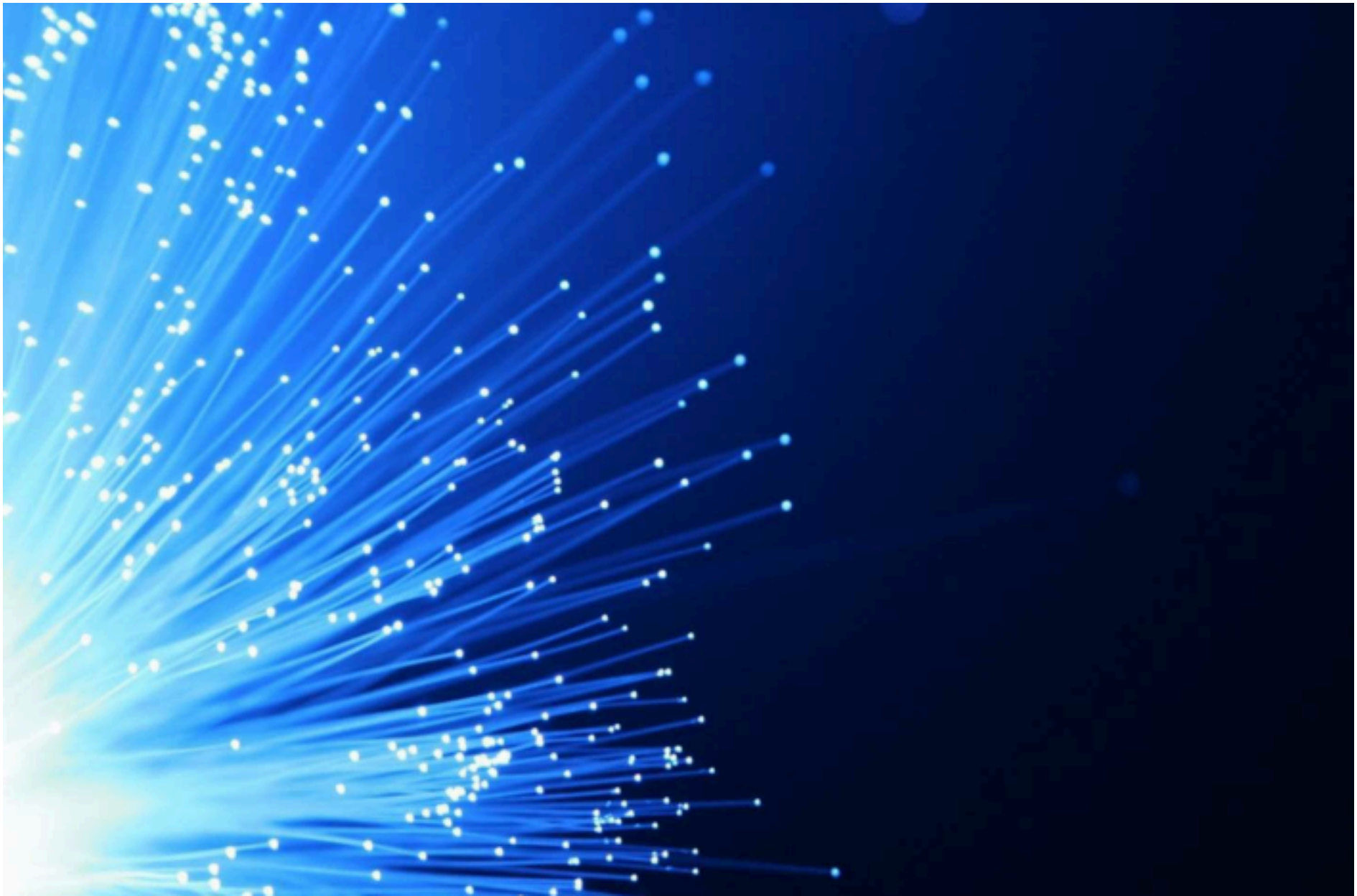


FIBRE OPTICS

Introduction

light

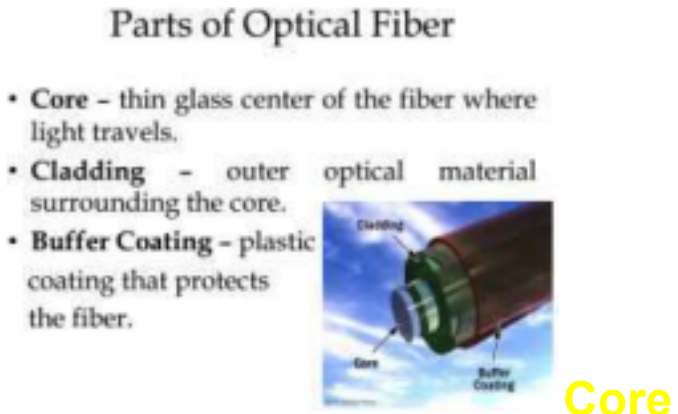
- light
- “Total Internal Reflection”
- in fiber-optic communication

1. **Core**

2. Cladding

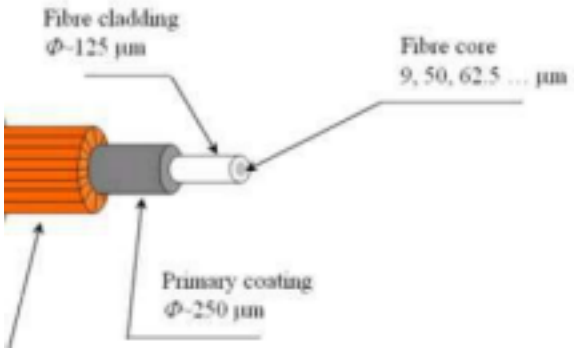
3. Sheath

The range of the core diameter is 5-100 micrometer.
The cladding diameter is usually 125 um and sheath diameter is about 250 um.



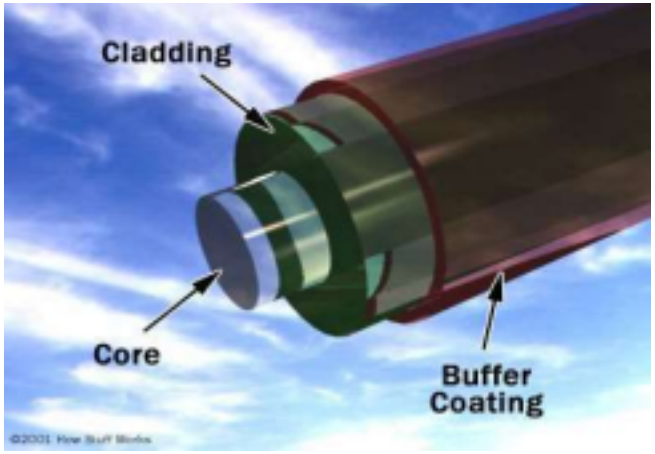
Core

Refractive Index
Is slightly greater than that of Cladding



Optical fibers are very fine fibers of glass. They consist of a glass core, roughly fifty micrometres in diameter, surrounded by a glass "optical cladding" giving an outside diameter of about 125 Micrometres.

Basic Structure



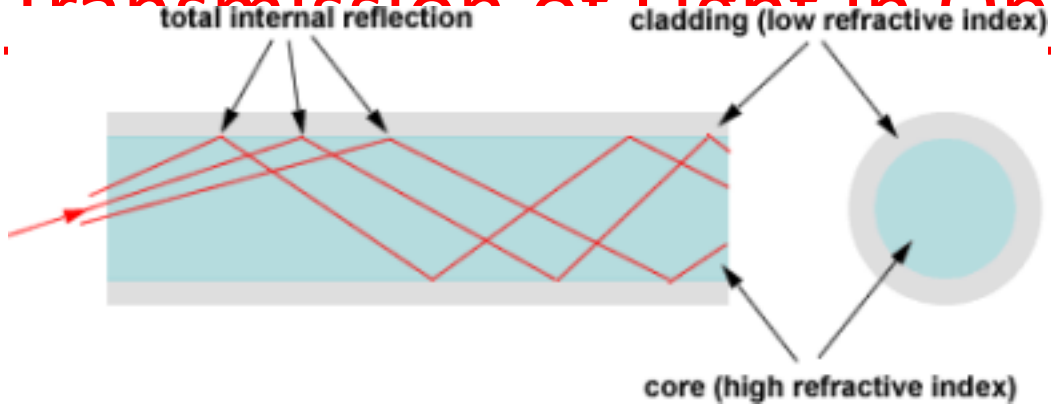
Core

Protective Sheath/Buffer Coating

Jacket

Cladding

Transmission of Light in Optical Fibre

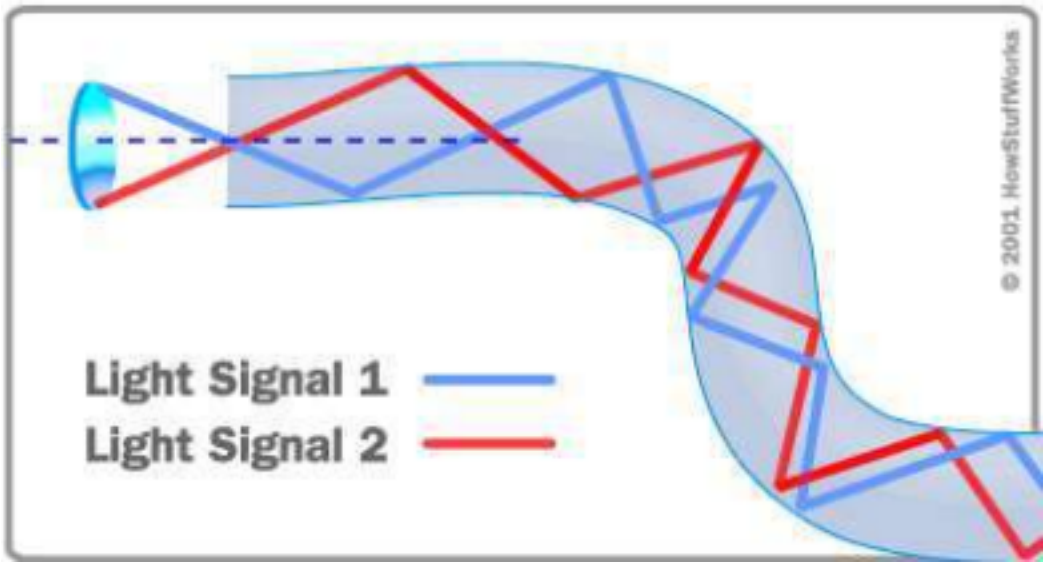


An optical fiber guides light waves in distinct patterns called *modes*.

In case of optical fibre, the refractive index of core (n_1) is

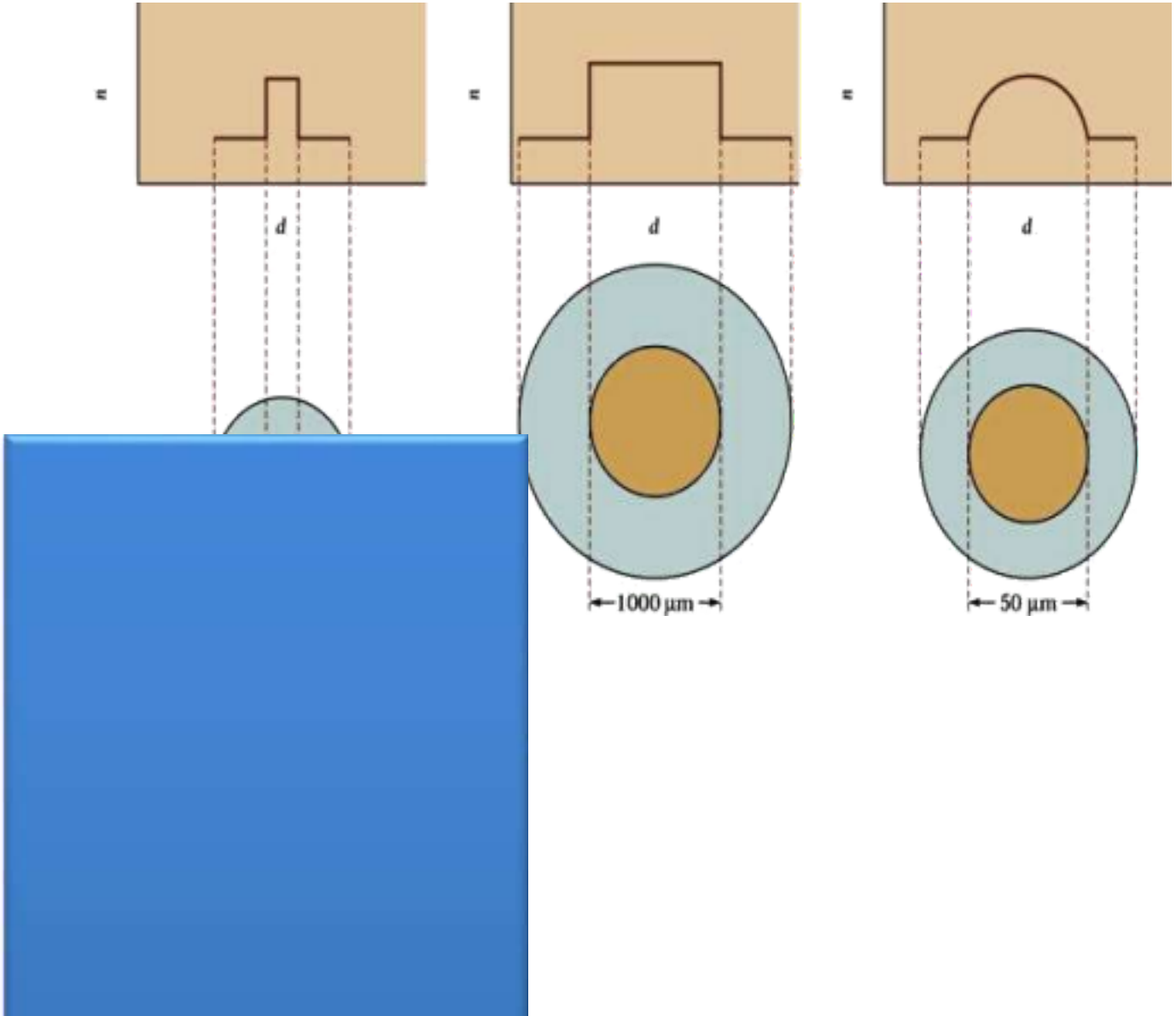
slightly greater than the

refractive index of cladding (n_2). Then light signal is



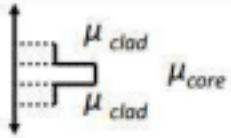
totally internally reflected. As a result, light ray undergoes multiple total internal reflections at core cladding interface until it emerges out

of the other end of the fibre even if the fibre is bent.


n
d
n
d
1000 µm
n
d
50 µm

Single (Mono) Mode :

This is called so because the refractive index of the fibre '**step**' up as we move from the cladding to the core and this type of fibre allows single mode to propagate at a time due to very small diameter of its core.

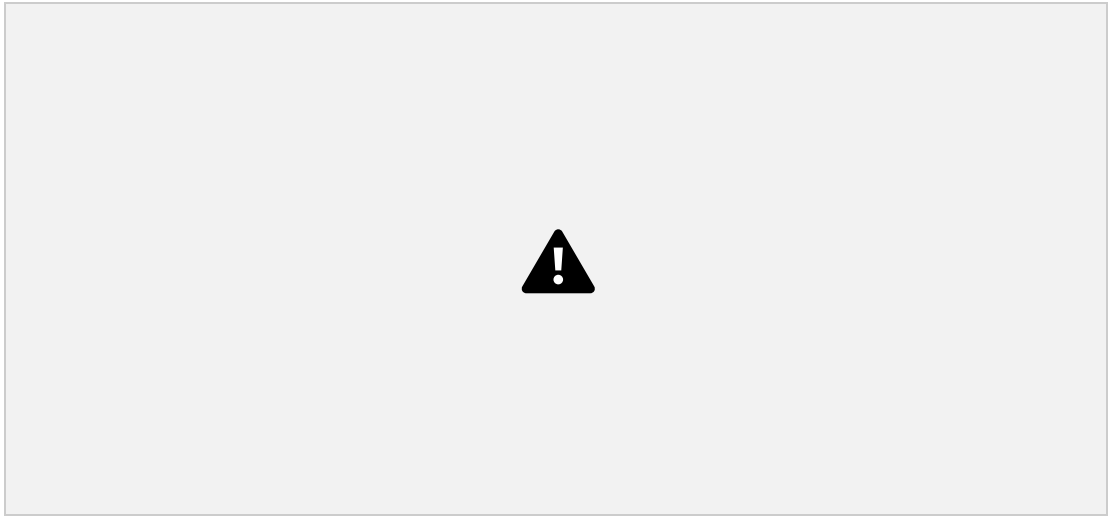


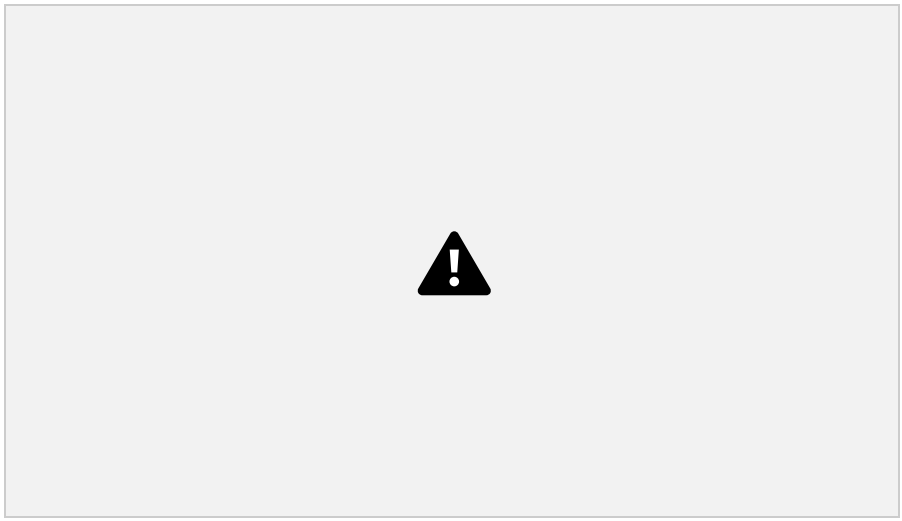
- In this fibre, the refractive indices of the cladding and the core remain constant

- In this fibre, the size of its core (diameter) is typically around 9-10 μm.

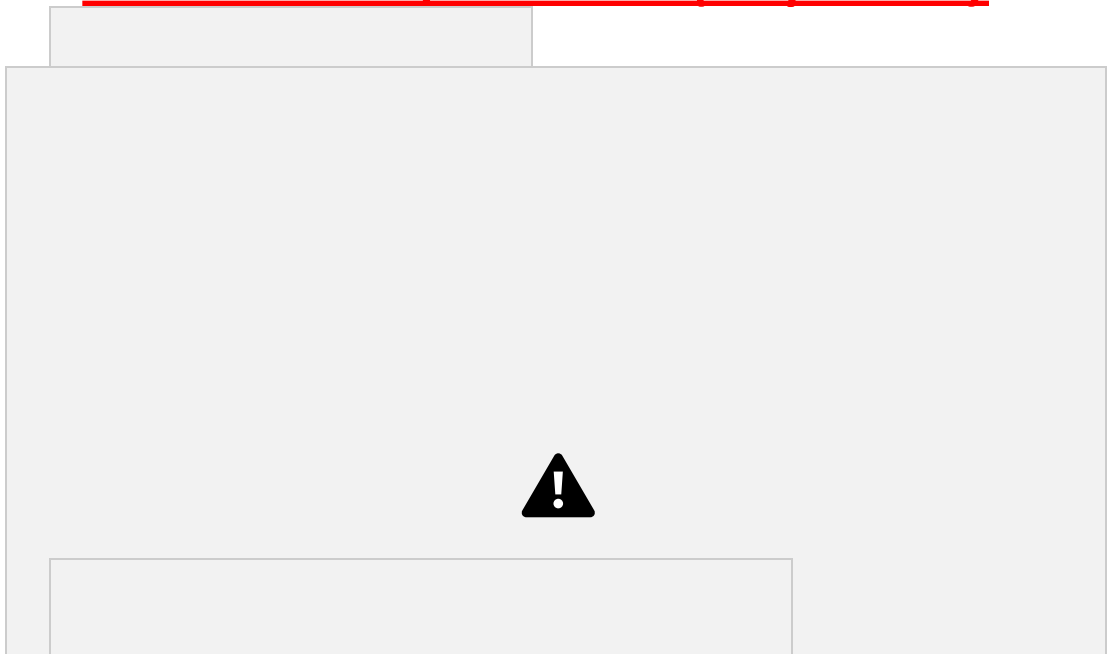
Single-mode
9/125 μm

Allows only one mode of propagation





- ***Multi Mode Optical Fibre(Step-Index)***



❑ Numerical Aperture (NA) varies from 0.20 to 0.29 respectively.

❑ Typically the core diameter is 50 µm to

100 µm

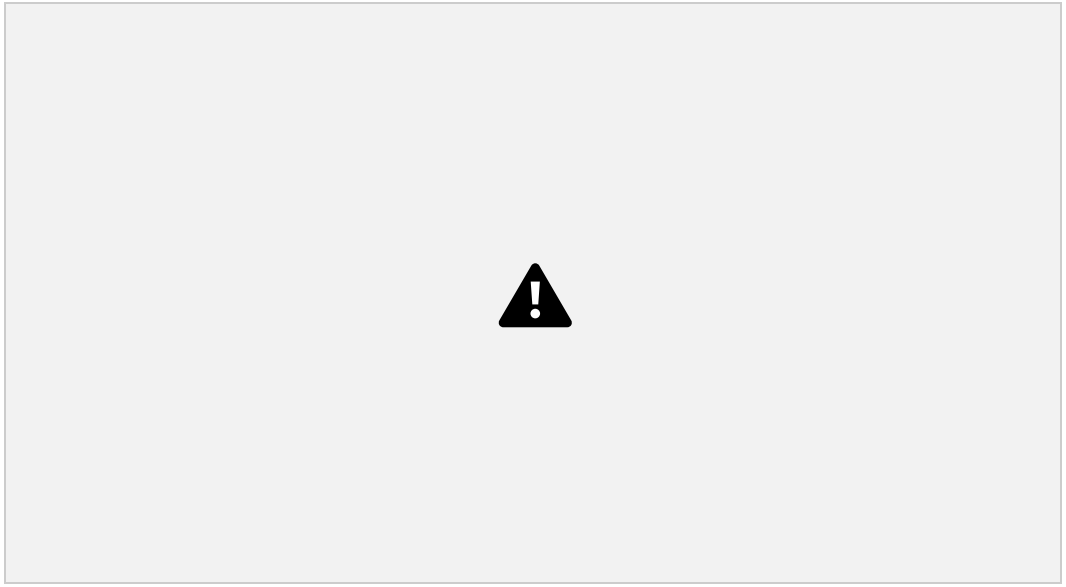
- ❑ Due to higher value of NA , and larger core size in this case, fibre connections and launching of light is very easy
- ❑ Due to several modes, the effect of dispersion gets increased, i.e. the modes arrive at the fibre end slightly different times and so spreading of pulses takes place.

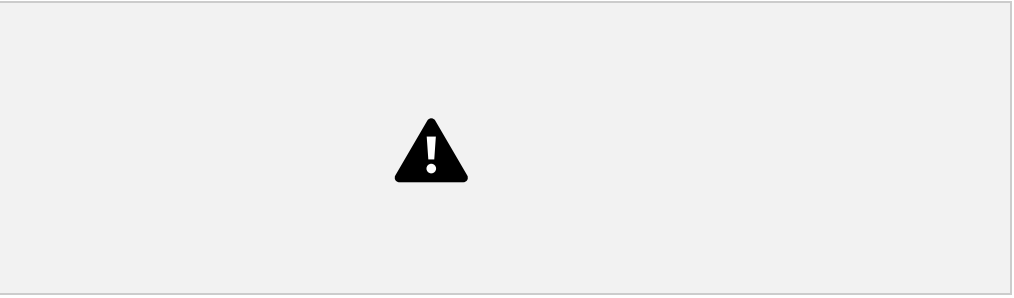
Graded index Multimode Fibre

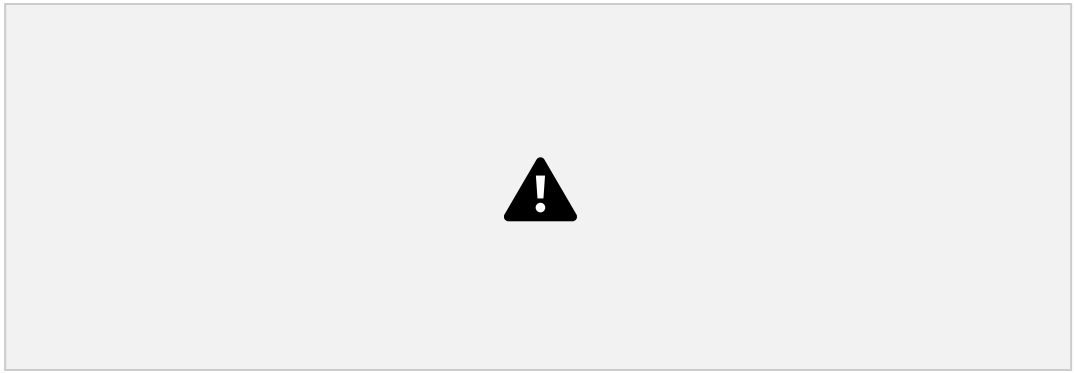
The profile of the refractive index is nearly parabolic that results in

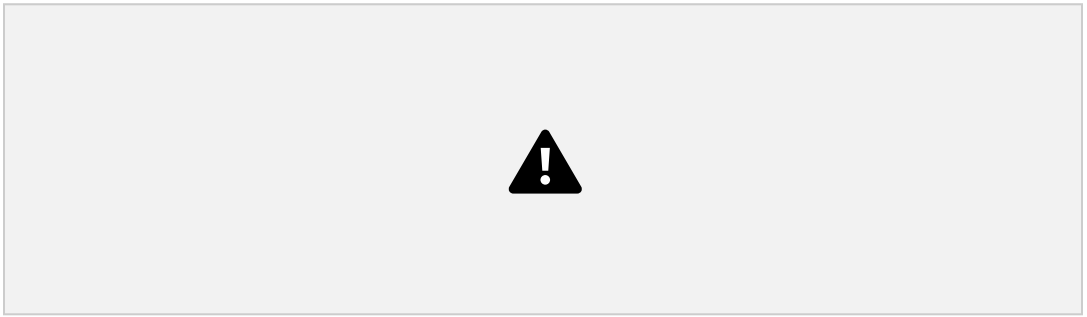
continual refocusing of the ray in the core, and minimizing the modal dispersion.

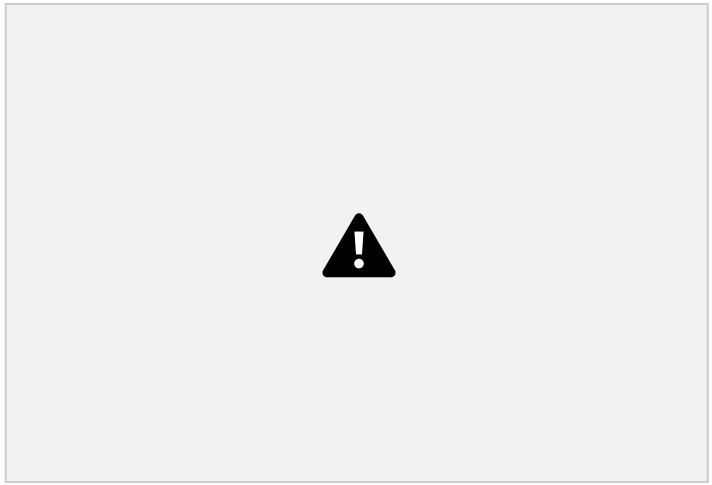
Standard graded index fibres typically have a core diameter of 50 µm or 62.5 µm and the cladding diameter of 125 µm.



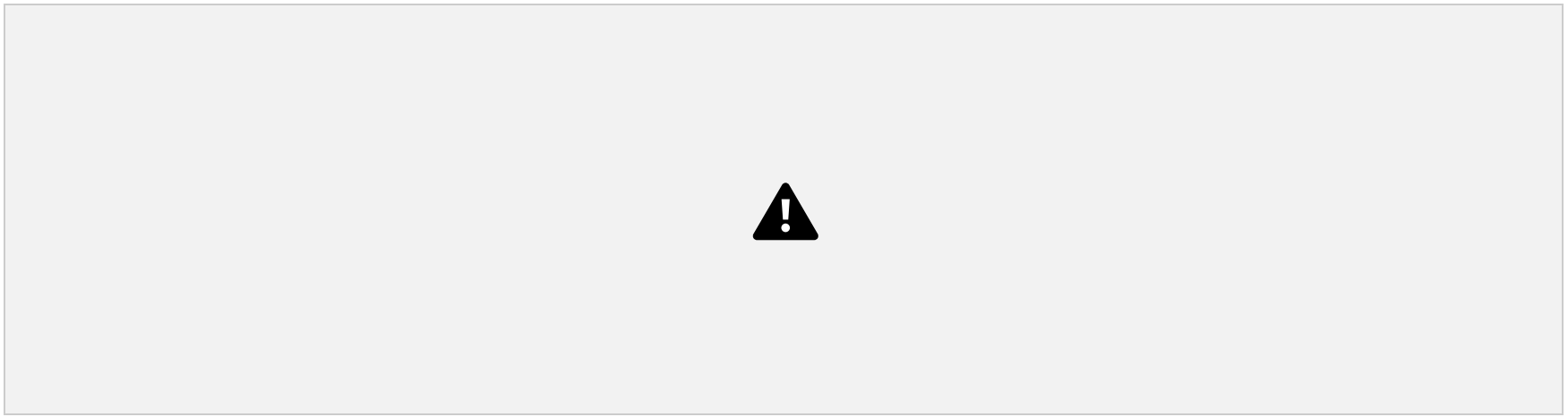


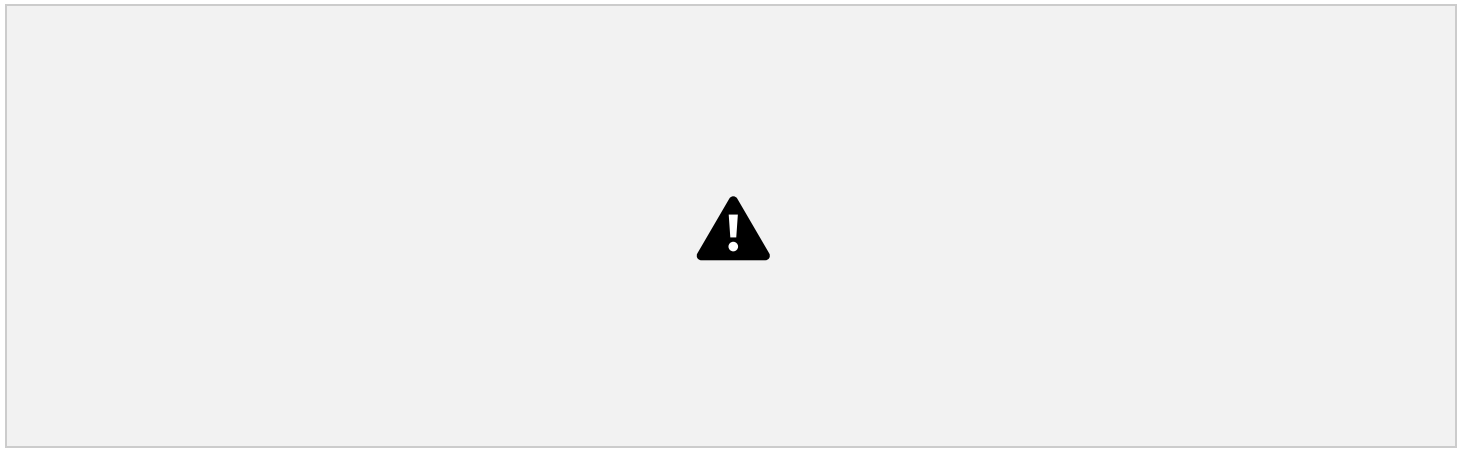


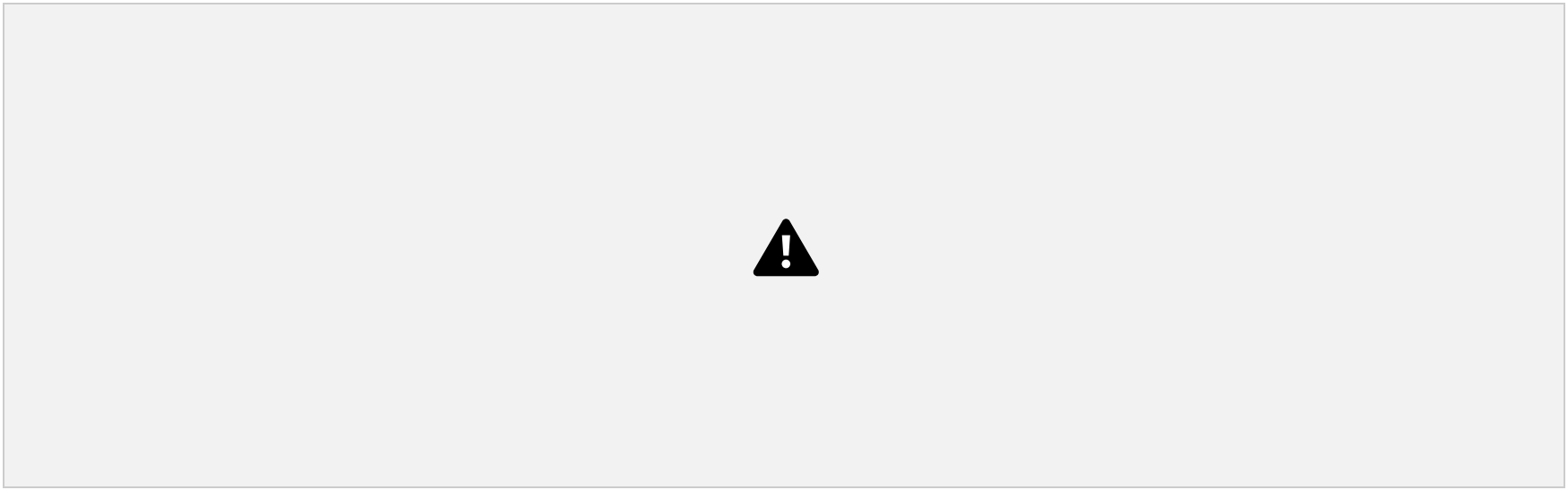




Acceptance Cone

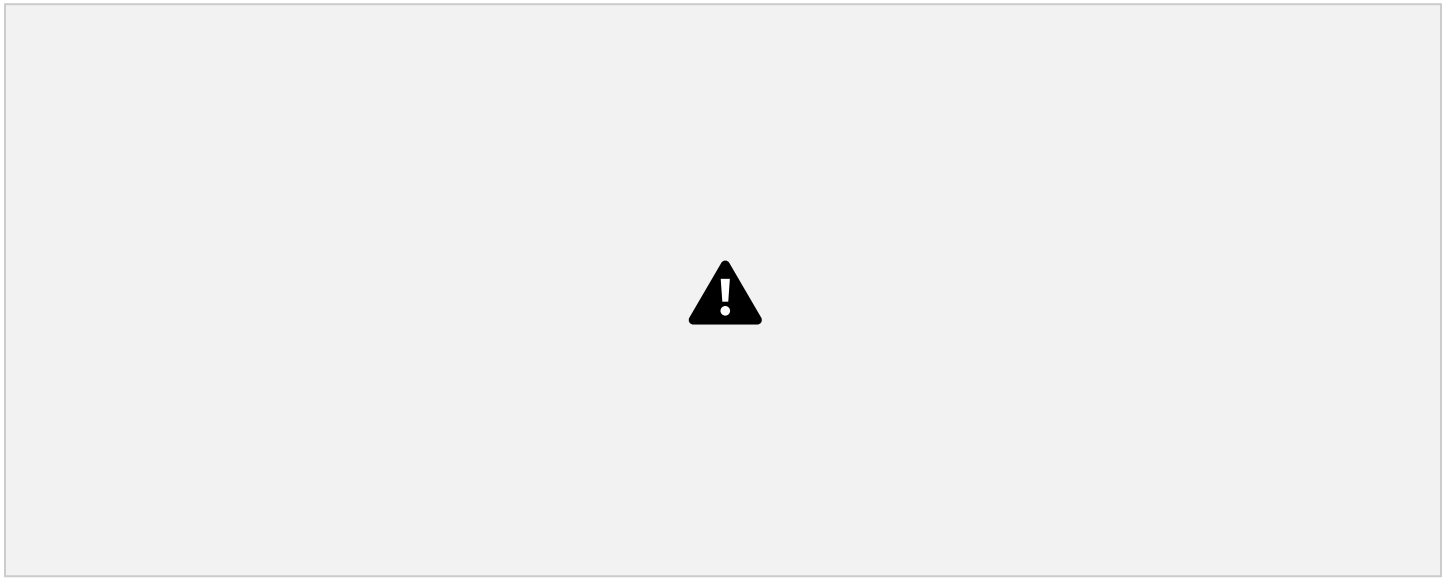


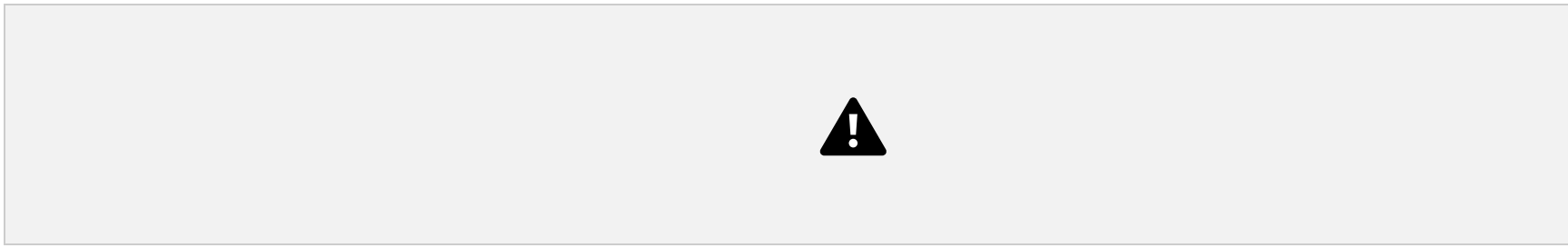


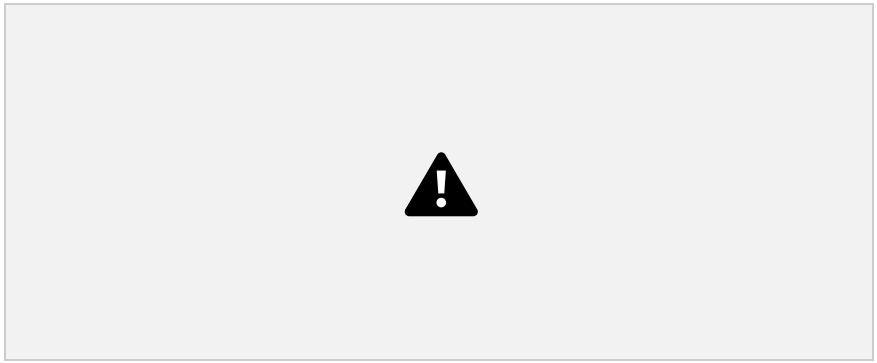


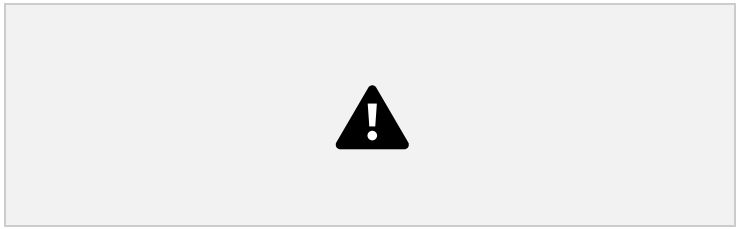
Fractional Refraction index/Relative refractive index

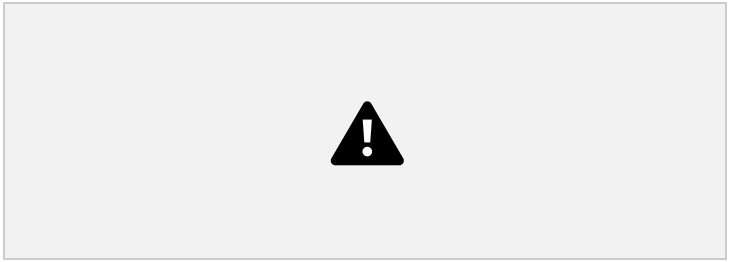
Relationships

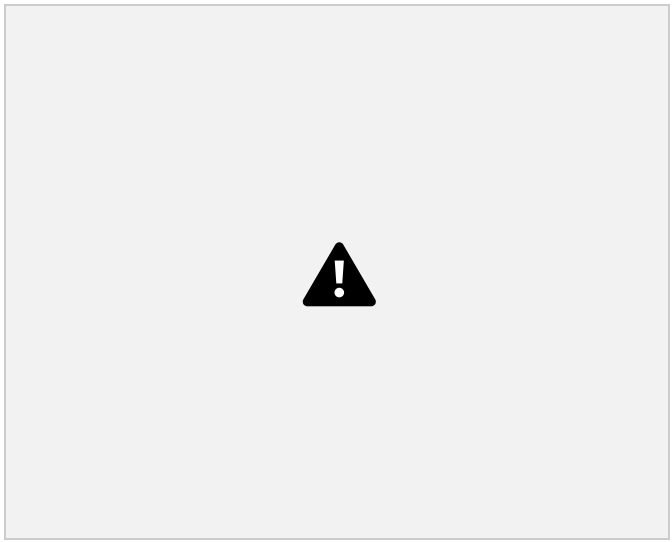


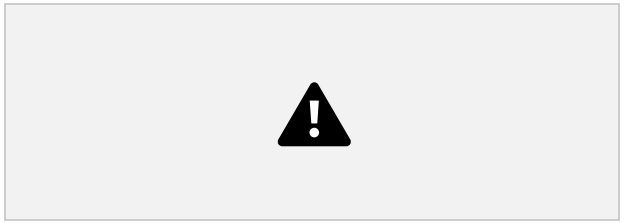


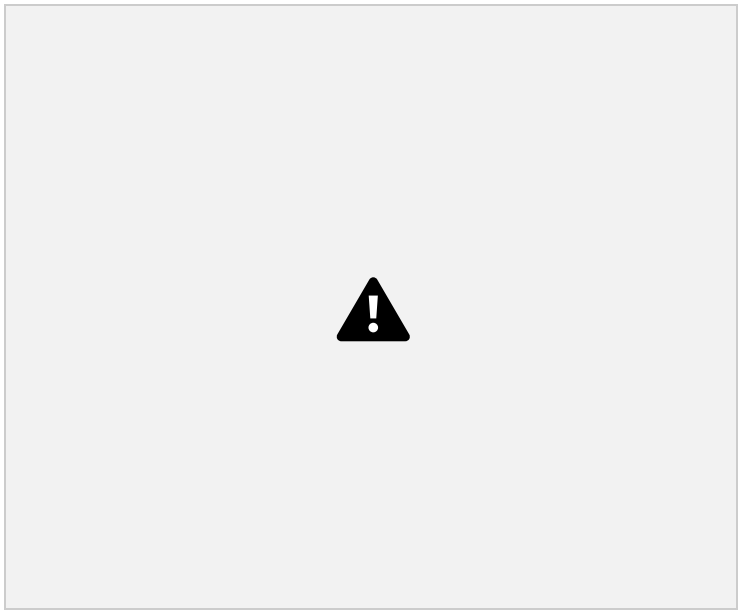


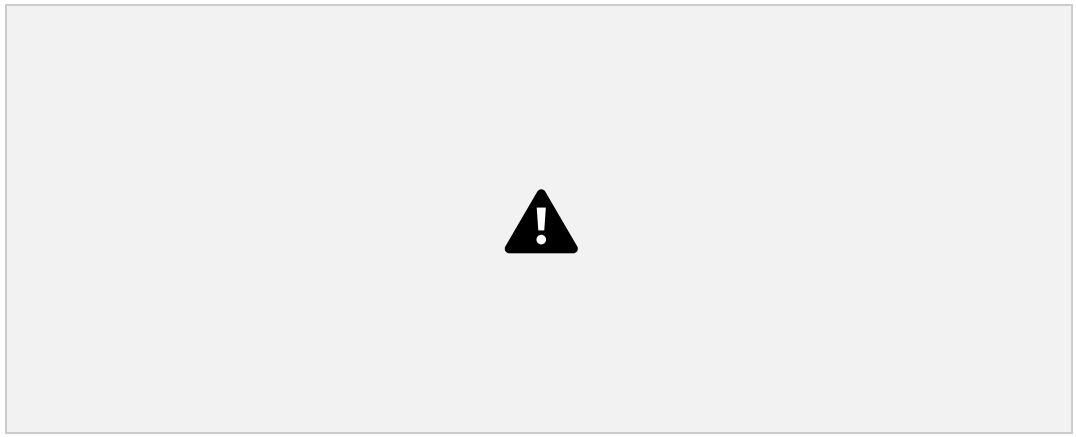




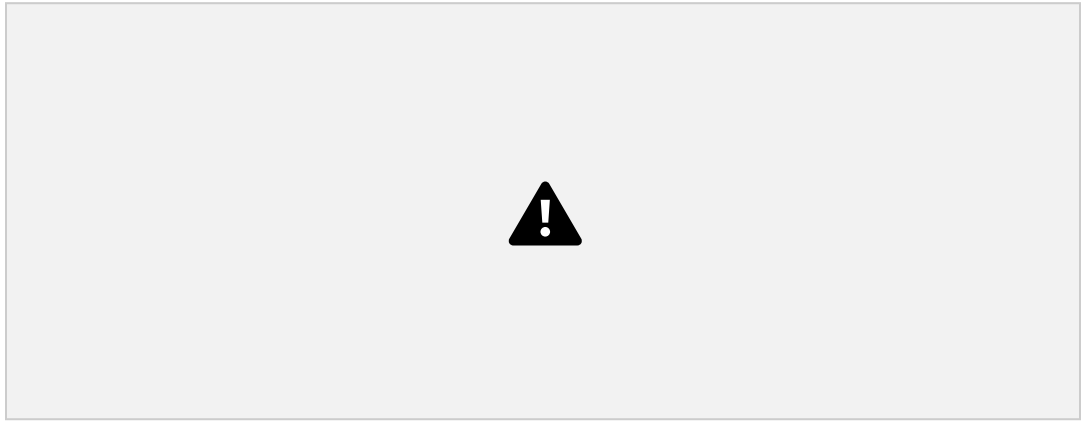








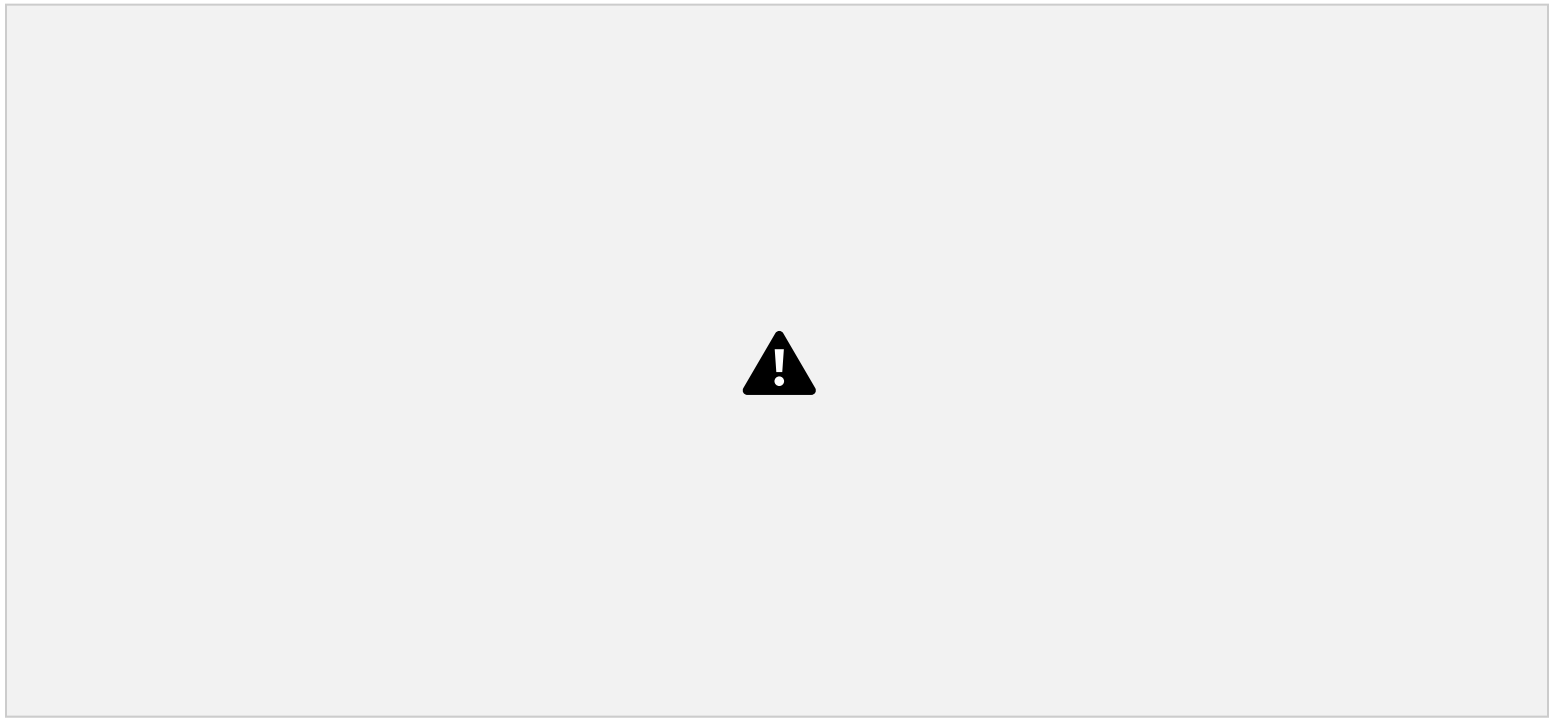
V-number (normalized frequency)

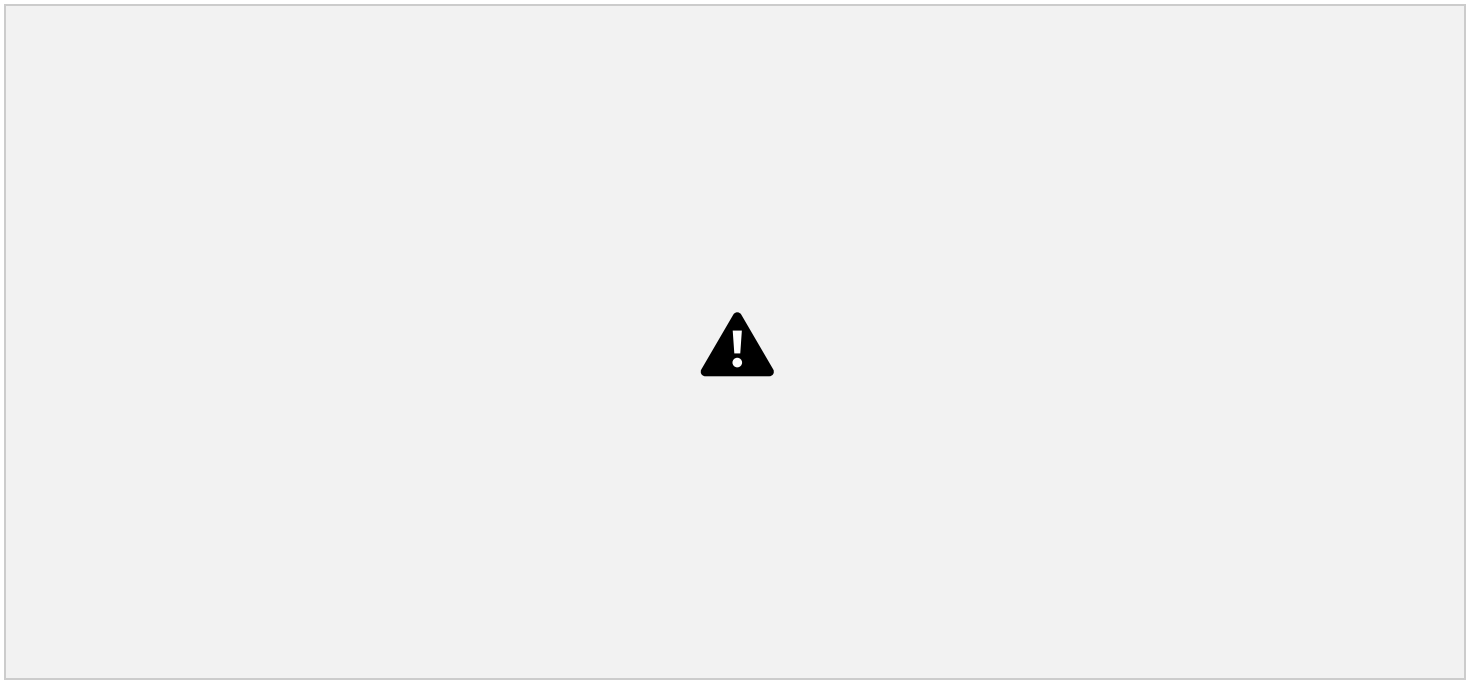


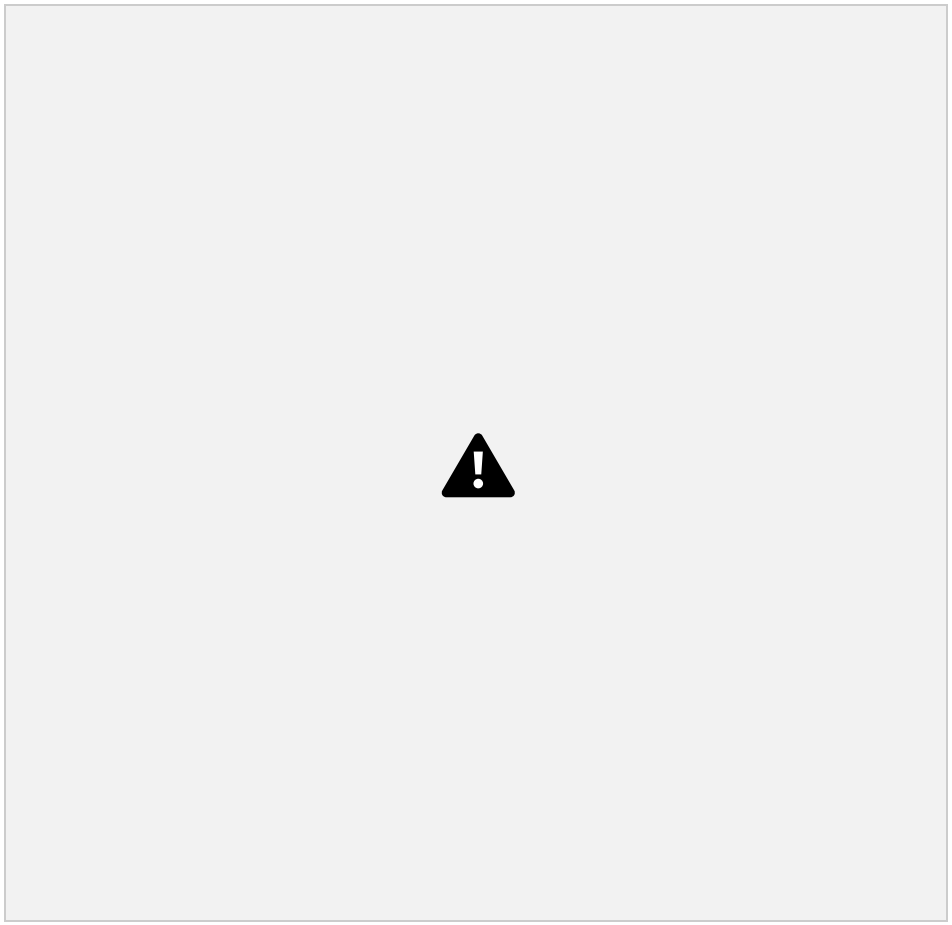
V-number & Number of Modes

Only an Approximate formula
Valid for Large V-Numbers Only

This spreading of output pulse in the time domain known as dispersion or distortion in optical fibre.







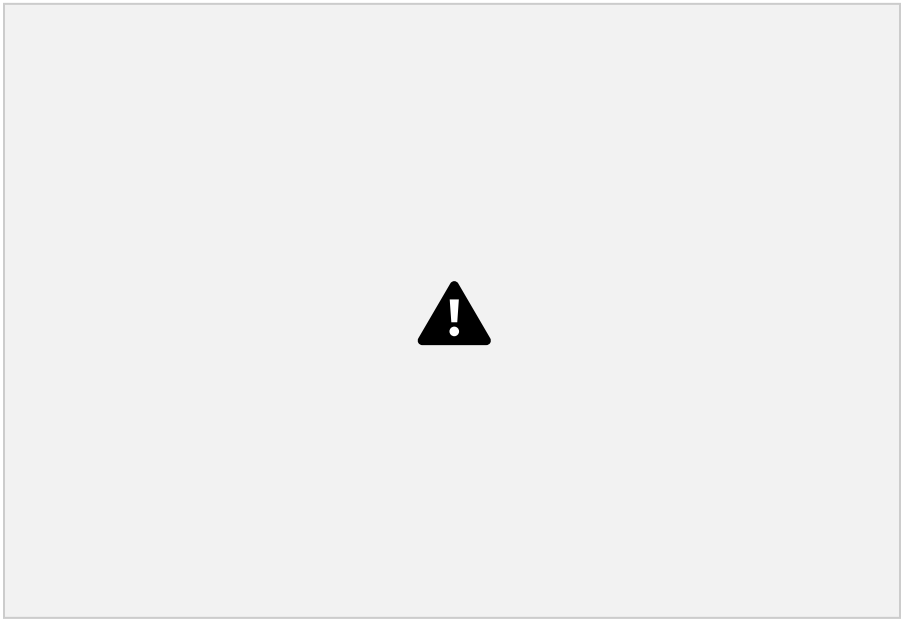
- **Also known as Modal Dispersion**

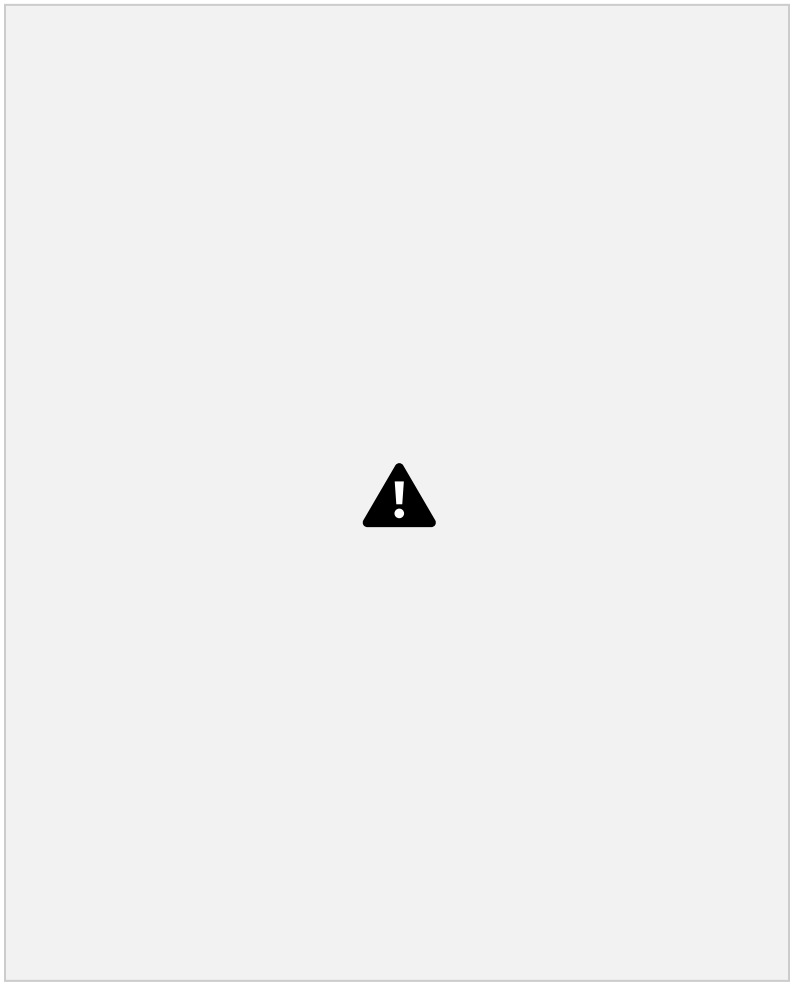
Spreading of a pulse because different modes (paths) through the fiber take different times

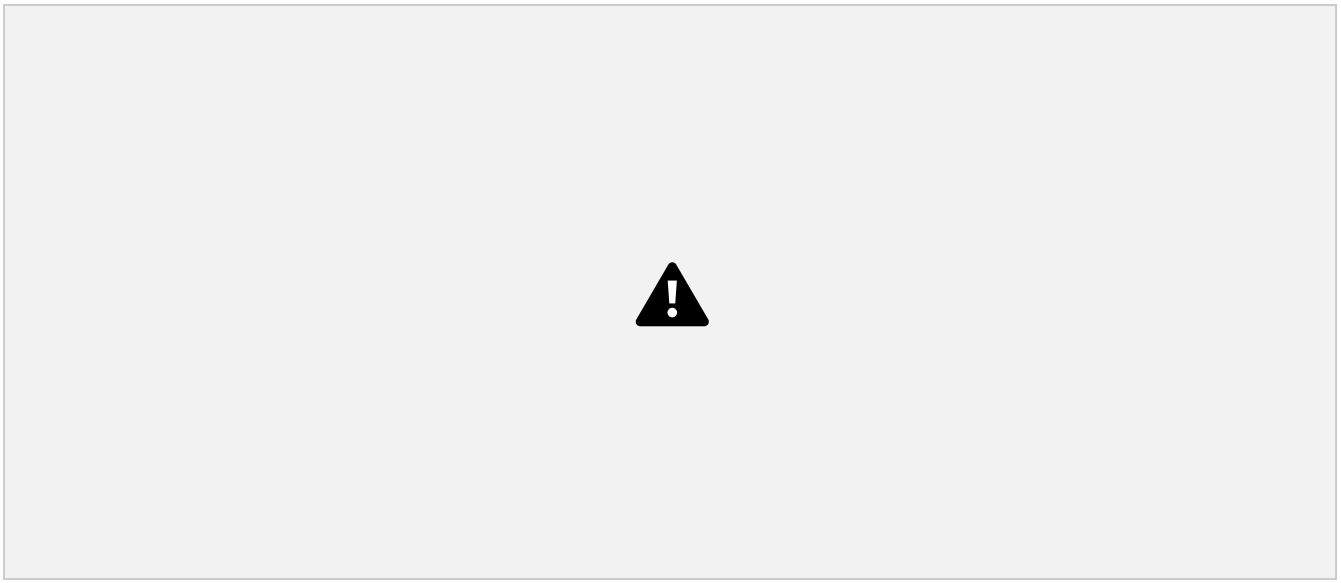
Only happens in multimode fiber

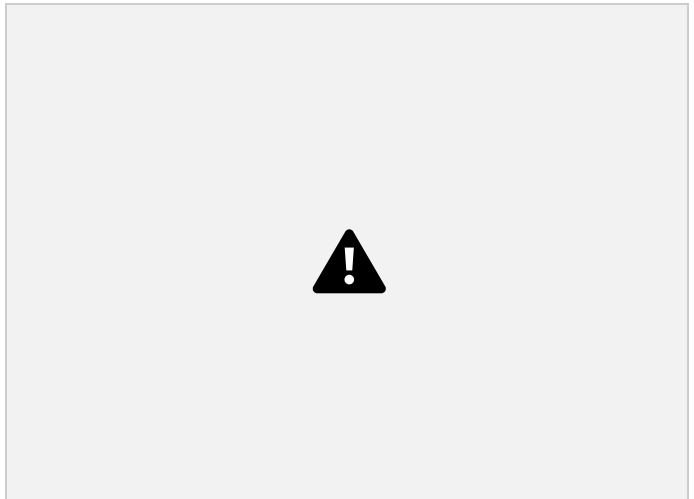
Reduced, but not eliminated, with graded-index fiber

Intermodal Dispersion

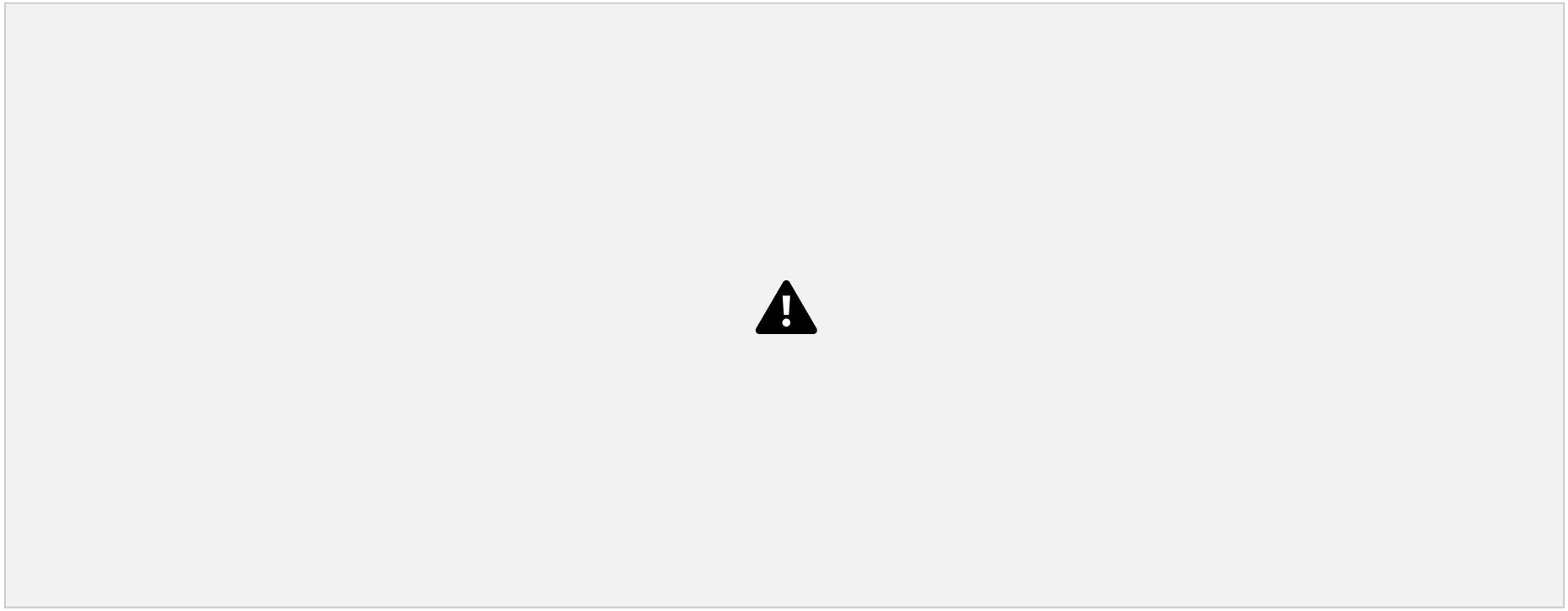




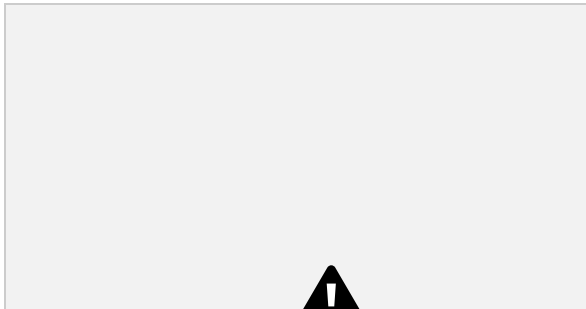


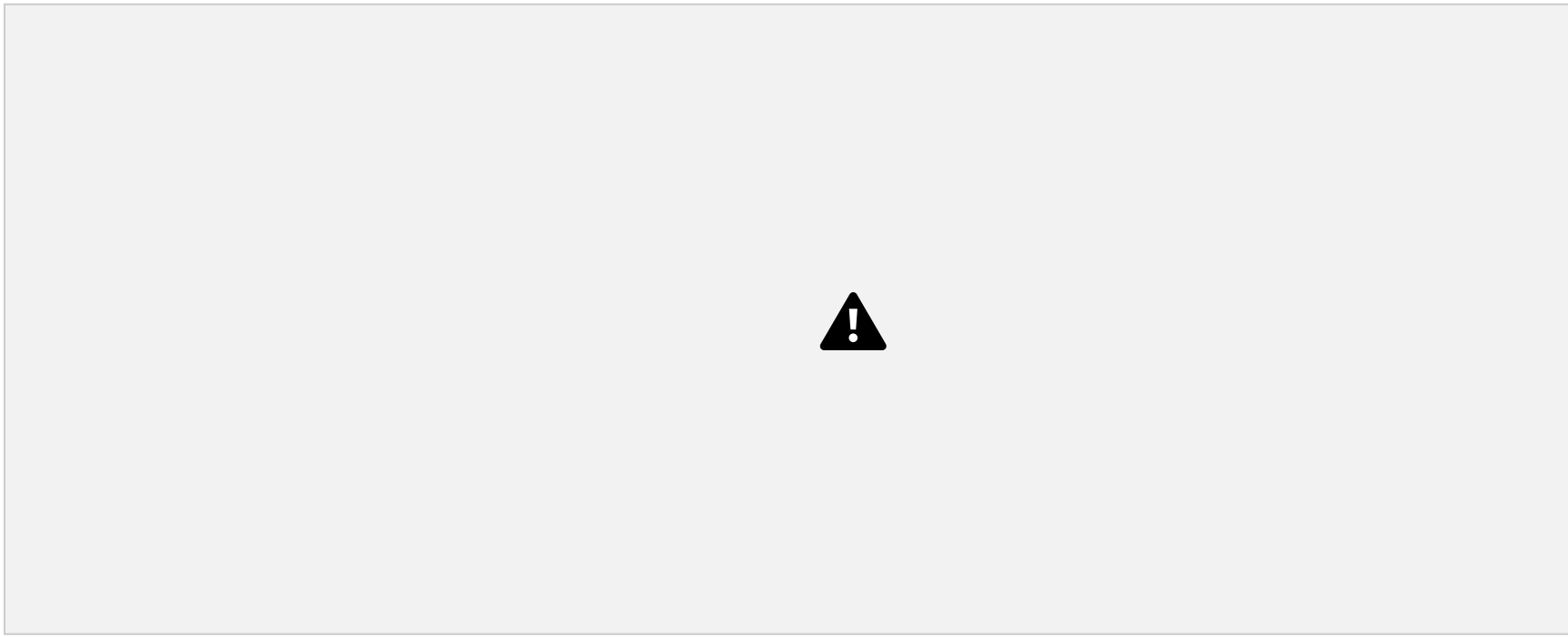


Chromatic Dispersion



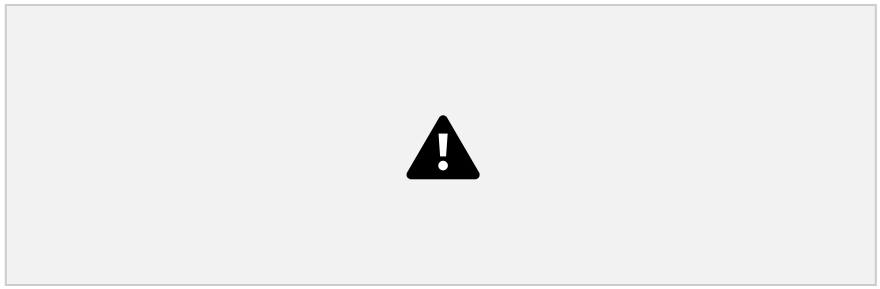
refractive index varies (slightly) with the wavelength.

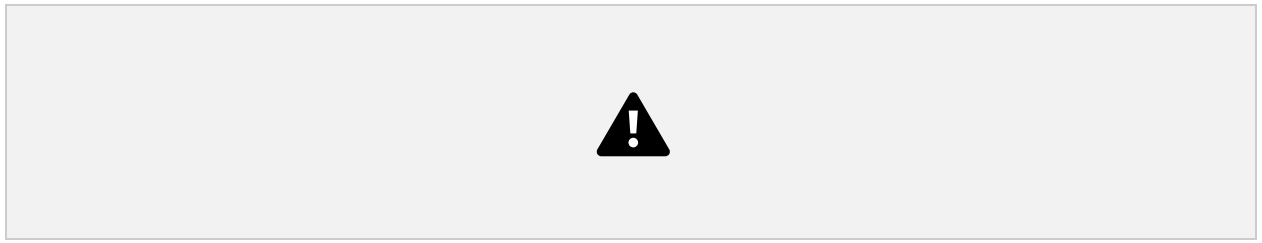


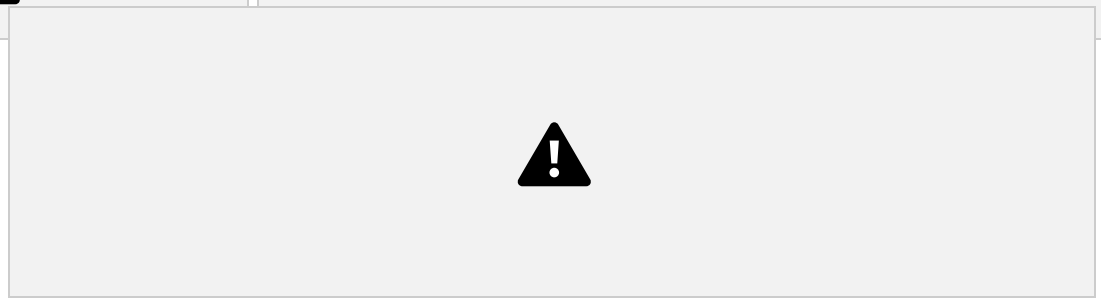


Waveguide dispersion (Affects mainly single mode)

•20% signal is travelling through the cladding and remaining 80% signal travels through the core by multiple total internal reflections.

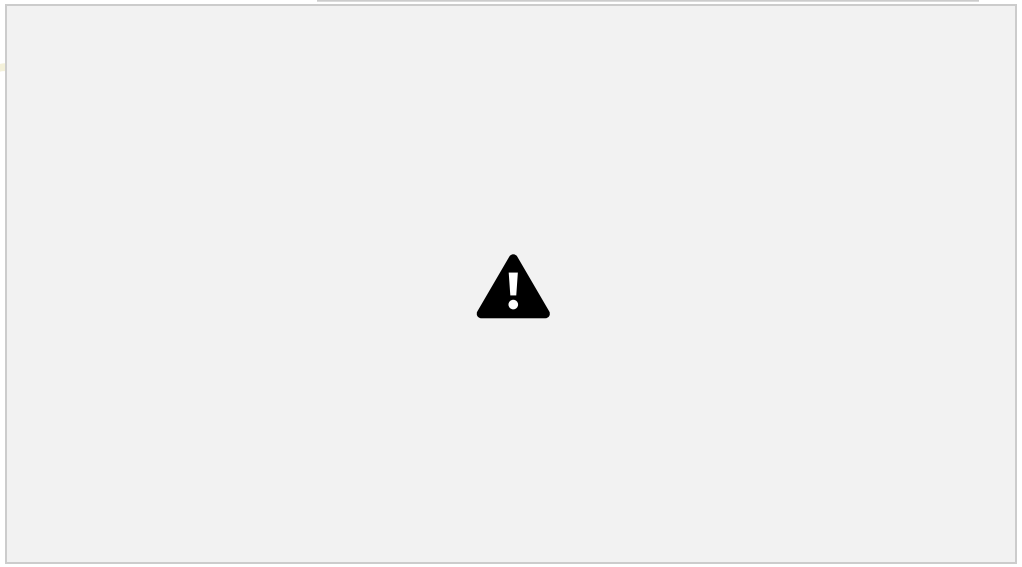


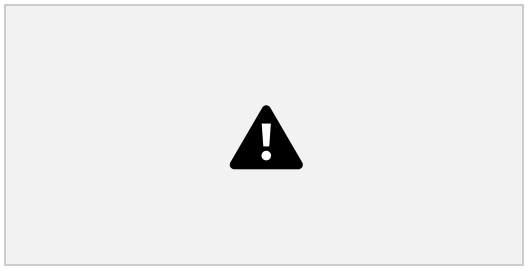


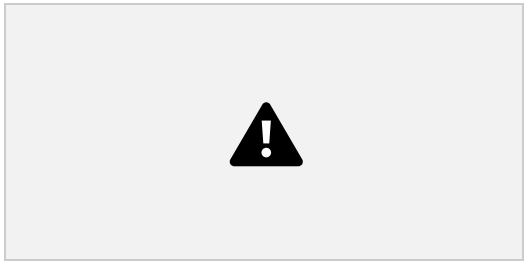


α:Attenuation coefficient

Cause/Reason








Optical fibre communication system

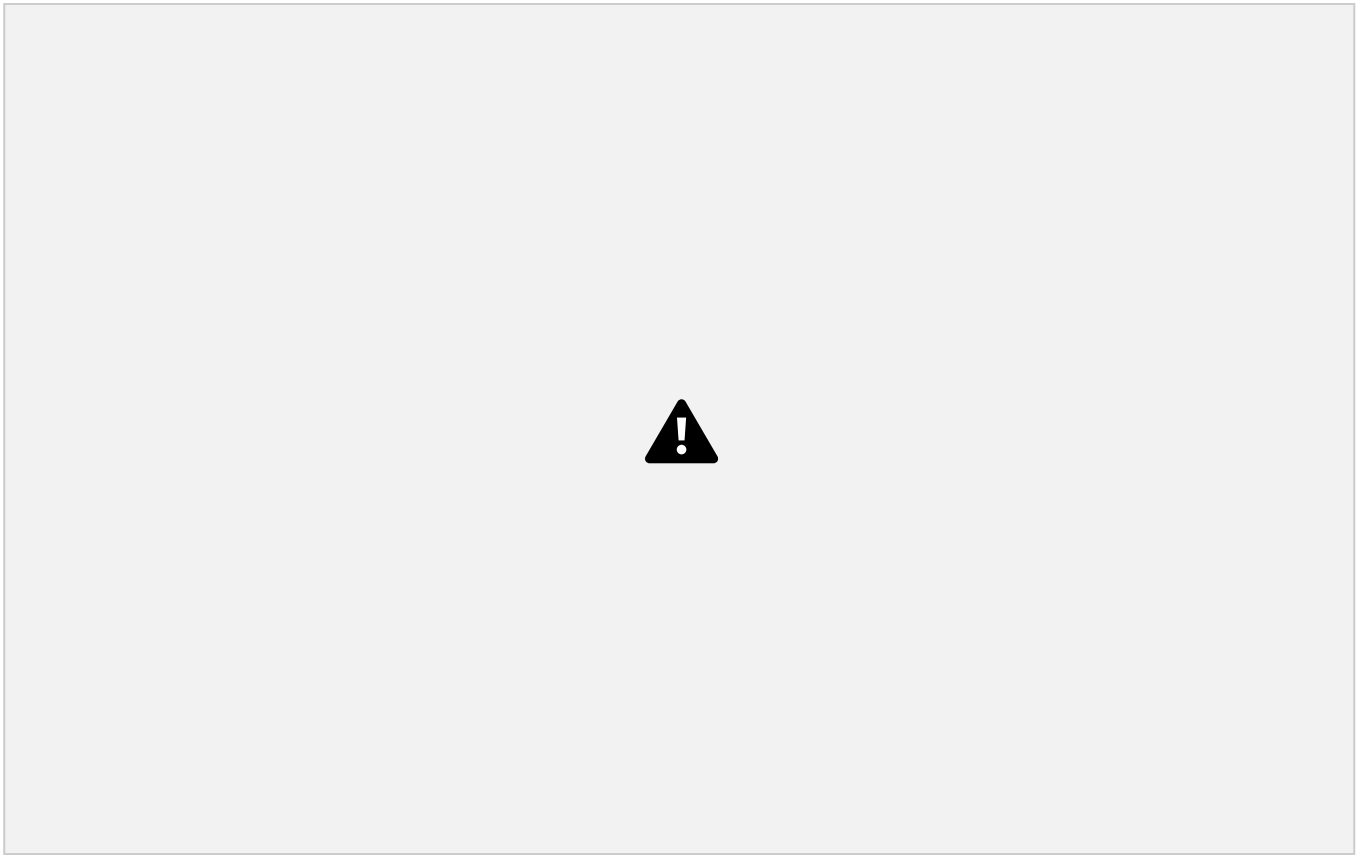


FIG. 3.14

Assignment:

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.