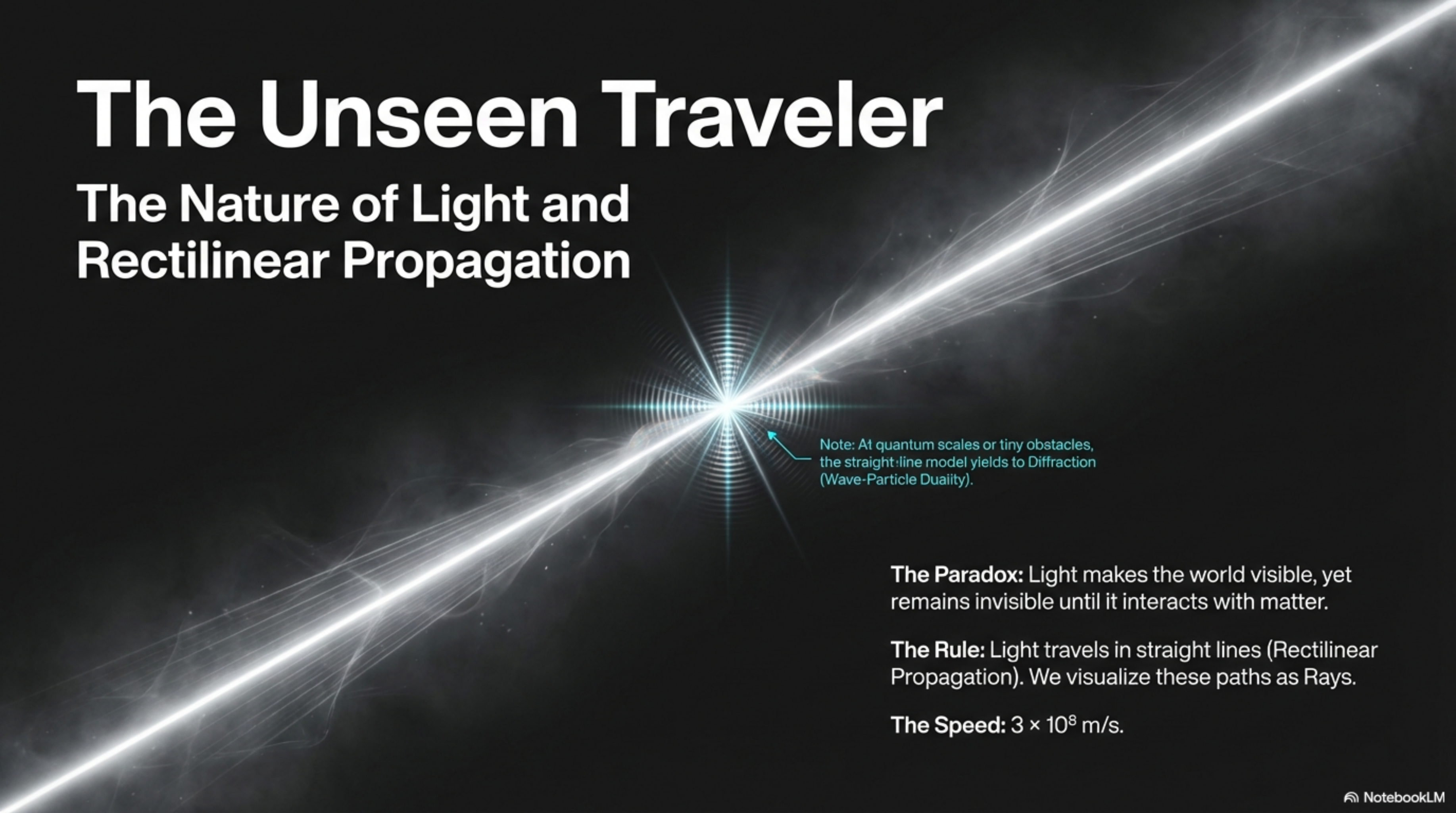


The Unseen Traveler

The Nature of Light and Rectilinear Propagation



Note: At quantum scales or tiny obstacles, the straight-line model yields to Diffraction (Wave-Particle Duality).

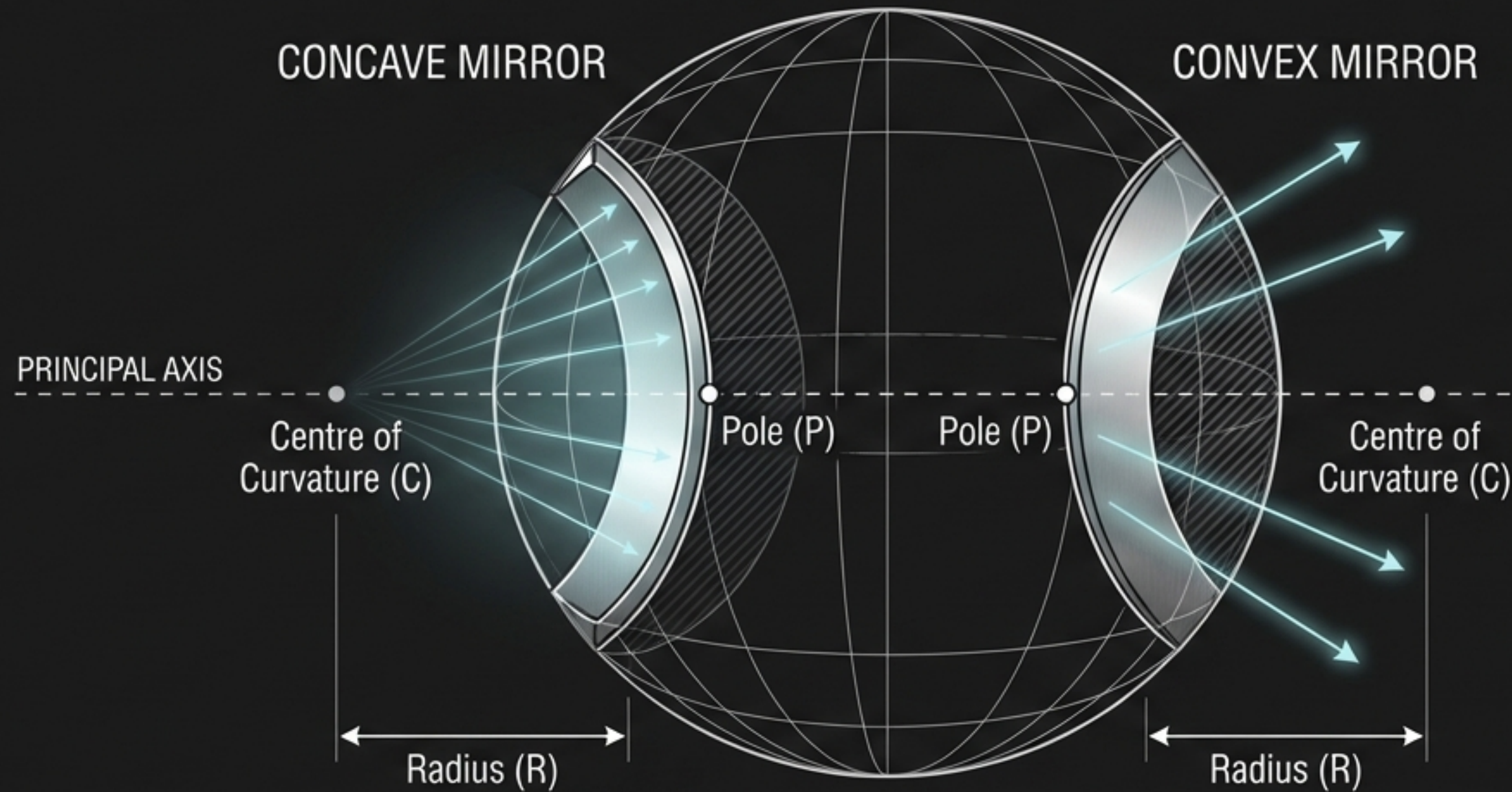
The Paradox: Light makes the world visible, yet remains invisible until it interacts with matter.

The Rule: Light travels in straight lines (Rectilinear Propagation). We visualize these paths as Rays.

The Speed: 3×10^8 m/s.

The Architecture of Reflection

From Sphere to Mirror: Anatomy of the Curve.



DEFINITIONS

Concave (Converging):
Curves inward. Focuses light.

Convex (Diverging):
Bulges outward. Spreads light.

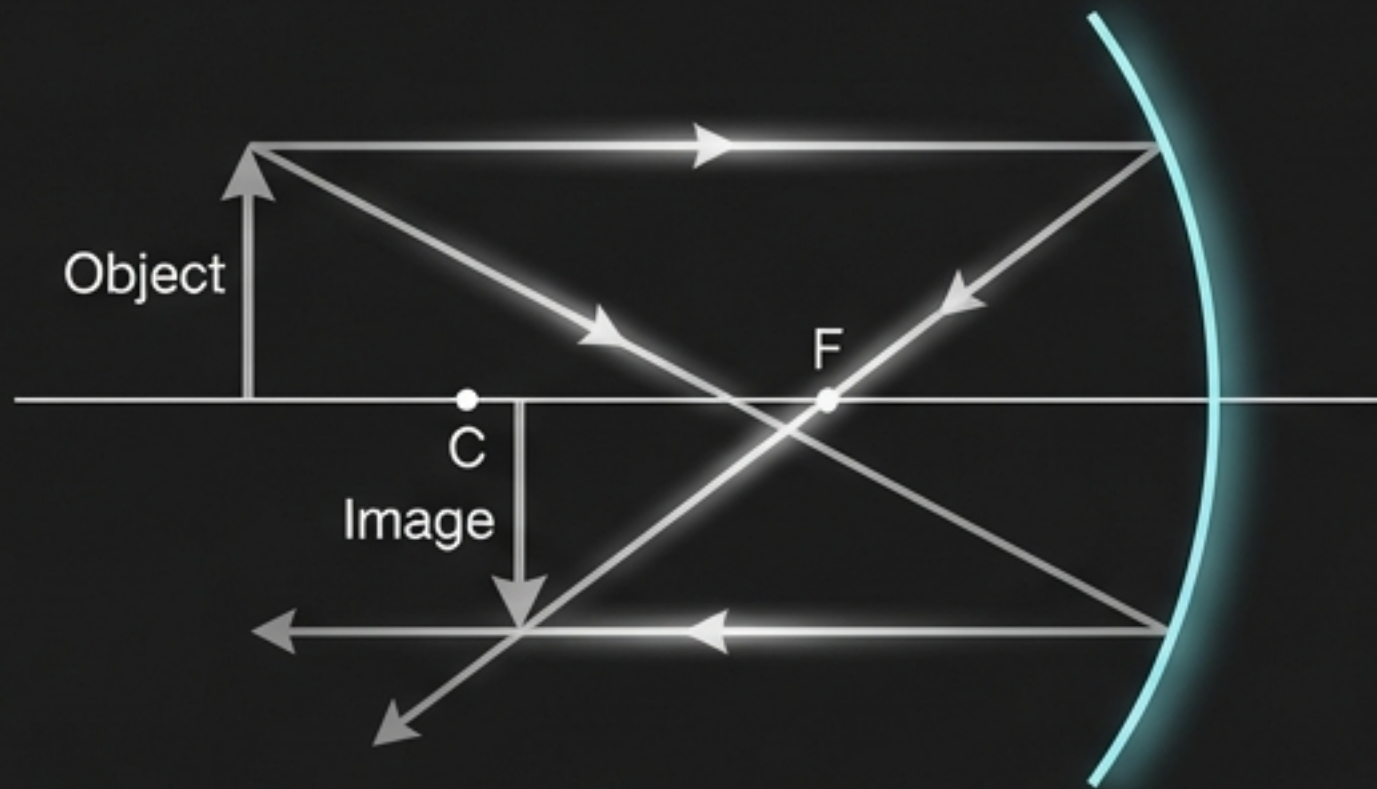
Centre of Curvature (C):
Lies in front of Concave,
behind Convex.

$$R = 2f$$

Where Rays Meet

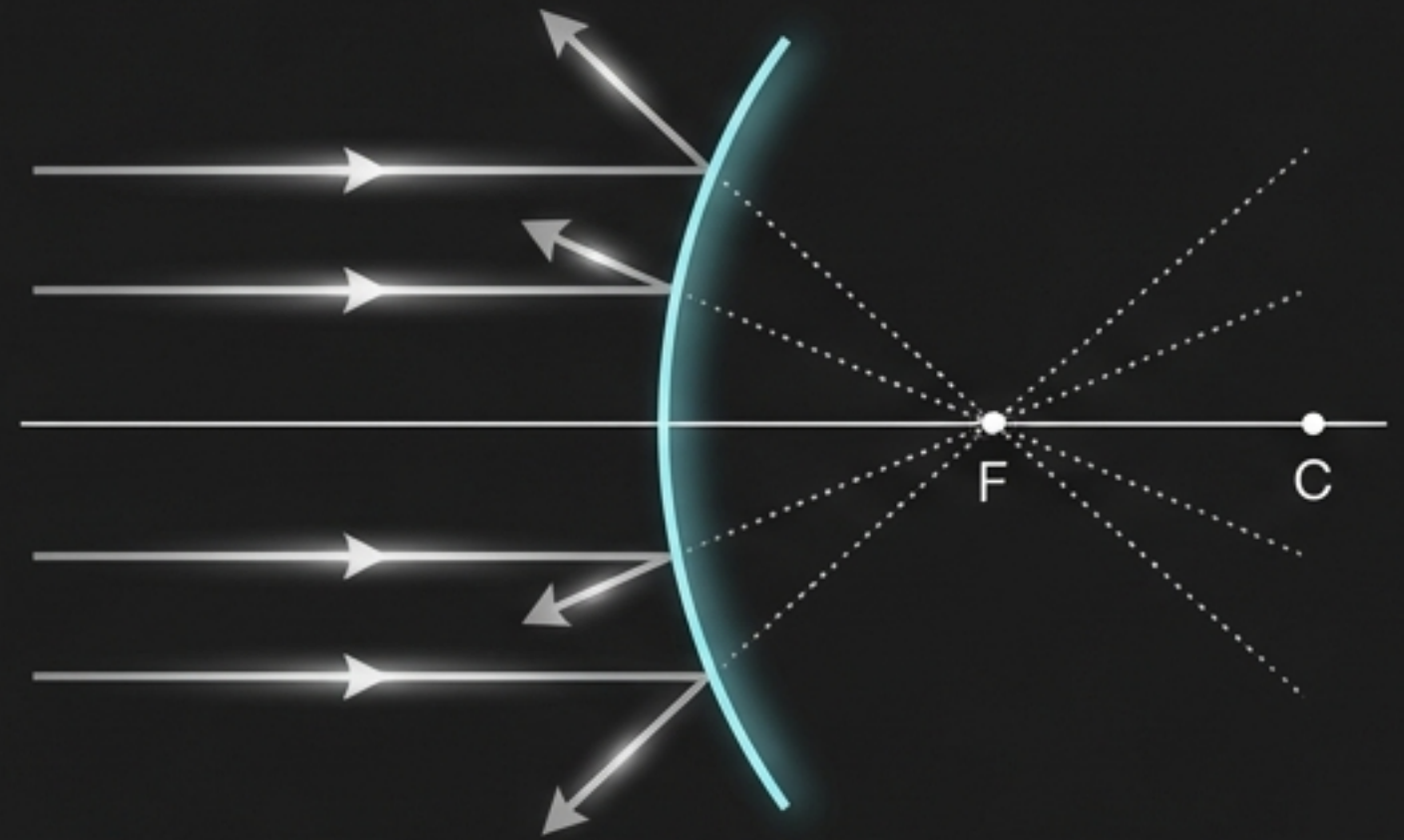
The Laws of Image Formation in Reflection.

The Concave Logic (Converger)



Object far (Beyond F) \rightarrow Real & Inverted.
Object close (Within F) \rightarrow Virtual, Erect & Magnified (e.g., Dentist Mirror).

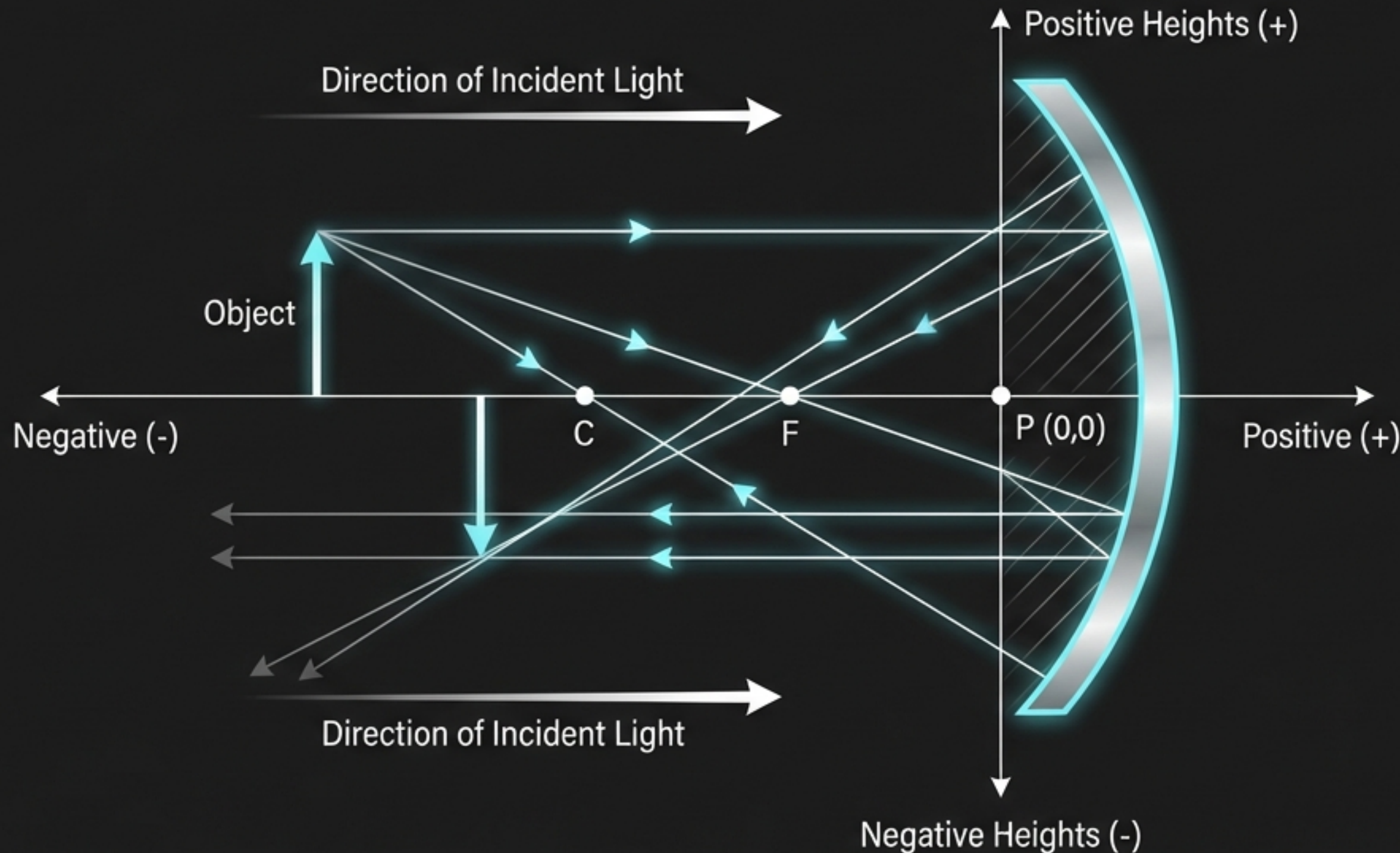
The Convex Logic (Diverger)



Always Virtual.
Always Erect.
Always Diminished (Field of View).
Use Case: Vehicle Rear-view Mirrors.

The Language of Mirrors

The New Cartesian Sign Convention & Mirror Formula



The Mirror Formula:

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

Magnification (m):

$$m = \frac{h'}{h} = \frac{-v}{u}$$

The Translator:

- m is Negative (-) → Real Image
- m is Positive (+) → Virtual Image

The Bend

Refraction: When Light Changes Worlds.

The Phenomenon:

Light changes speed when entering a medium of different optical density.

- Rare → Dense: Bends Towards Normal (Slows down).
- Dense → Rare: Bends Away from Normal (Speeds up).

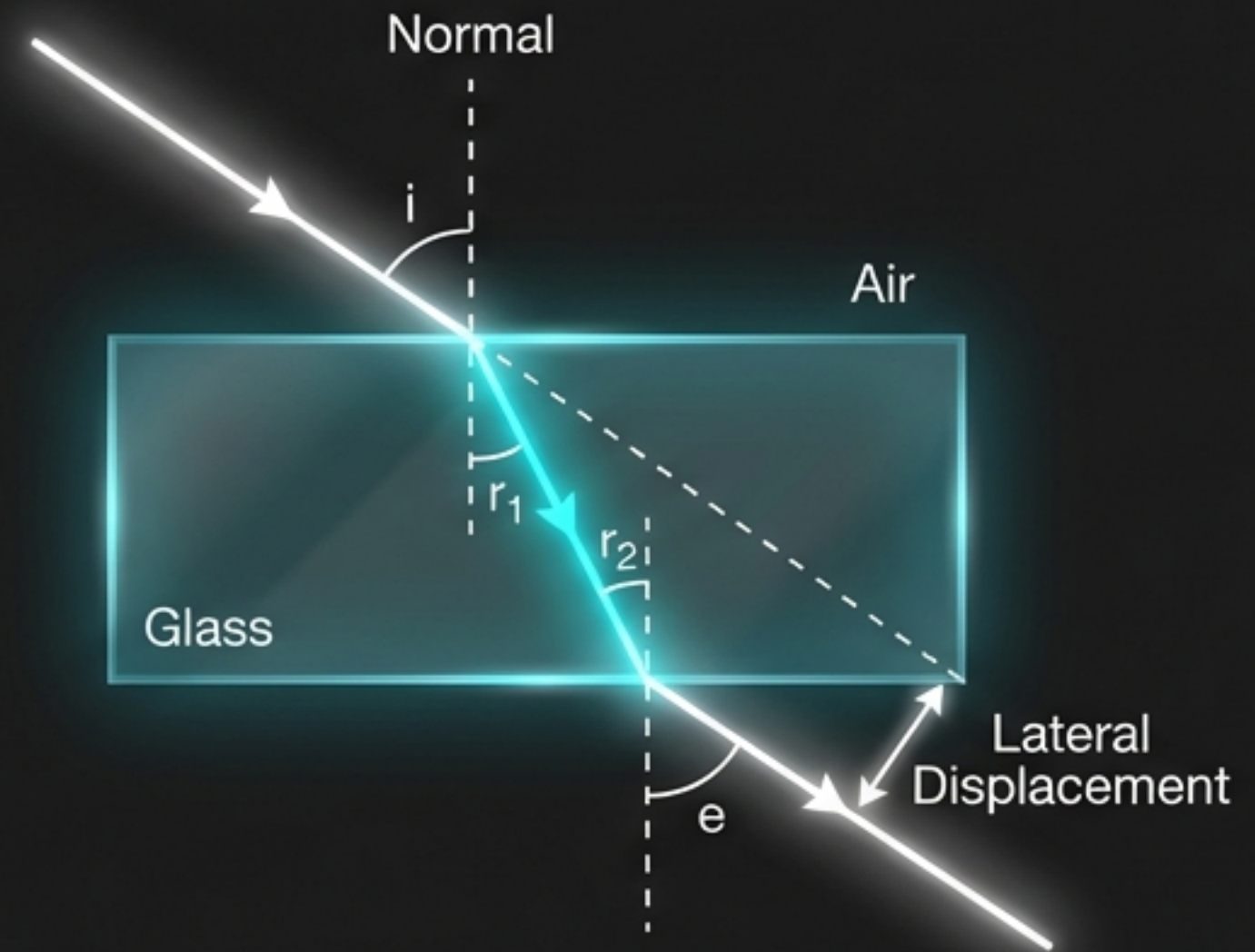
Refractive Index (n):

$$n = \frac{c}{v}$$

(Speed in Vacuum / Speed in Medium)

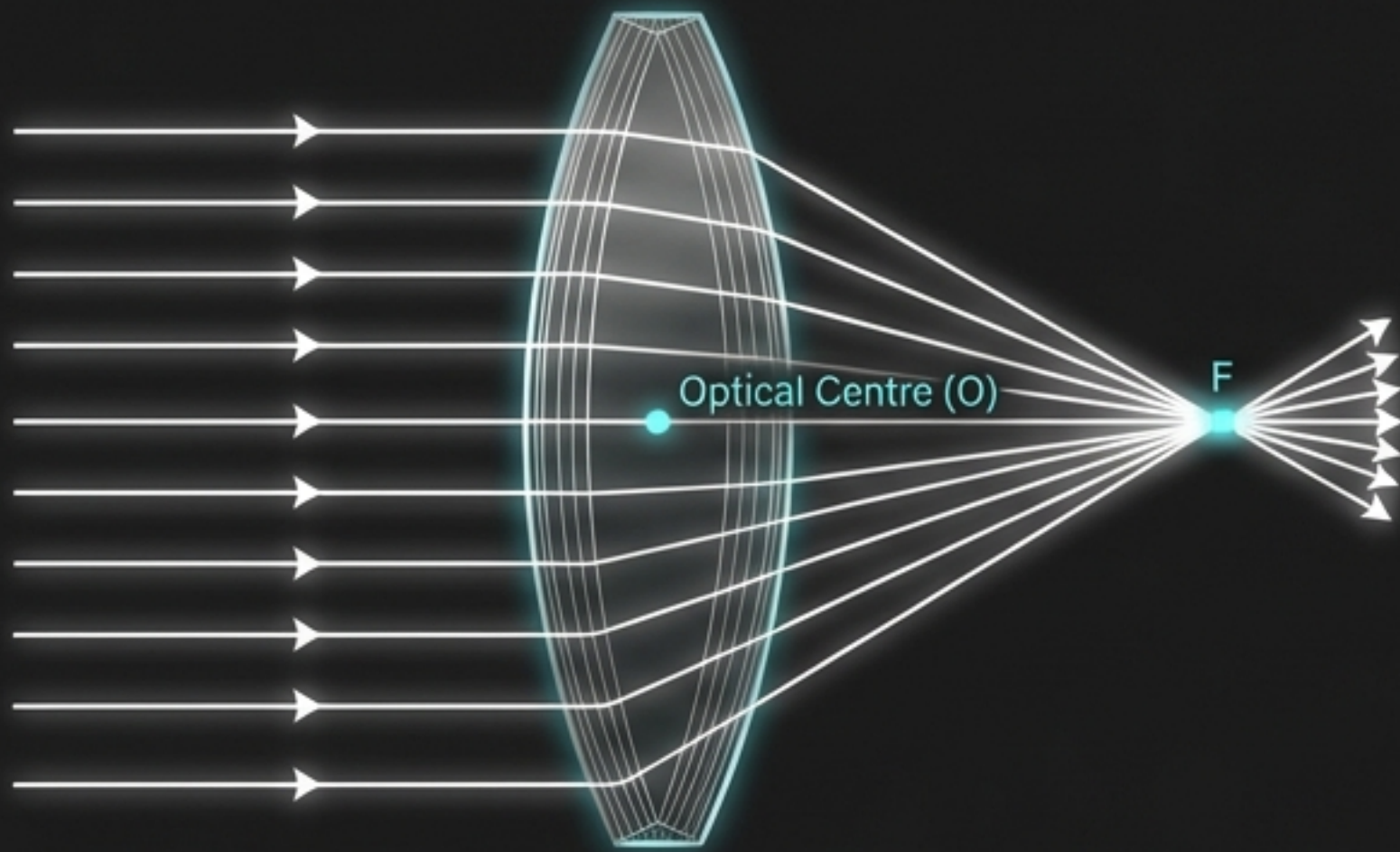
Snell's Law:

$$\frac{\sin i}{\sin r} = \text{constant}$$

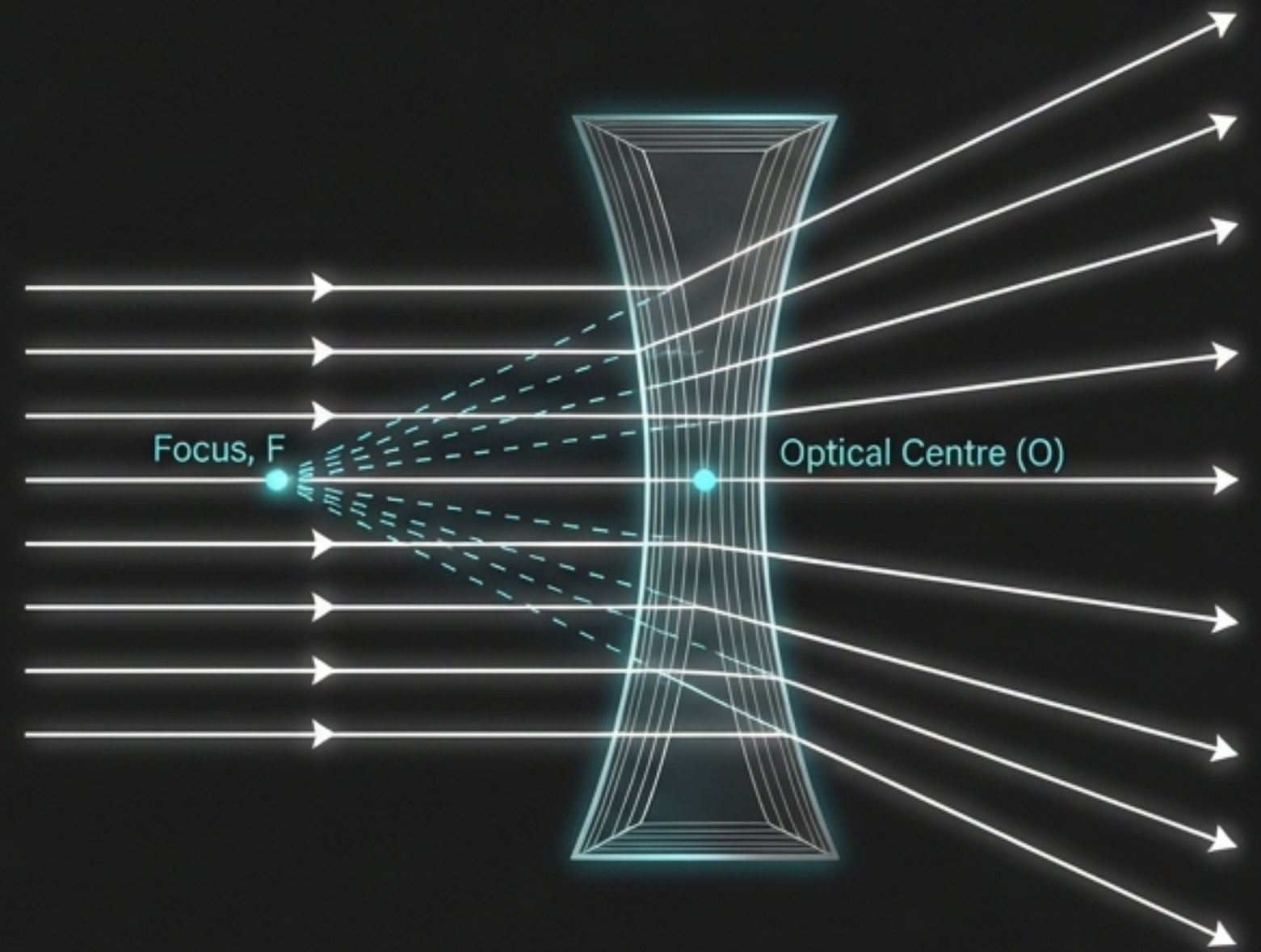


The Architecture of Lenses

Manipulating Transmission through Curvature.



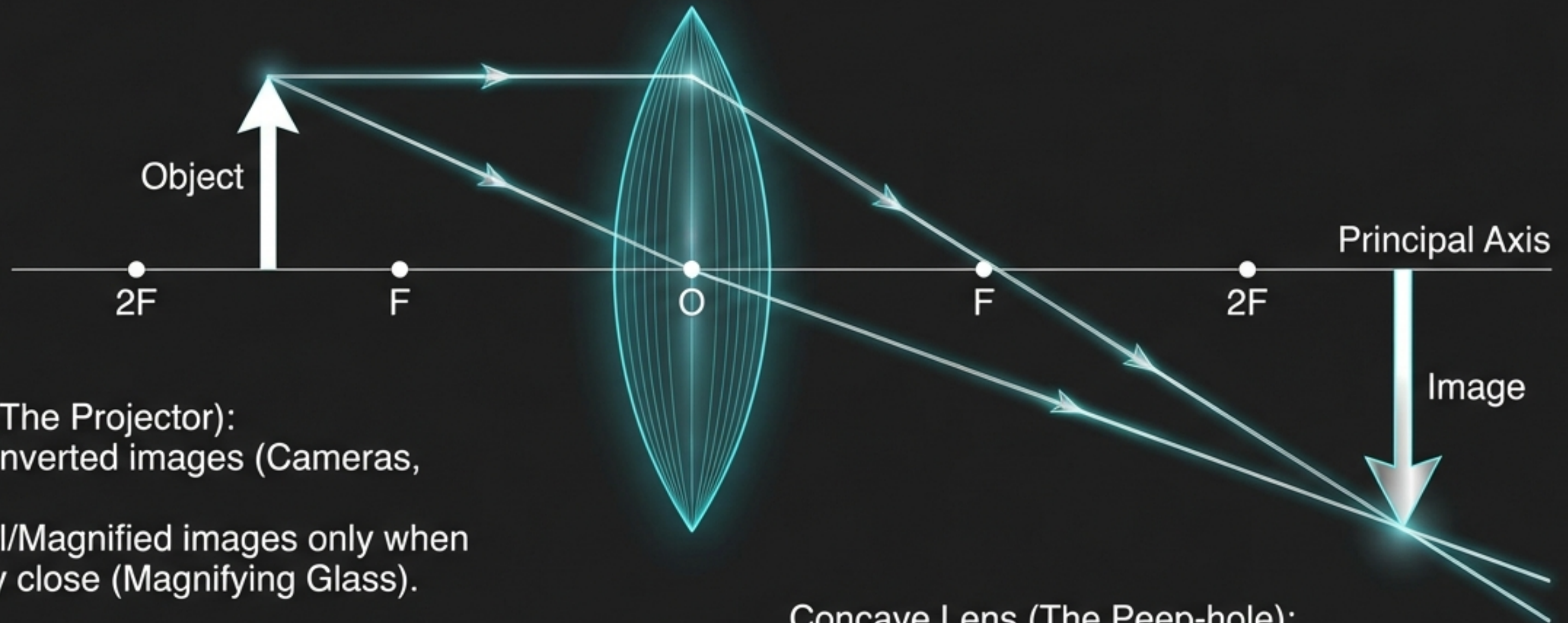
The Convex Lens (Converging): Thicker in the middle. Focuses light. (Optical Symmetry: Behaves like a Concave Mirror).



The Concave Lens (Diverging): Thinner in the middle. Spreads light. (Optical Symmetry: Behaves like a Convex Mirror).

Destiny of the Image

Refraction Ray Diagrams.



Convex Lens (The Projector):

- Forms Real/Inverted images (Cameras, Projectors).
- Forms Virtual/Magnified images only when object is very close (Magnifying Glass).

The Rule of Center:

Rays passing through the Optical Centre (O) emerge undeviated.

Concave Lens (The Peep-hole):

- Always Virtual.
- Always Erect.
- Always Diminished.

The Language of Lenses

Formula, Magnification, and Power.

The Lens
Formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

(Highlight the minus sign in Cyan to distinguish it from the mirror formula).

Magnification
(m):

$$m = \frac{v}{u}$$

(Highlight that this is positive, unlike the negative mirror magnification).

Power of a
Lens (P):

$$P = \frac{1}{f}$$

(where f is in meters)

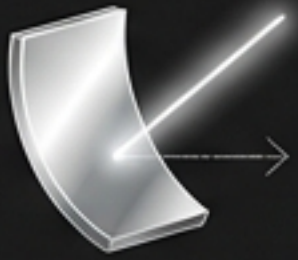
Unit: Diopetre (D)

Example: +2.0D = Convex

Example: +2.0D = Convex | -2.5D = Concave

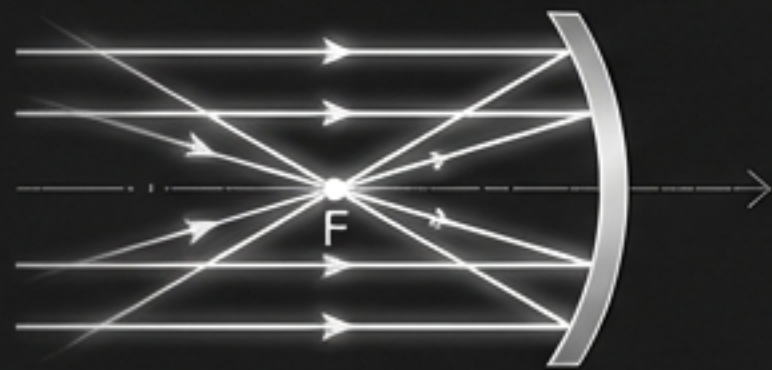
The Great Symmetry

Two Ways to Manipulate Light. One Unified Physics.



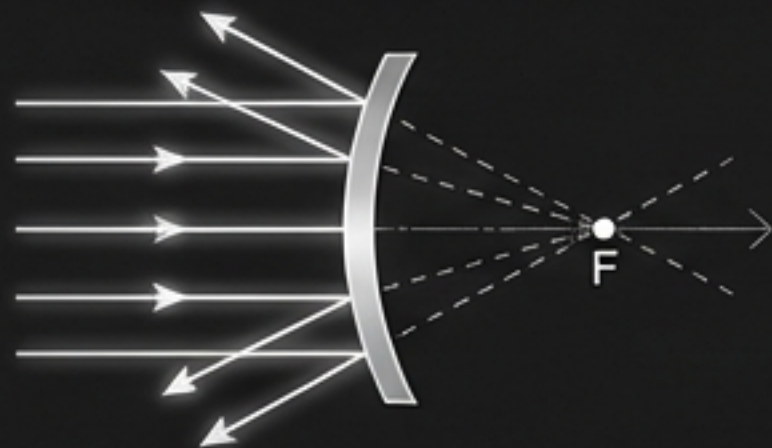
REFLECTION
(Mirrors)

Converger: Concave Mirror



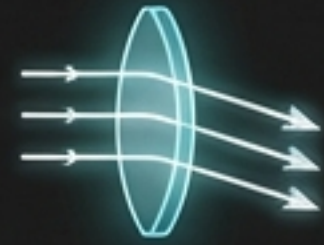
$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

Diverger: Convex Mirror

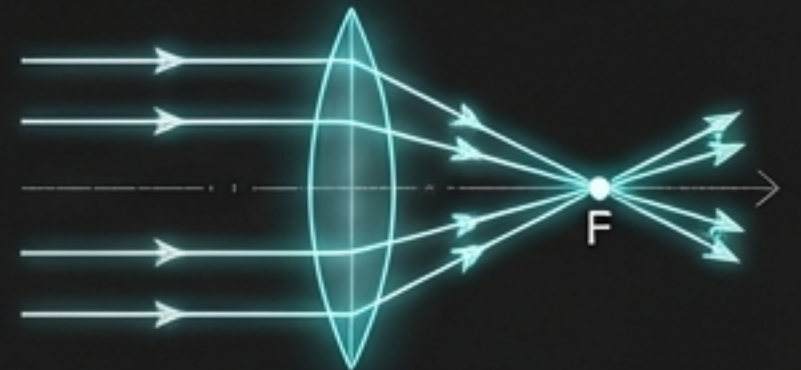


$$\text{Mag: } -\frac{v}{u}$$

REFRACTION
(Lenses)

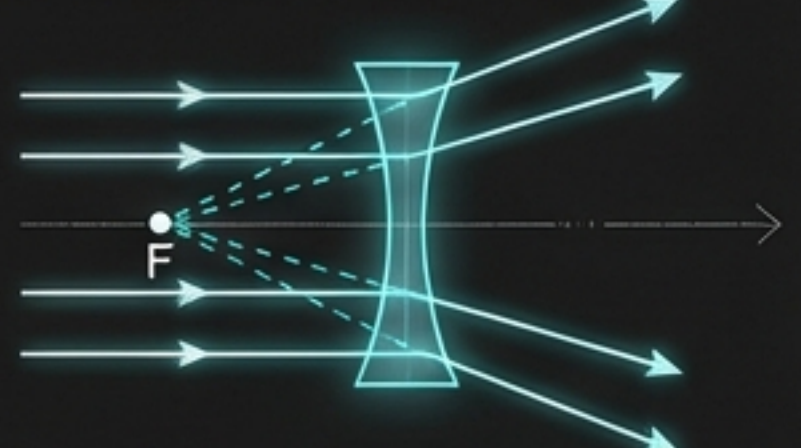


Converger: Convex Lens



$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Diverger: Concave Lens



$$\text{Mag: } +\frac{v}{u}$$

From the human eye to the telescope,
these geometric rules unlock the universe.