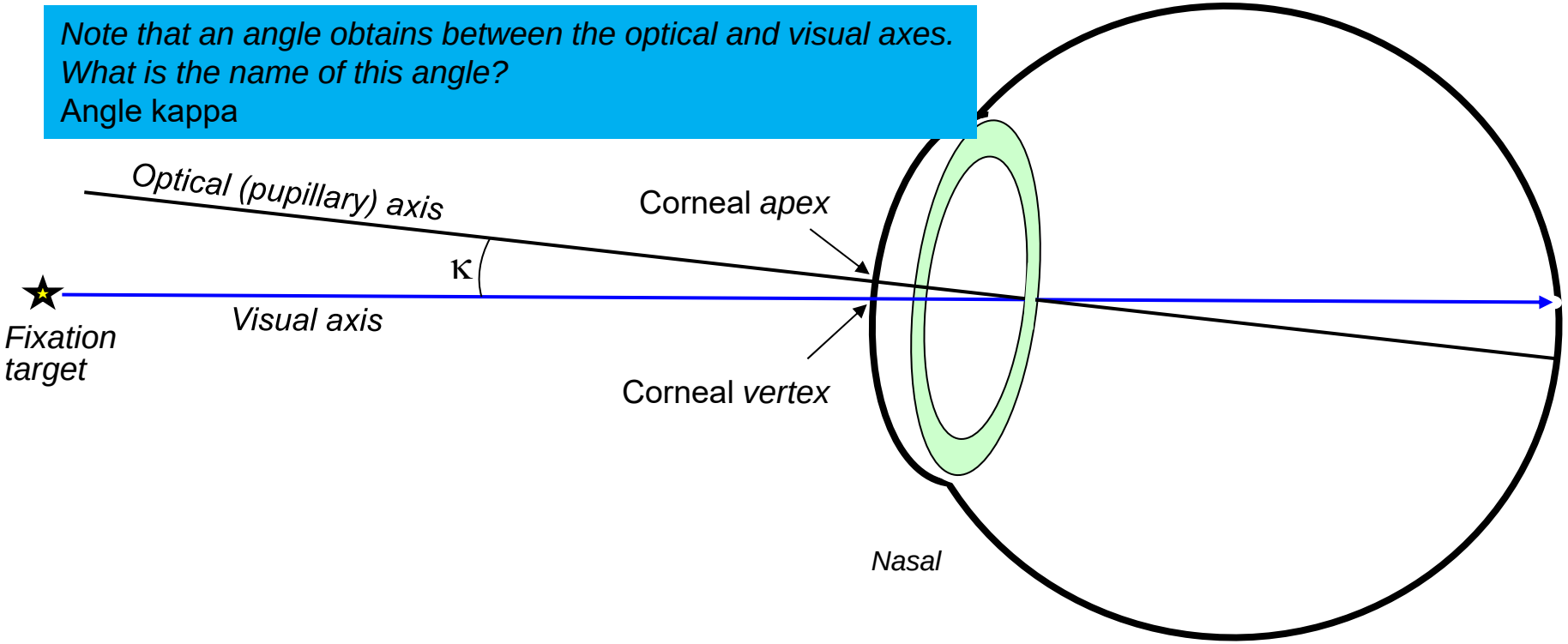

Q

Corneal Optics

(OD, viewed from above)

How can one ascertain the angle kappa in the clinic?

Note that an a
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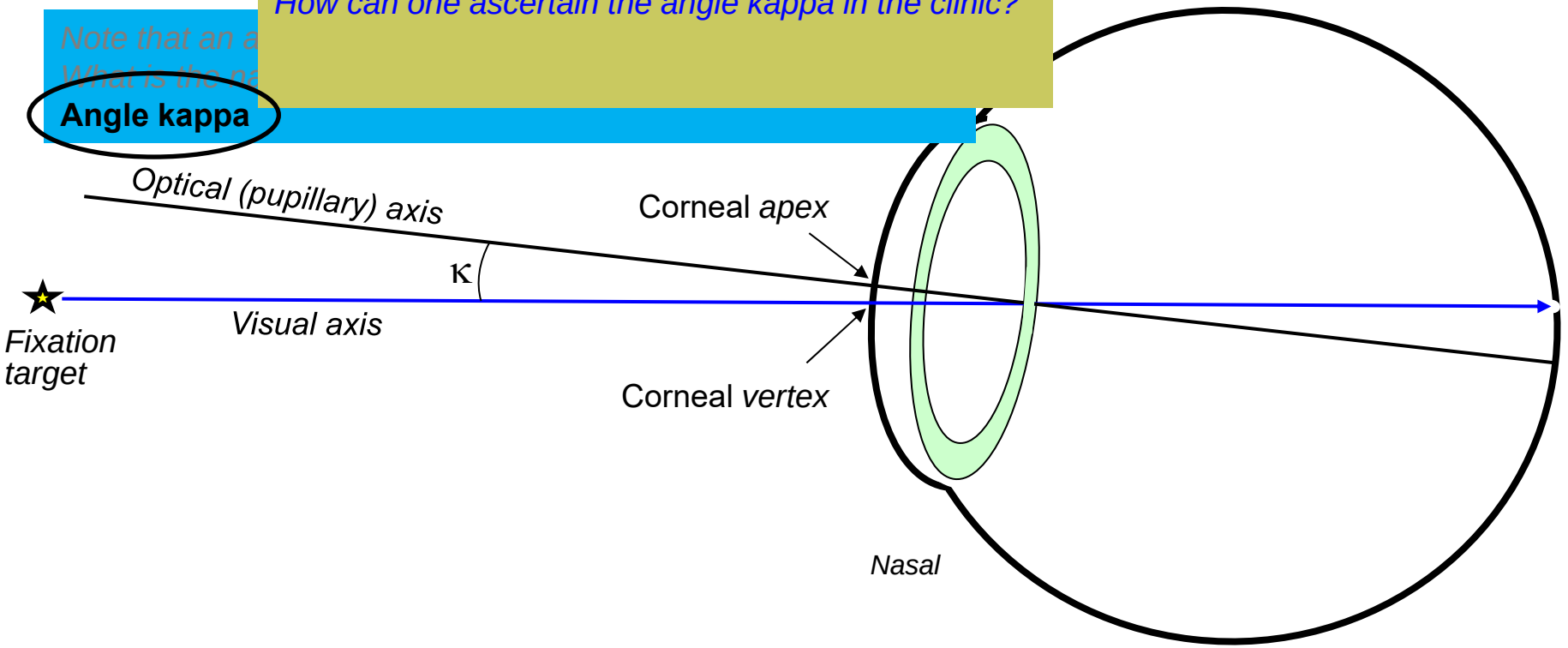
Angle kappa



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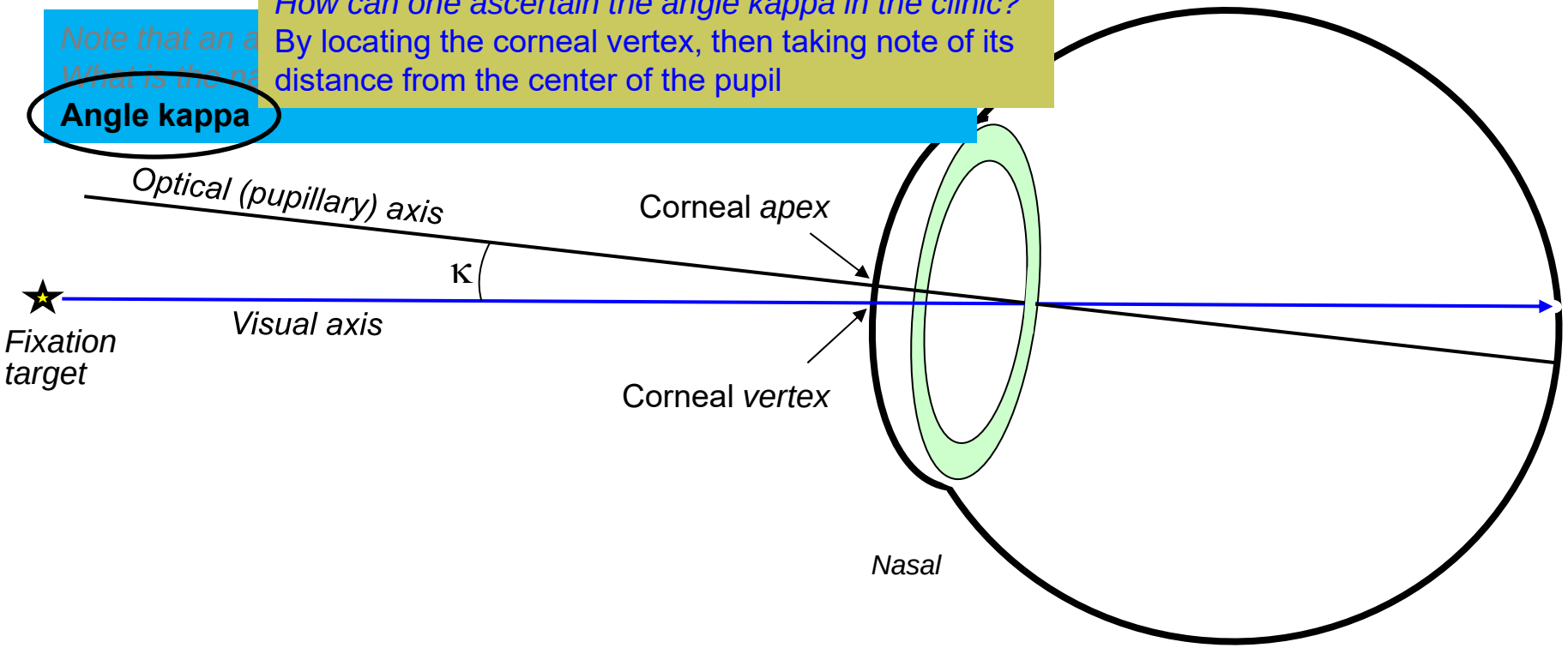
Corneal Optics

(OD, viewed from above)

How can one ascertain the angle kappa in the clinic?
By locating the corneal vertex, then taking note of its distance from the center of the pupil

Angle kappa



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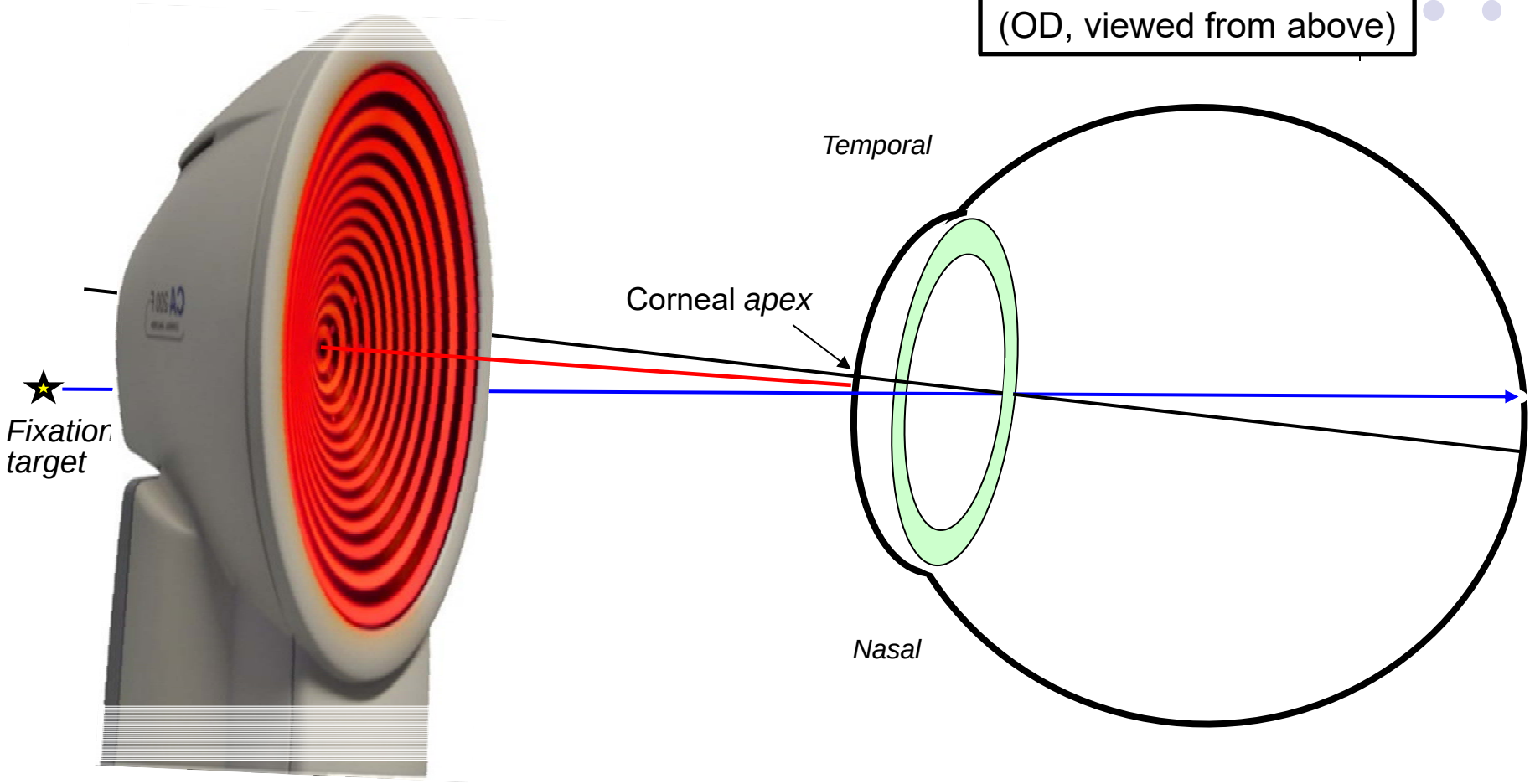

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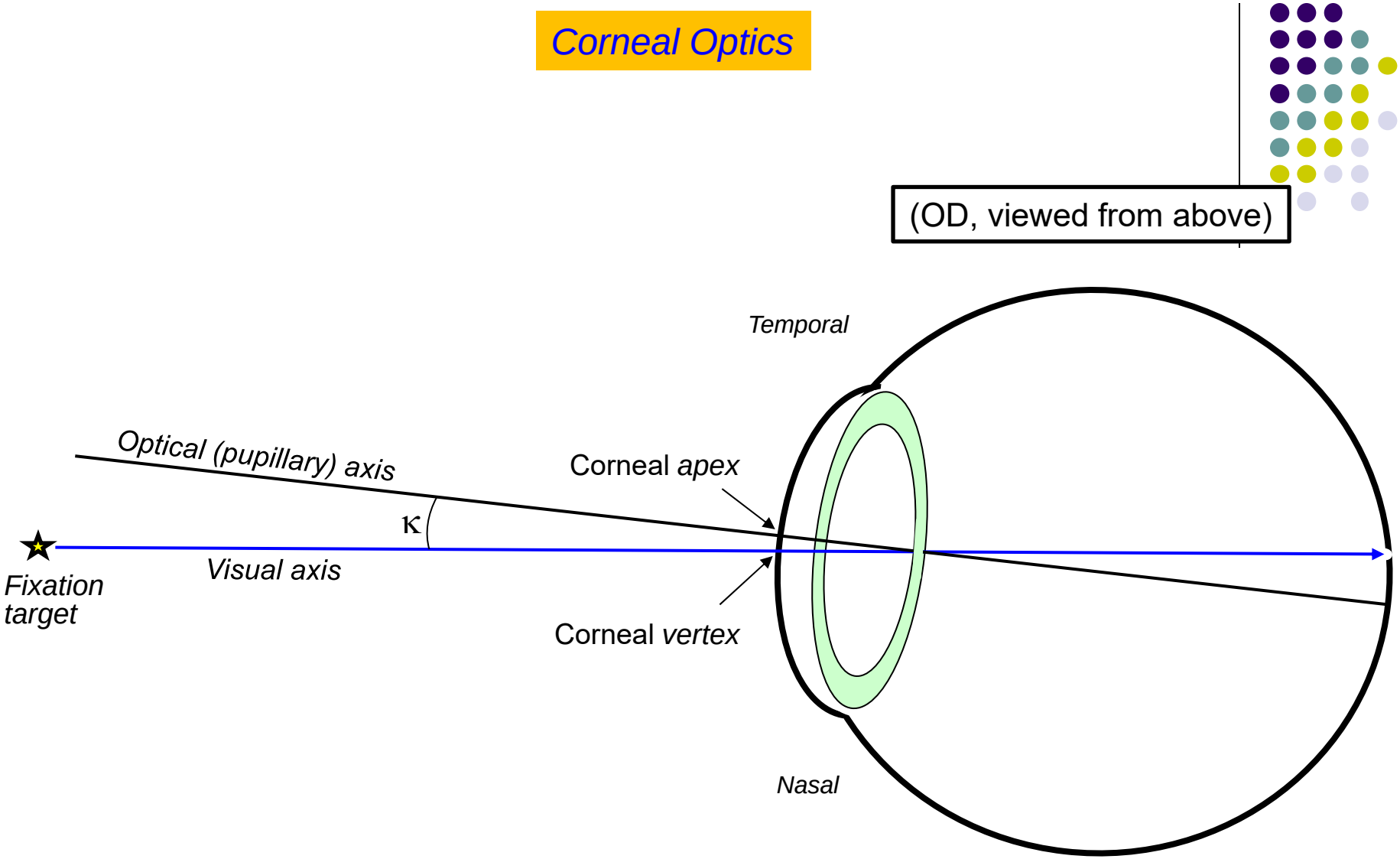

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A number of techniques have been developed to deal with these issues. But the most important factor is an awareness of the potential errors on the part of the surgeon.

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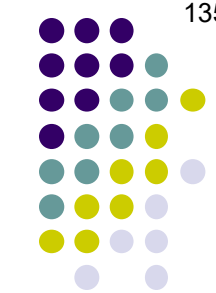
What is the difference between corneal topography *and corneal* tomography*?*

A

Corneal Optics



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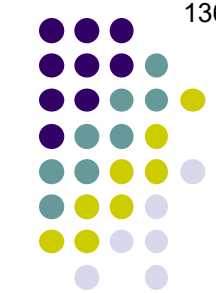
Q

Corneal Optics



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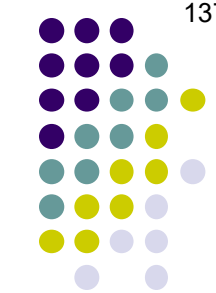
A/Q



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There are two basic technologies:
--Scanning-slit
--Scheimpflug imaging

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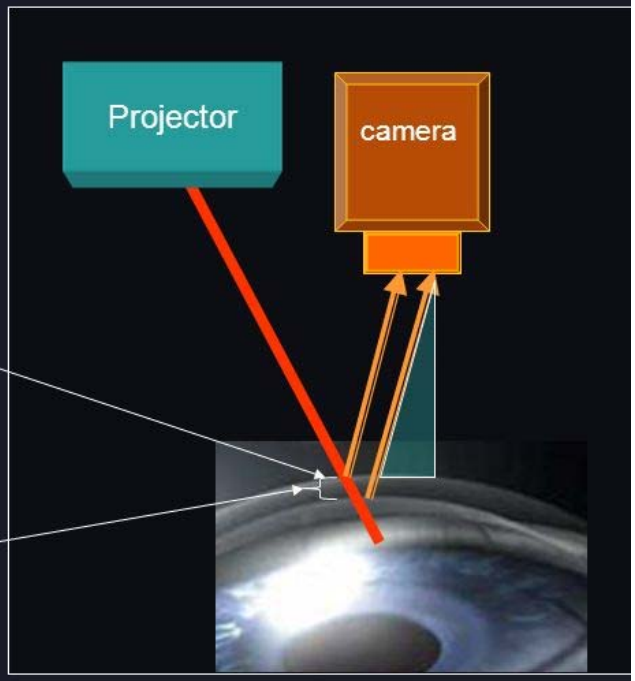
How does scanning-slit technology work?
Multiple slit-beam images (which reflect off both the anterior *and* posterior corneal surfaces) are collected, and used to reconstruct the structure of the cornea. (Note: Some scanning-slit systems work by combining this technology with Placido-disk imaging)

Scanning slit technology

- The scanning slit triangulates the area between the reflected beam and camera axis to determine the edge.
- Overall analysis of reflected beams determines 'floats'.
- Difference in two edges created by the same beam , adjusting for time delays, determines the depth.



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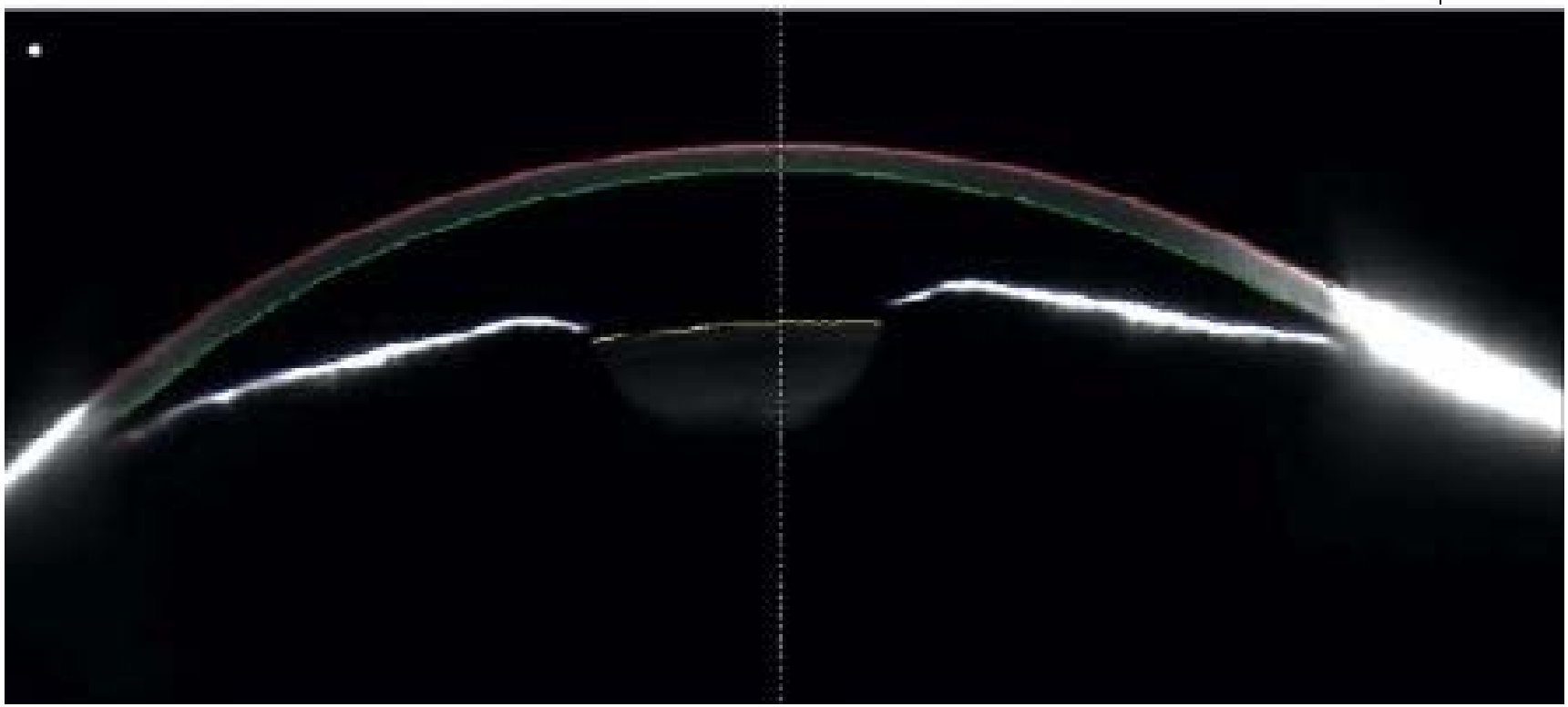
What is Scheimpflug photography?
A technique that allows one to take 'side on' pics of the cornea as slit-beam illumination passes through it

Corneal Optics



Corneal tomography: Scheimpflug image

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Multiple Scheimpflug images of the cornea are collected and integrated to produce a model of the cornea

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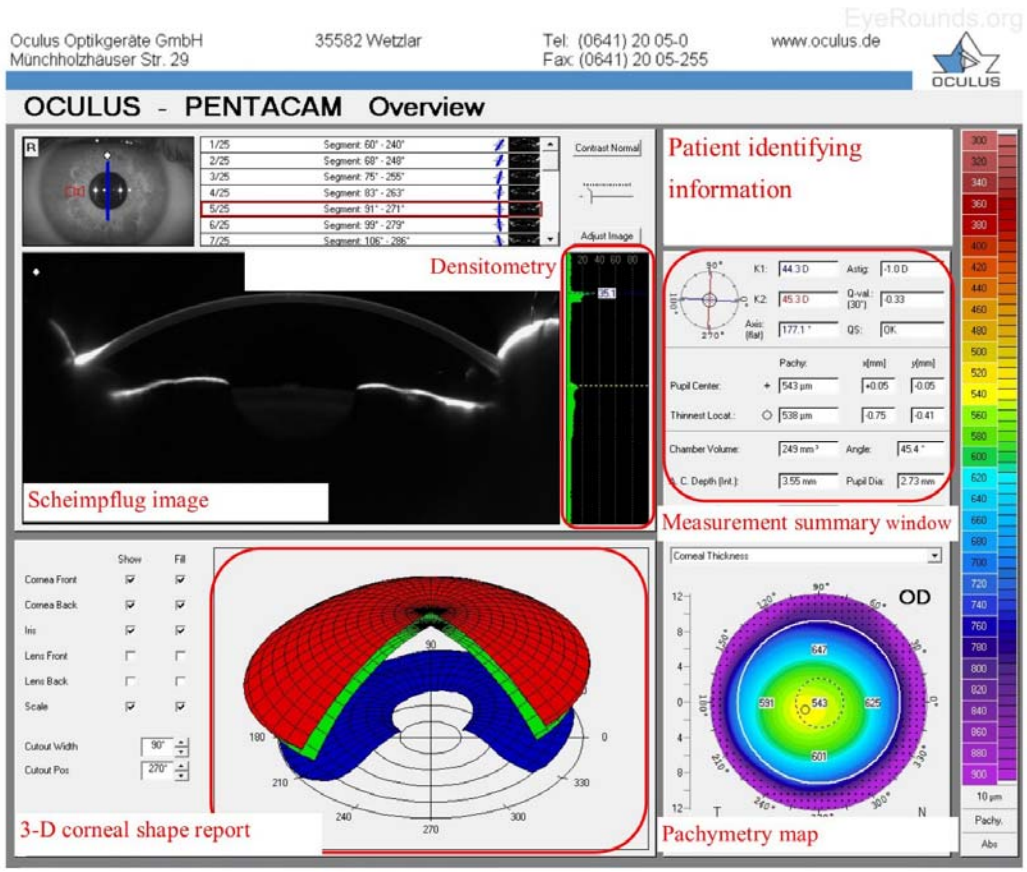
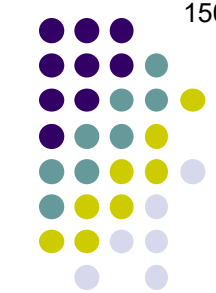


Pentacam Overview Report. **Upper pane:** the Scheimpflug image is a cross-sectional image showing the cornea, anterior chamber, iris, and lens. **Lower panes:** A 3-D representation of the patient's corneal shape is provided; the anterior corneal surface is shown in red, posterior corneal surface in green, and iris in blue. **A pachymetry map is a color map that indicates corneal thickness; cooler colors are thicker and warmer colors are thinner (numeric scale on right).**

Q

Corneal Optics



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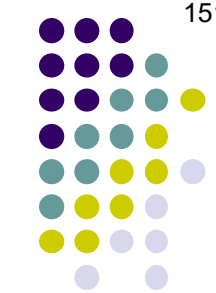

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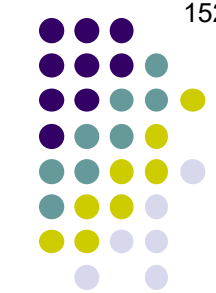
Does tomography measure the curvature of the posterior *corneal surface?*
Yes (well, Scheimpflug systems do; again, scanning-slit systems estimate it)

Q



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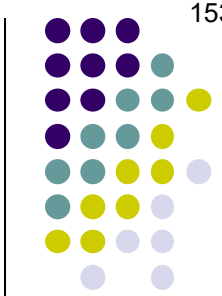
Corneal Optics



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  To determine whether a prospective pt suffers from a corneal ectatic disorder

Q

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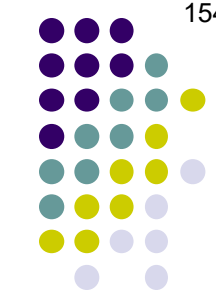

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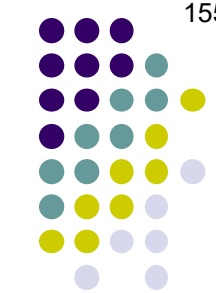

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  - Pellucid marginal degeneration

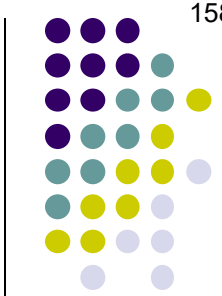
Corneal Optics

Corneal Placido-disk topography: Mires typical of…

Corneal Optics

Corneal Placido-disk topography: Mires typical of…**keratoconus**

Corneal Optics



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For more on ectatic disorders, see slide-set K12

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