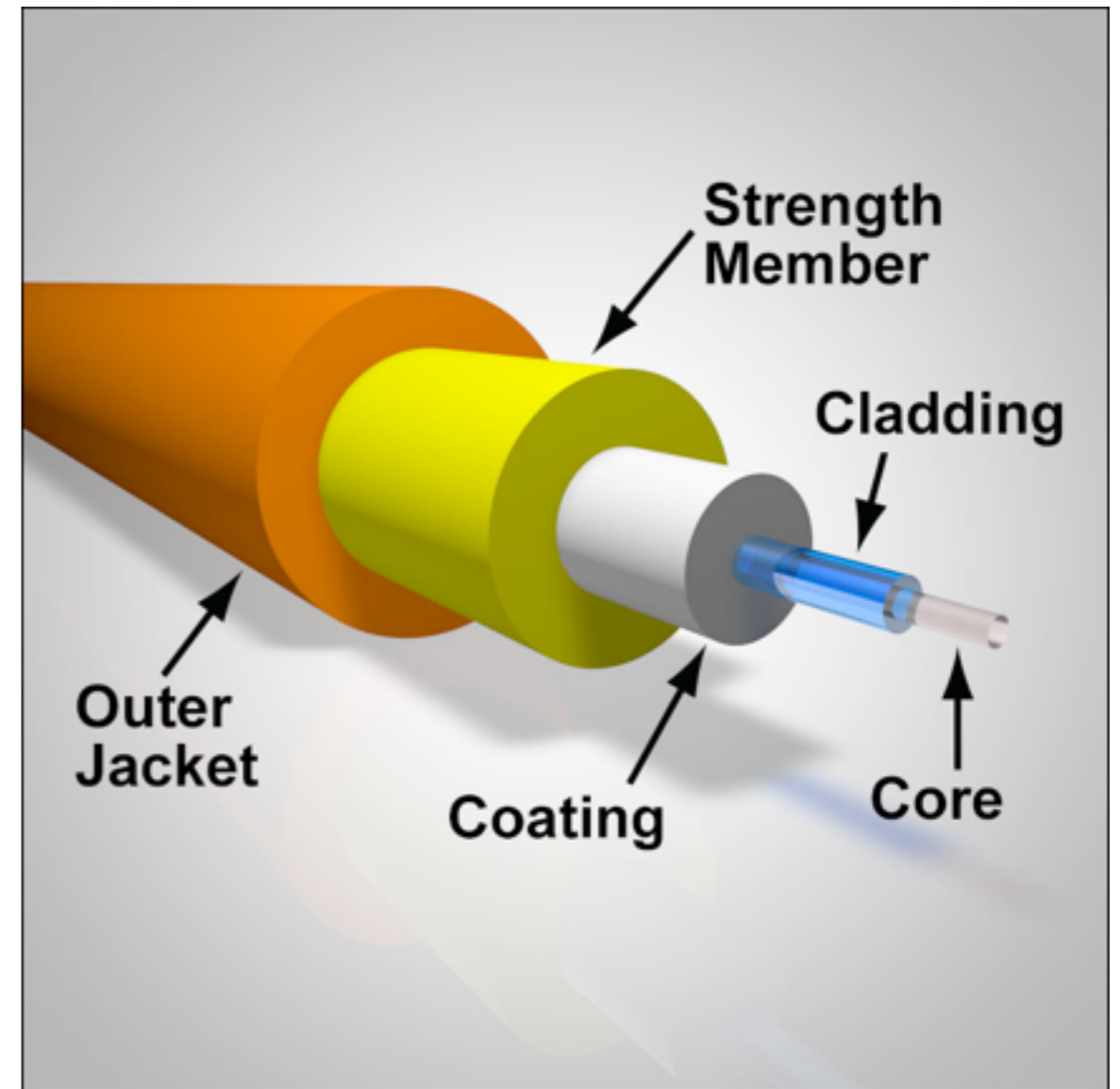
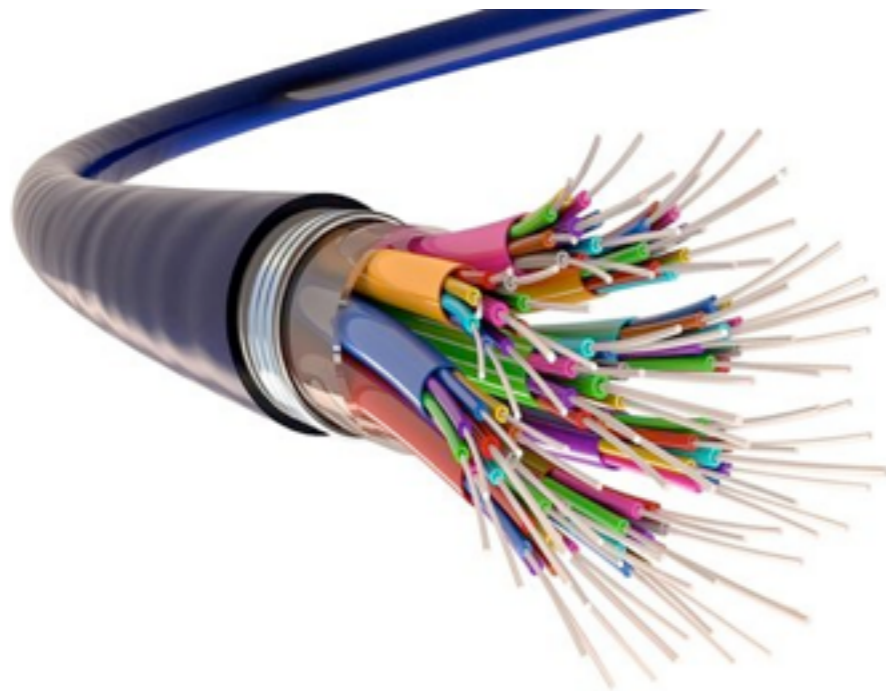


Fibre optics and optical communication

Jimmy Sebastian

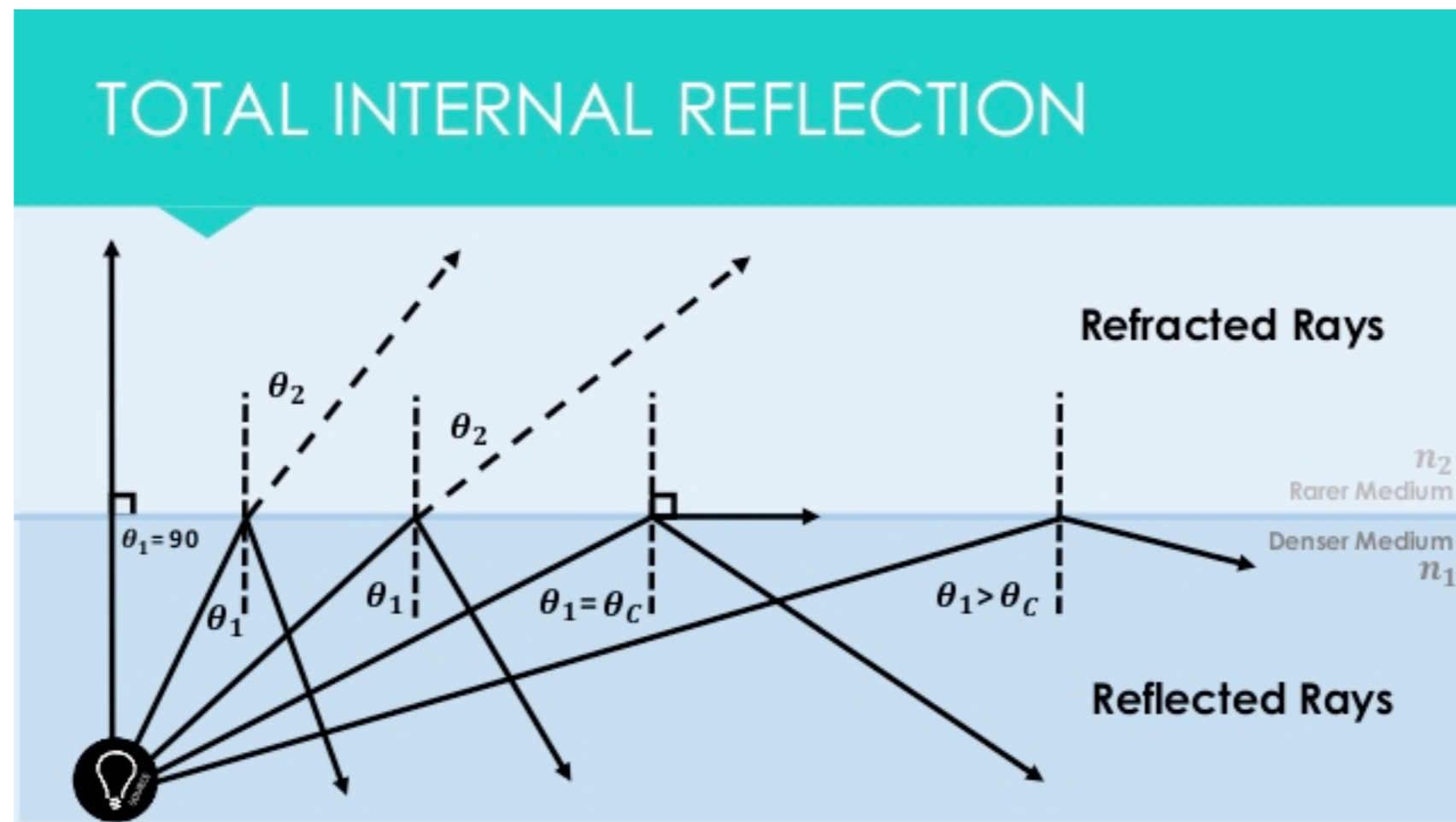
Optical fibre



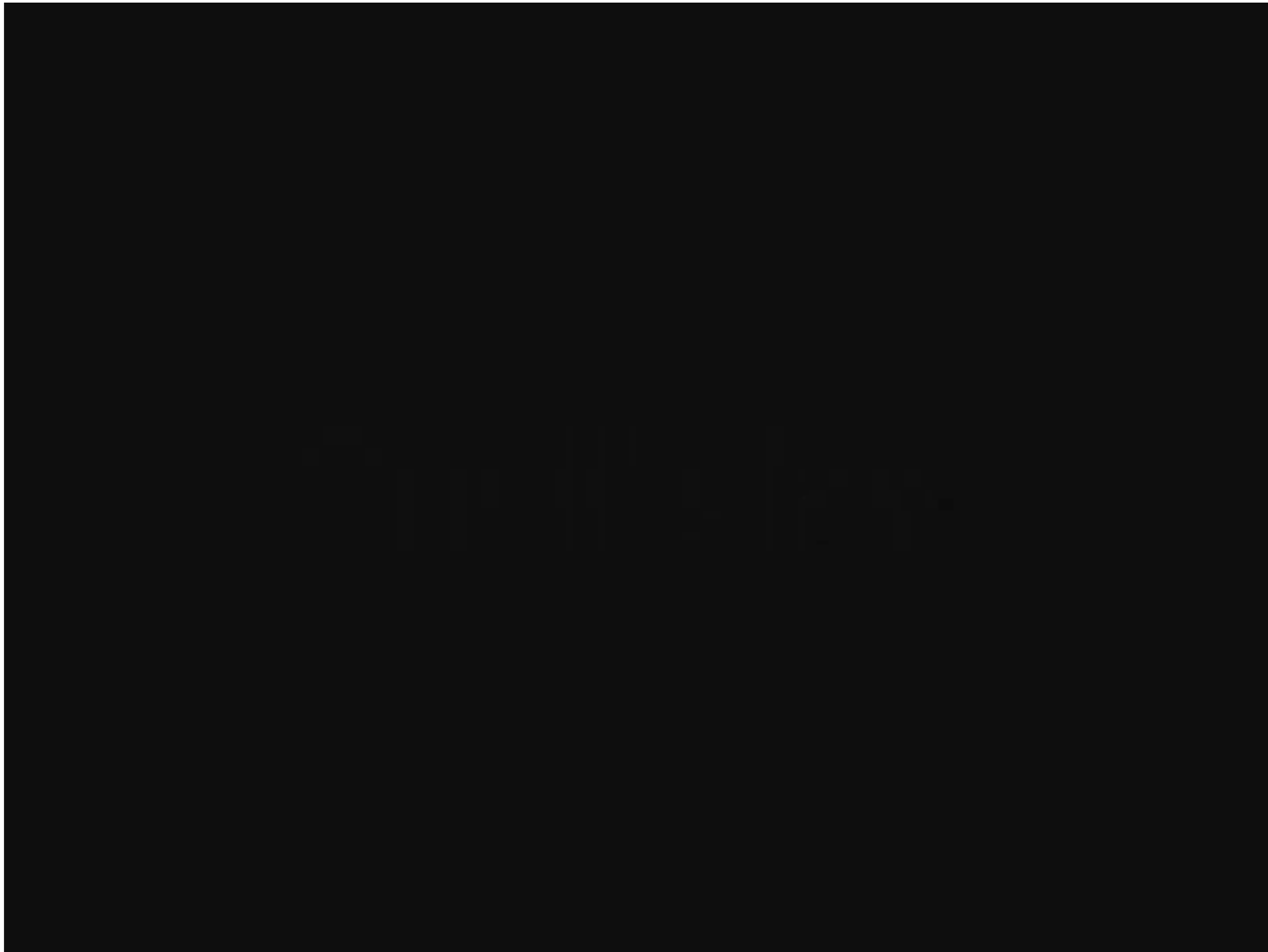
Optical fibre

- The diameter of the core of the optical fiber is small (8.5 micrometer to 62.5 micrometer)
- It is surrounded by coaxial middle region called cladding. The diameter of cladding is of the order of 125 micrometers
- The refractive index of cladding is always lower than the core.
- The core carries the light, cladding helps to confine the light to the core and the buffer coating surrounding the cladding protects the fiber from physical damage.

Principle



Total internal reflection

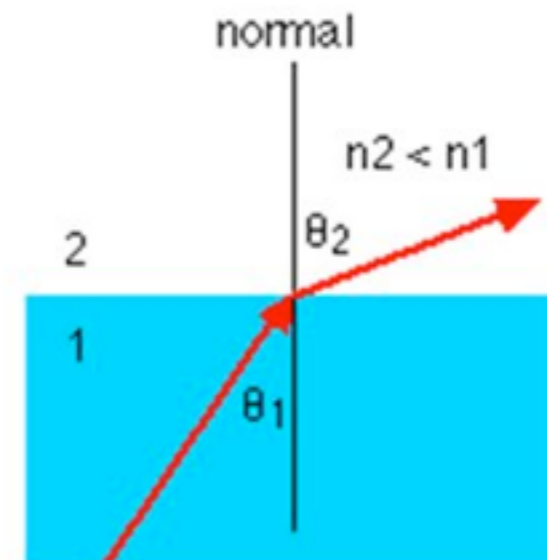
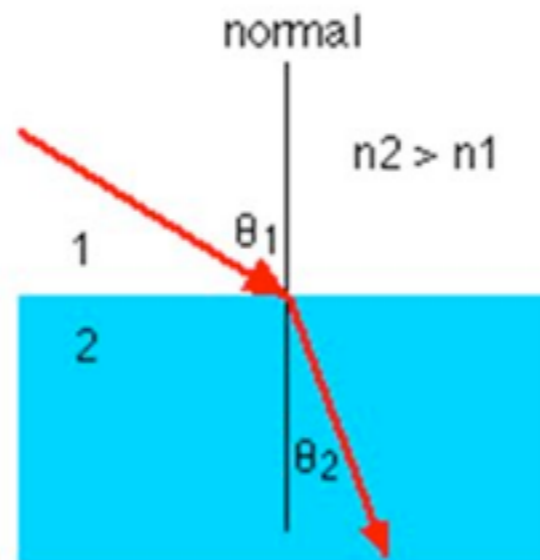
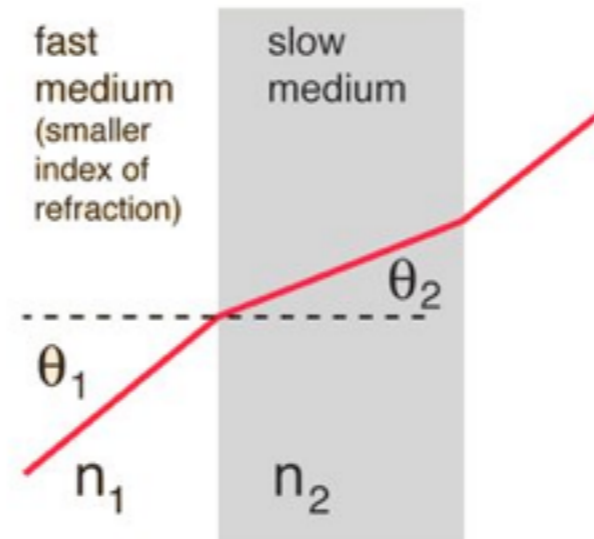


Light propagation

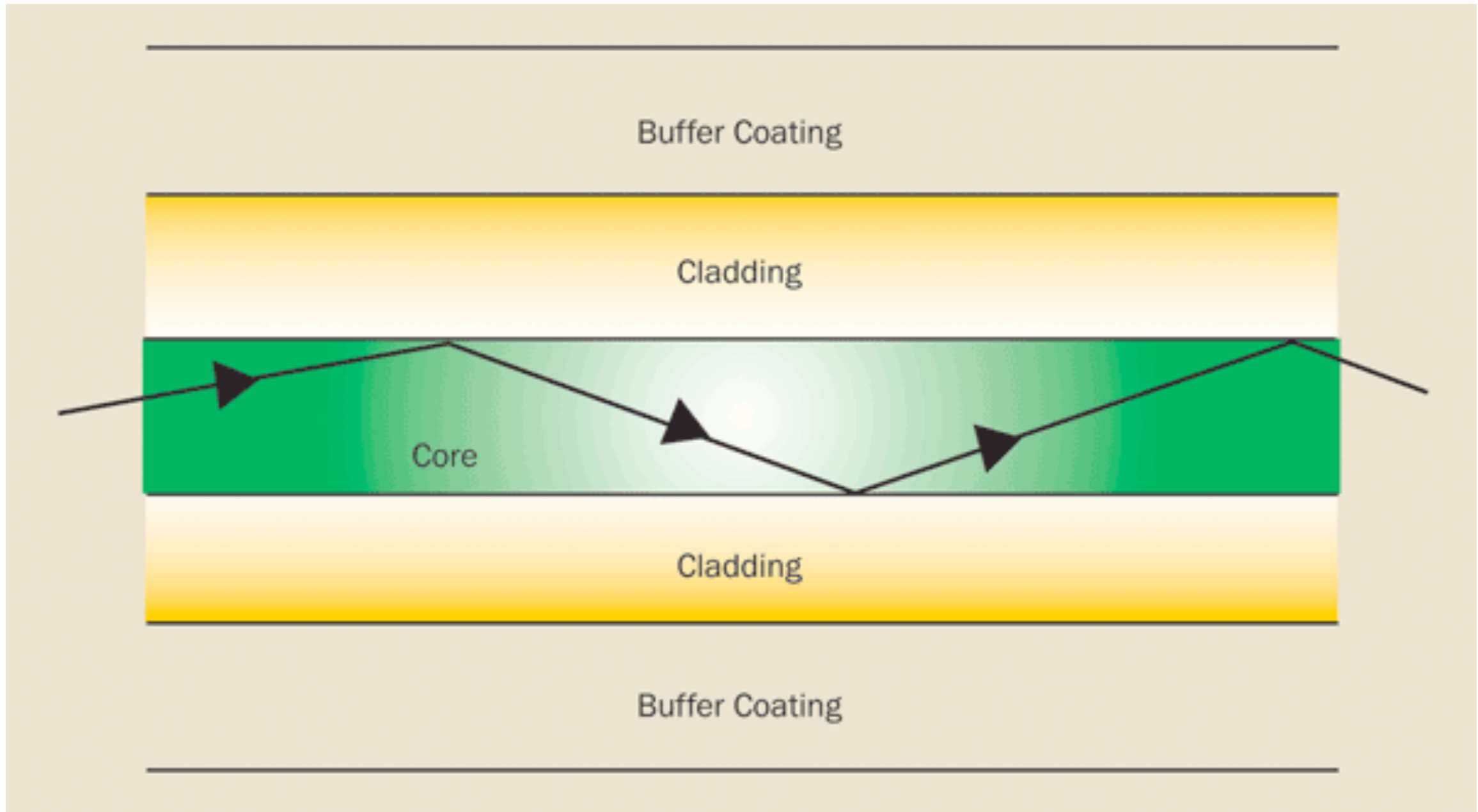
Recall: Snell's Law

Snell's Law

$$\frac{n_1}{n_2} = \frac{\sin \theta_2}{\sin \theta_1}$$



Principle



Propagation of light

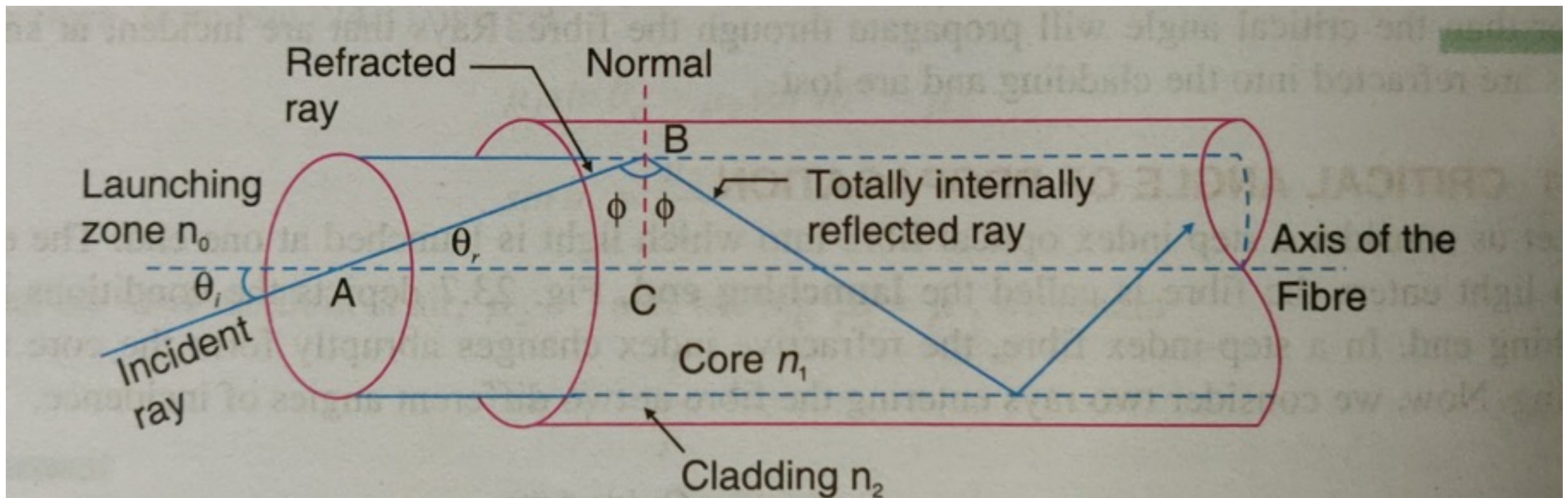


Fig. 24.8 : Geometry for the calculation of acceptance angle of the fibre.

Fig. 24.8 : Geometry for the calculation of acceptance angle of the fibre.

Cladding n_2

Acceptance Angle

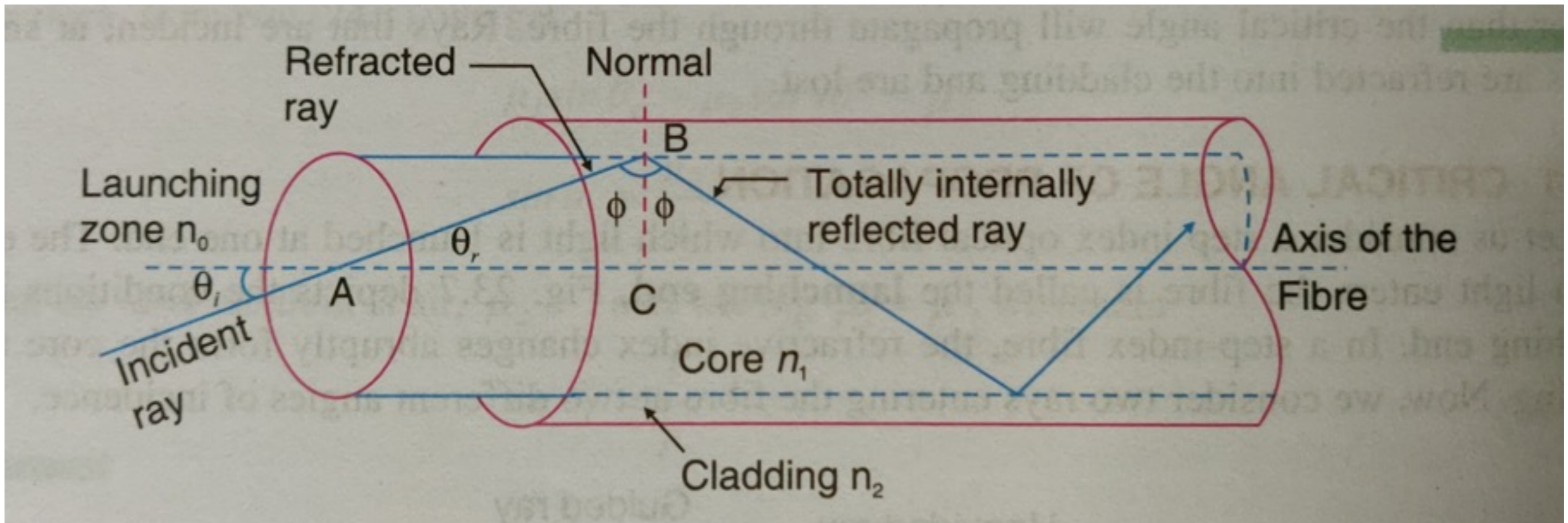
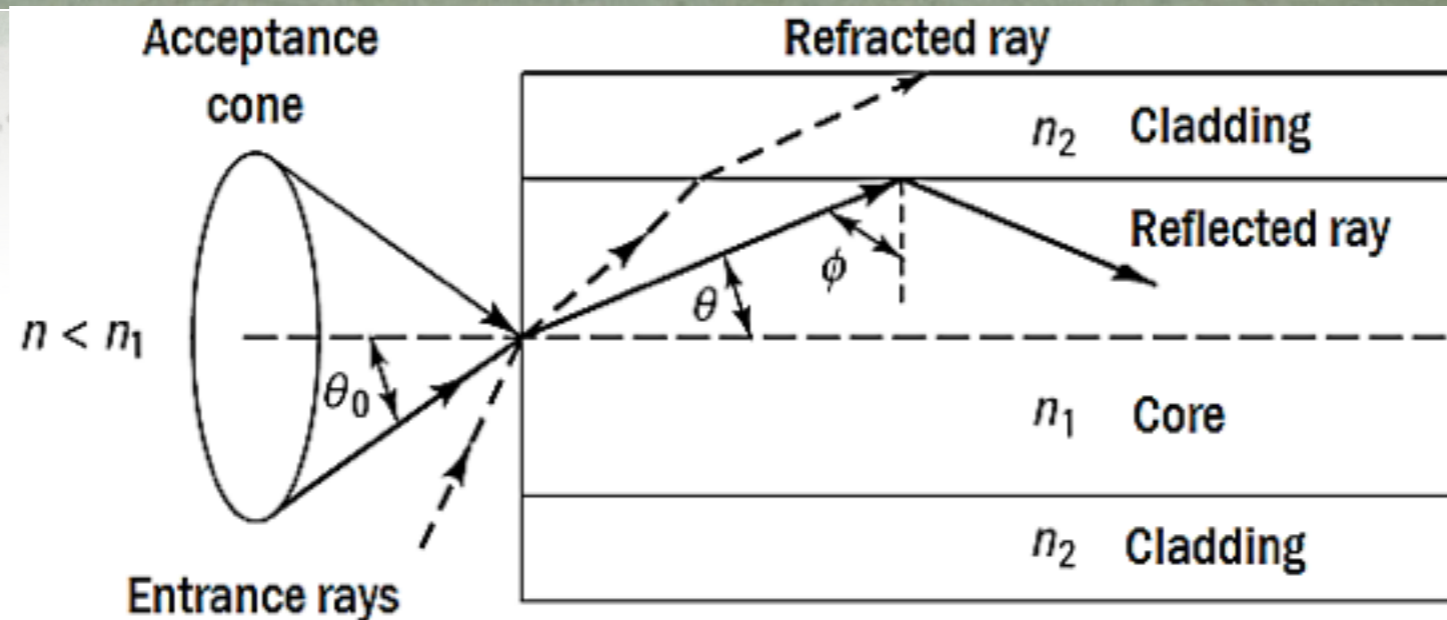
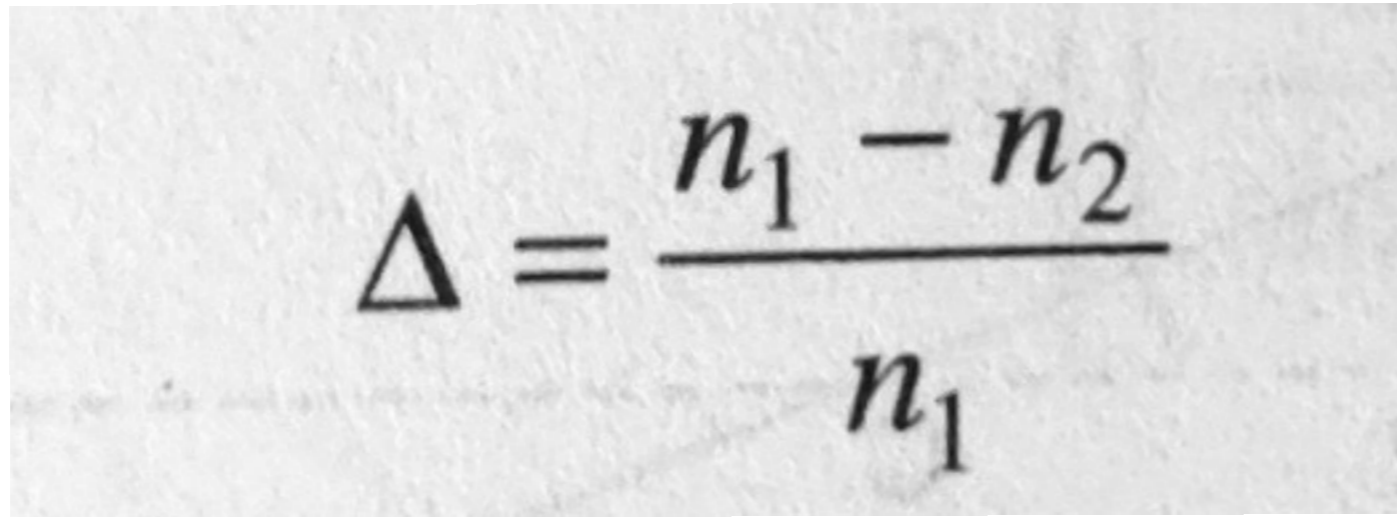


Fig. 24.8 : Geometry for the calculation of acceptance angle of the fibre.



Fractional refractive index change

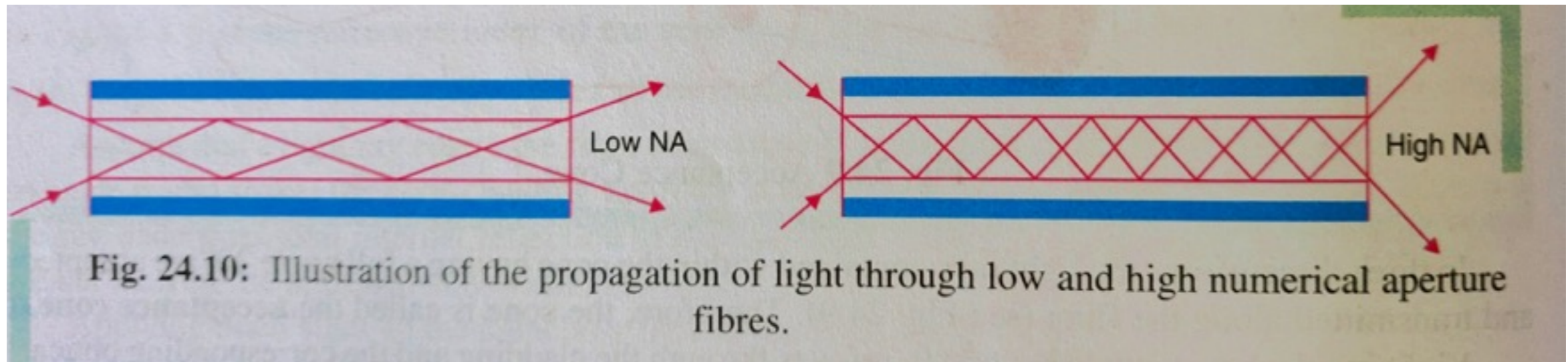

$$\Delta = \frac{n_1 - n_2}{n_1}$$

The fractional difference between the refractive indices of the core and the cladding is known as fractional refractive index change.

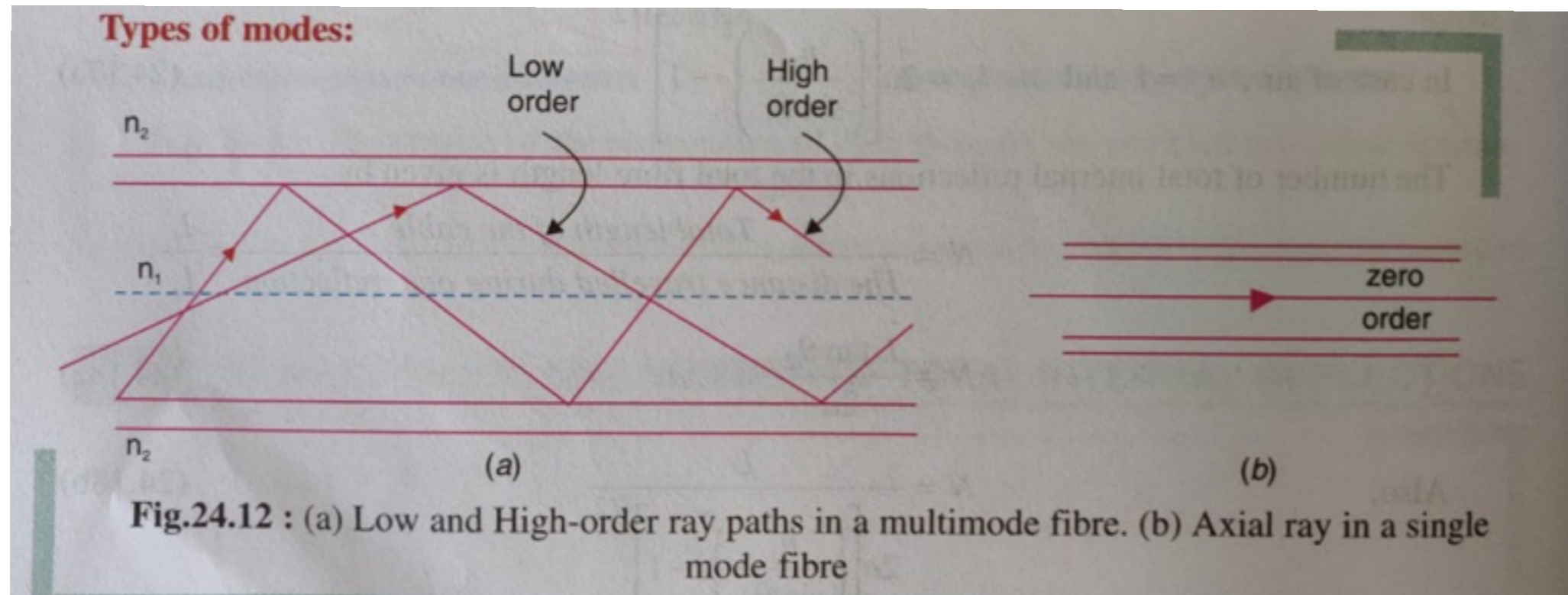
Since n_1 is always greater than n_2 the parameter is always positive.

Its value is of the order of 0.01.

Numerical aperture



Modes of propagation

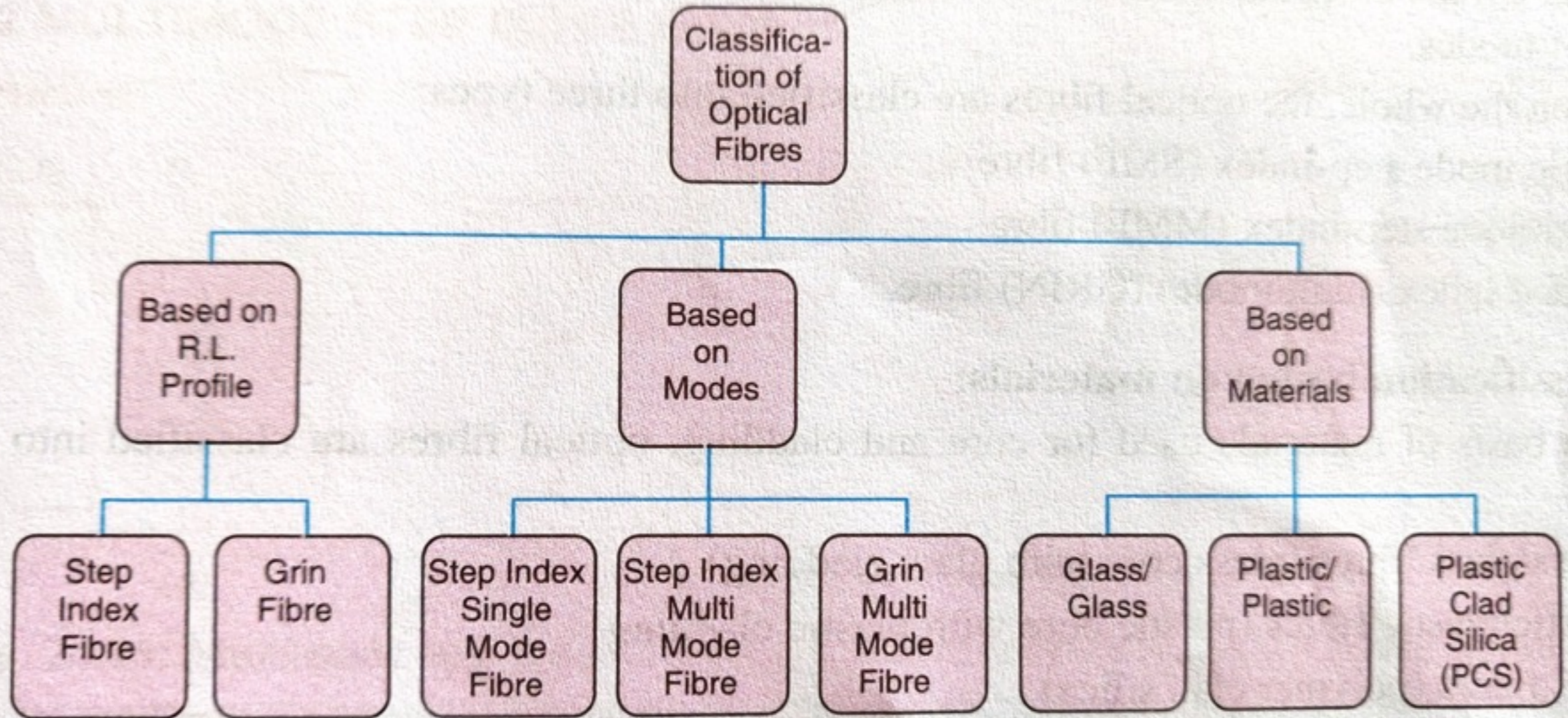


Higher order modes: The modes that propagate at angles close to the critical angle.

Lower order modes: The modes that propagate with angles larger than the critical angle that is lower than the critical propagation angle.

Classification

Classification



Classification-refractive index

1. Step index fibres and 2. Graded index (GRIN) fibres.

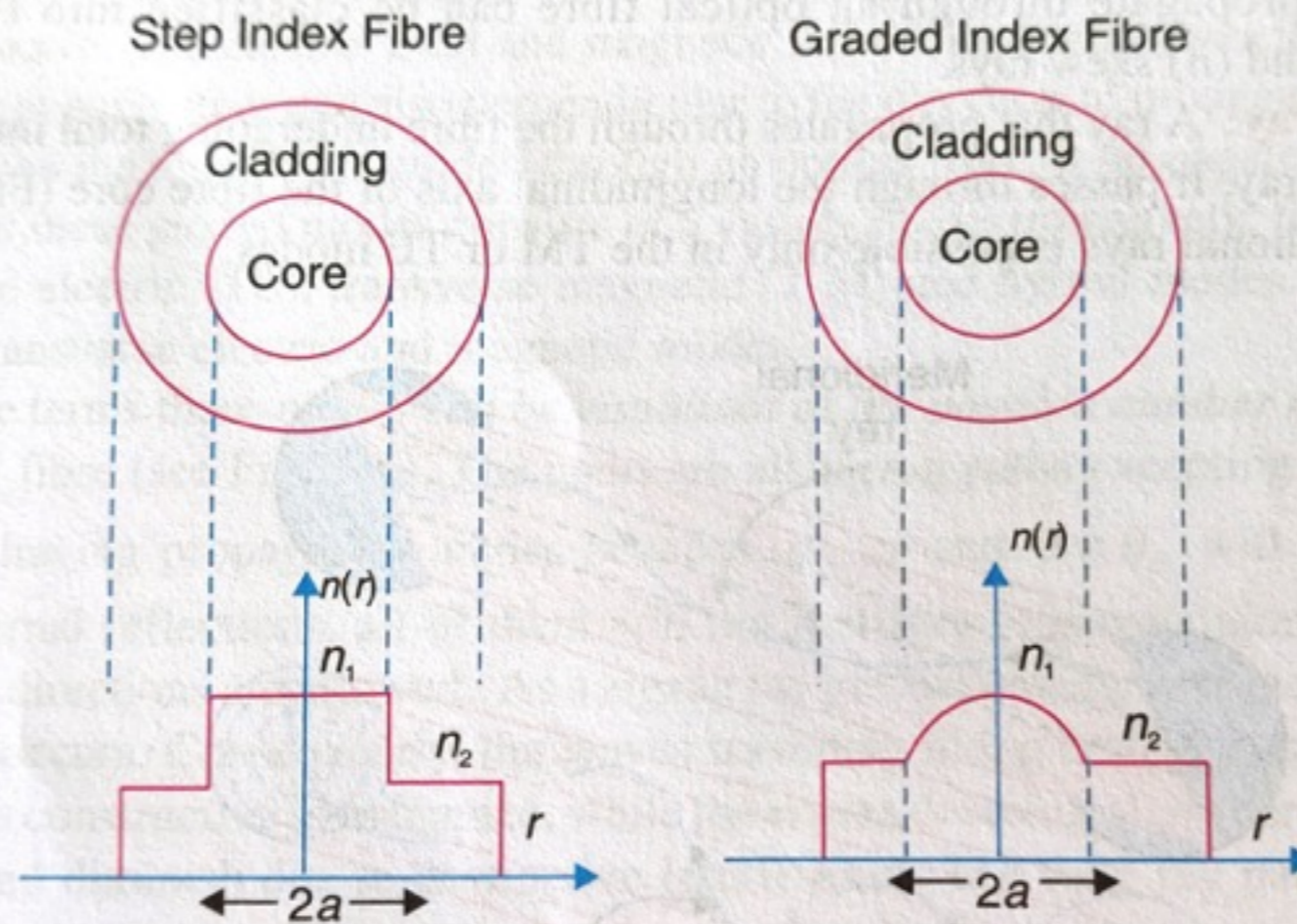
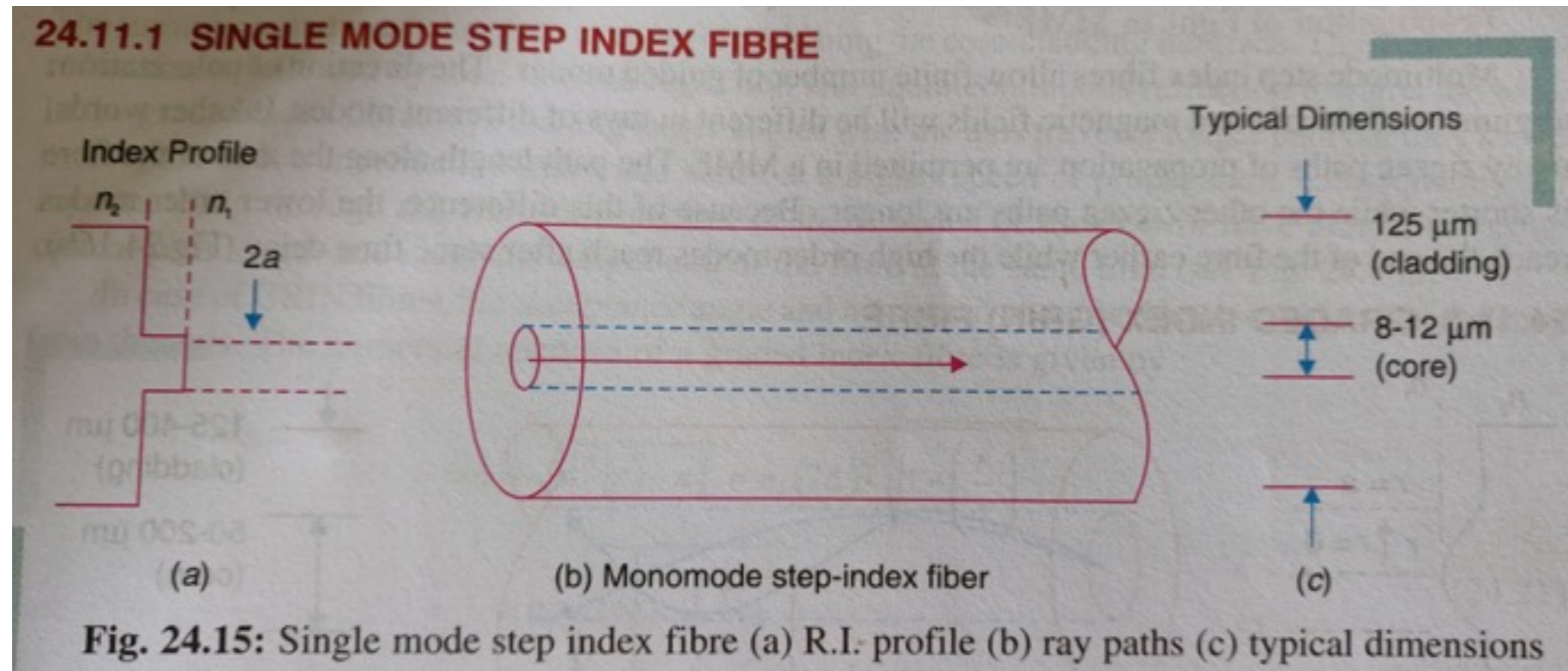


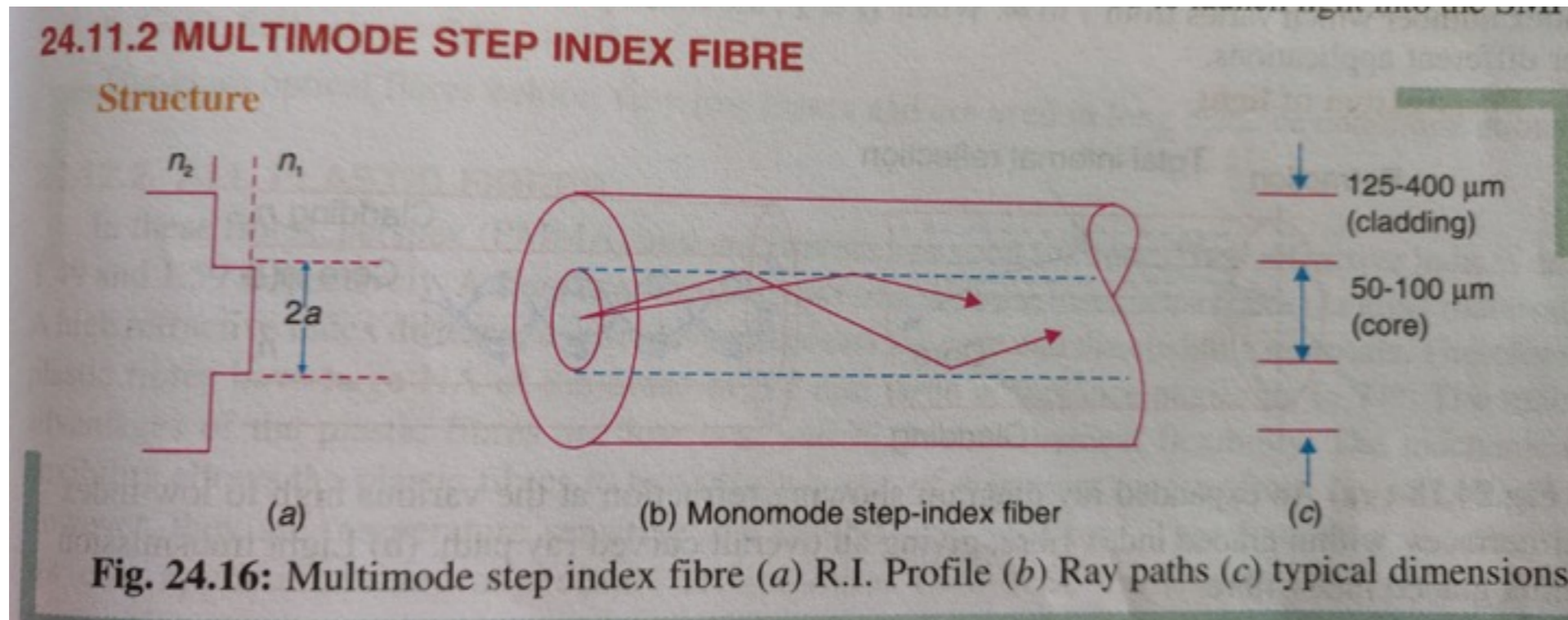
Fig. 24.14 : Classification of optical fibres based on R.I. profile (a) Step index fibre (b) GRIN fibre

Classification - modes of light



Single mode fibre: It has a smaller core diameter and can support only one mode of propagation

Classification - modes of light



Multi mode fibre: It has a larger core diameter and supports a number of modes.

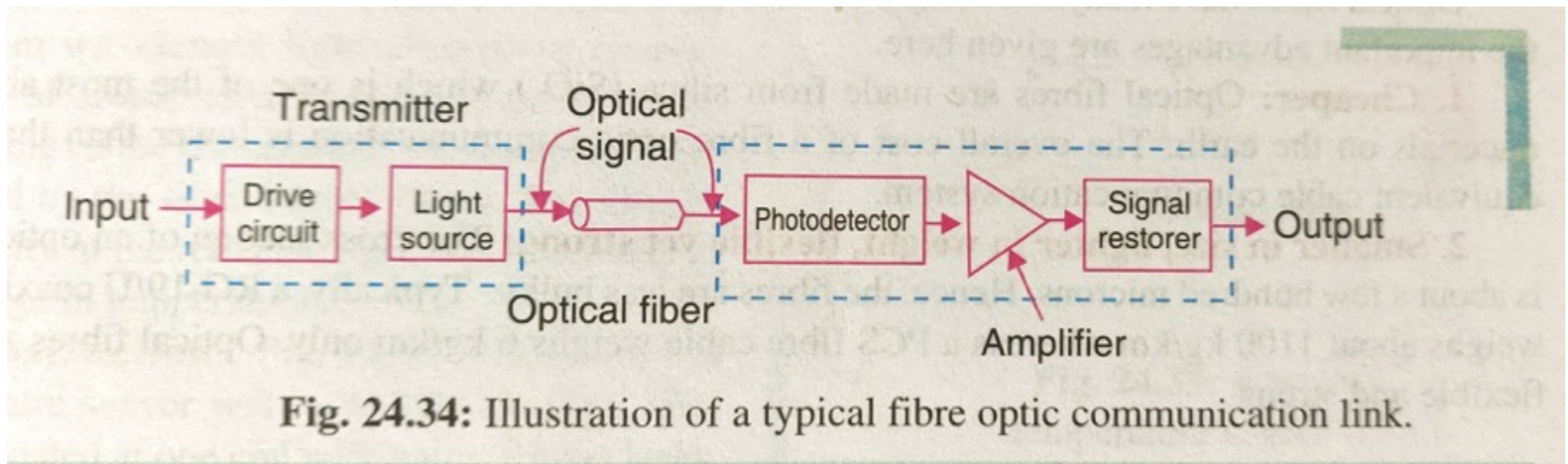
Classification - material of fiber

- **Glass fibre (glass core with Glass cladding)**
- **Plastic fibres(Plastic core with pastic cladding)**
- **PCS fiber (plymer clad silica)**

Application of optical fibres

- **Illumination and Image transmission (endoscopes)**
- **Optical communications (replace copper with OF)**
- **military application (replace copper with OF)**

Fibre Optic Communication system

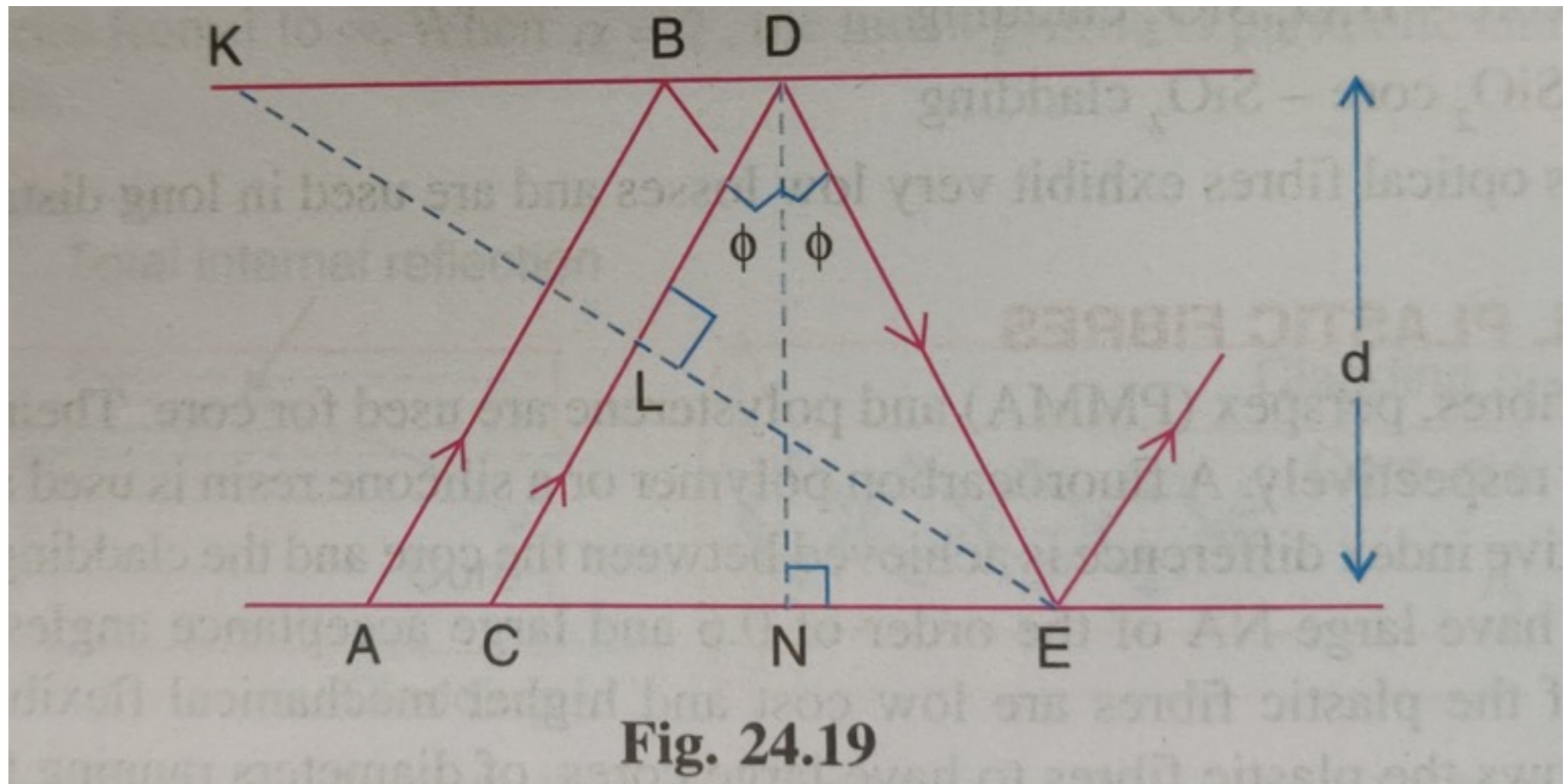


- Transmitter converts electrical signal to light signals (850, 1300, 1550nm)
- Optical fibre transmits the signal
- Receiver captures the signals at the other end.
- A pulse of light corresponds to 1 and absence 0
- In between transmitter and receiver repeaters are needed to regenerate the signals.
- At the receiver end light signals received by photodetector, amplified and converted to electrical signal.

Merits of optical fibre

- **Cheaper (SiO₂)**
- **Smaller in size, lighter in weight, flexible and strong**
- **Non Hazardous (no short circuit)**
- **Immune to EMI and RFI**
- **No cross talk (less noise)**
- **Wider bandwidth(for telephone one cables)**
900 pairs of wire 10,000 calls
1mm OF = 50,000 calls
- **low transmission loss per unit length.**

V-Number (normalized frequency)



- AB and CD are parallel rays in an incident beam.