Optical Components
Booklet notes

Contents (just the topics, full contents on the booklet):

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Chapter 1: Free and guided propagation of optical waves

1.1 Premise

- Performance:
  - Transmission capacity: Quantity of information transferred per unit time
  - Maximum distance between the source and used
- All the physical phenomena must be known
- Visible: 400 nm → 750 nm
- Microwaves: 25 um → 1mm
- Information transfer → Modulated electromagnetic signal
- In this chapter: main properties of the modern communications systems
- Guided or non-guided propagation';
  - Guided: EM radiation is confined in a guiding structure
  - Non-guided: EM radiation propagates through space → for broadcast
- We start with slowly varying weakly nonlinear dielectrics at optical frequencies
- NLSE3D describes the evolution of the electric field envelope
- Then we apply the results for guided and non-guided propagation independently
  - Free space propagation: Neglect all nonlinear and dispersive terms (purely diffractive propagation)
  - Guiding structures: Diffractive and guiding effects (the later due to the refractive index variation in the transverse plane with respect to propagation direction) compensate each other

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Figures

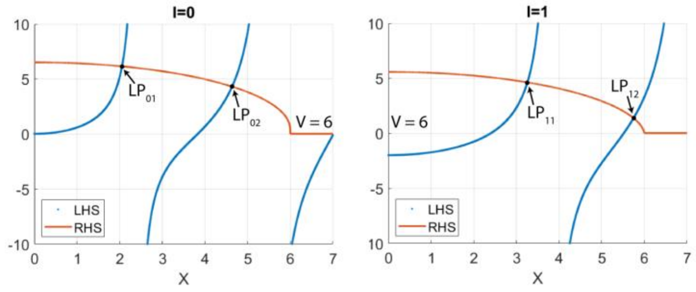

Figure 2.7: Graphical solution of the dispersion relation for the modes LP_{0m} (left panel) and LP_{1m} (right panel).

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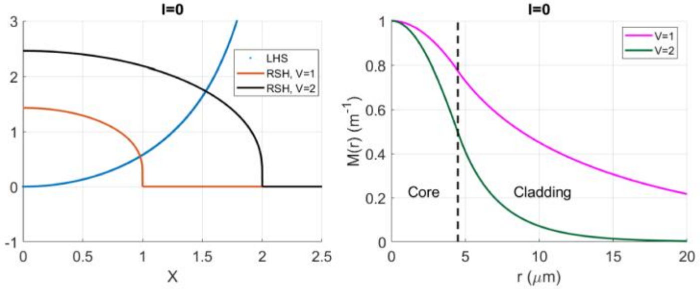

Figure 2.8: Graphical solution of the dispersion relation for the fundamental mode LP_{01} (left panel) and mode profiles for two values of normalized frequency (right panel). The core radius is $a = 4.5$ μm.

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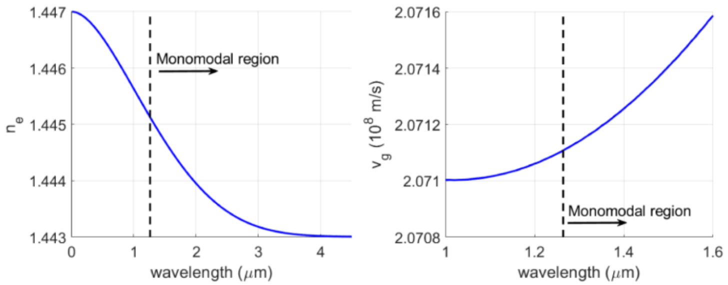

Figure 2.9: Effective refractive index (left panel) and group velocity (right panel) as functions of the wavelength, for the fundamental mode.

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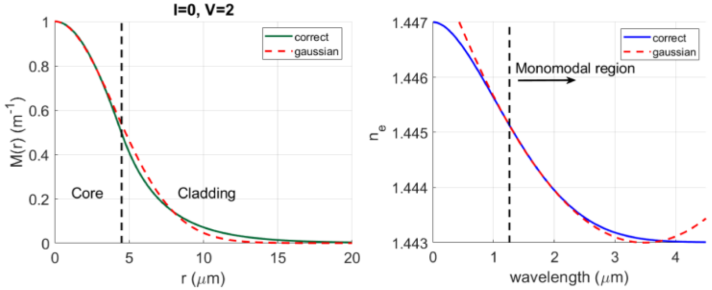

Figure 2.10: Mode profile for $V = 2$ (left panel) and effective refractive index (right panel). The full lines correspond to the correct solution, whereas the dashed lines is obtained under the Gaussian approximation. The fundamental mode is considered.

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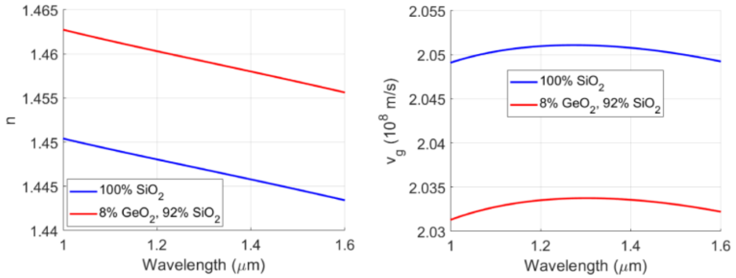

Figure 1.11: Refractive index (left panel) and group velocity (right panel) for the pure silica (blue curve) and for silica doped with germanium dioxide (red curve), obtained from Sellmeier formula.

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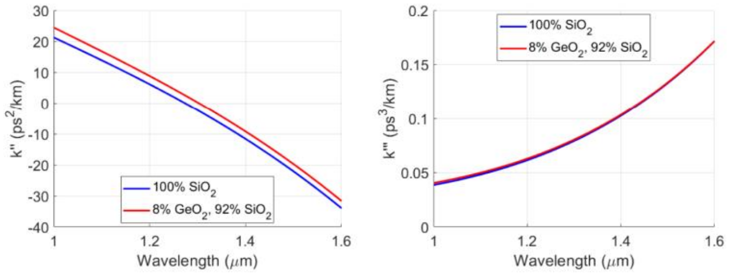

Figure 1.12: Second (left panel) and third (right panel) order dispersion for the pure silica (blue curve) and for silica doped with germanium dioxide (red curve), obtained from Sellmeier formula.

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Exercise 1: Isotropic media
- We apply any rotation on E and we should get the same in P
- We obtain the relation: XR = RX with X the susceptibility tensor
- We do it with a z-axis and x-axis rotation

Exercise 2: Frequency dependent and complex X
- From the relation P = e_0[[X]]*[E]
- From the fact that X(r, t-tau) = 0 for t-tau<0 due to causality

Exercise3: Linear isotropic media
- Directly from the wave equation and P = e_0XE

Exercise 4: Linear and homogeneous medium → \Nabla . [E] = 0
- From

Exercise 5: Ideal reference case
- Directly from the wave equation

Exercise 6: Propagation constant
- Taking the operators of the derivatives acting on the cosine function

Exercise 7: 2D Fourier transform
- Apply the Fourier transform and separate the exponentials

Exercise 8: H and <P> calculations
- Apply Maxwell's equations and assume slowly variant envelope

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Exercise 9: Intensity attenuation
- We have the electric field, get the poynting vector

Exercise 10: Neglect third order dispersion
- We start with the equation and the suggested values

Exercise 11: Verify the effective refractive index with data
- Use the graphical solution and then calculate beta and n_eff

Exercise 12:

Exercise 13:

Exercise 14:

Exercise 15:

Exercise 16:

Figure 1.11: Refractive index for pure Silica and Silica doped with Germanium from the Sellmeier formula

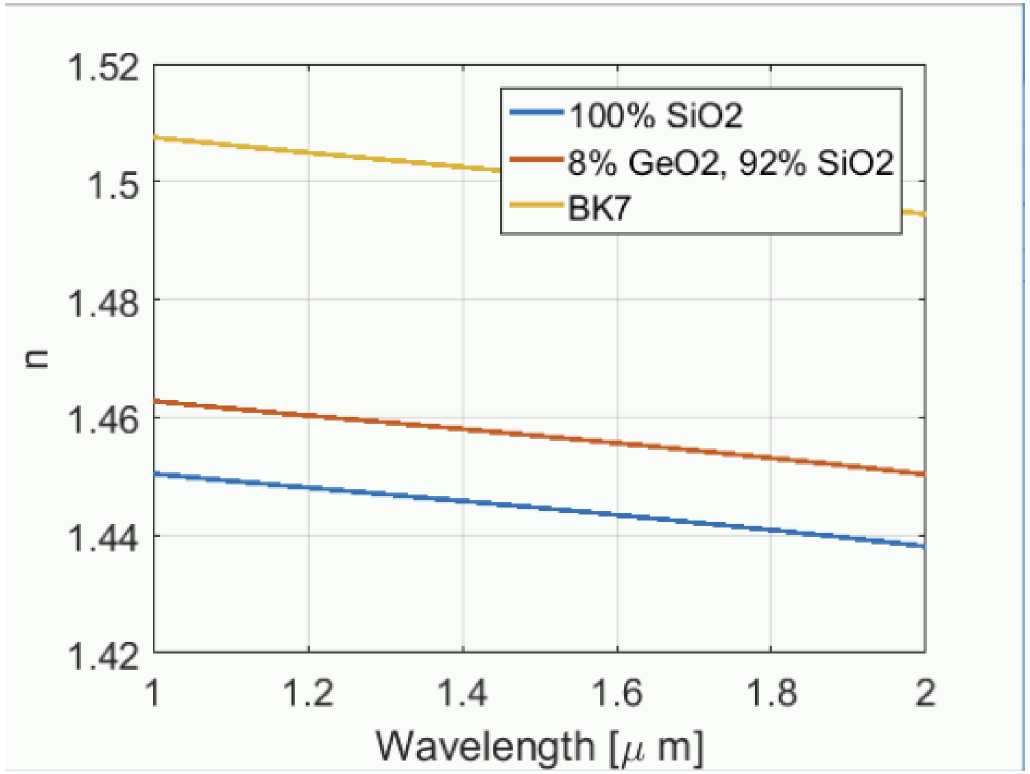
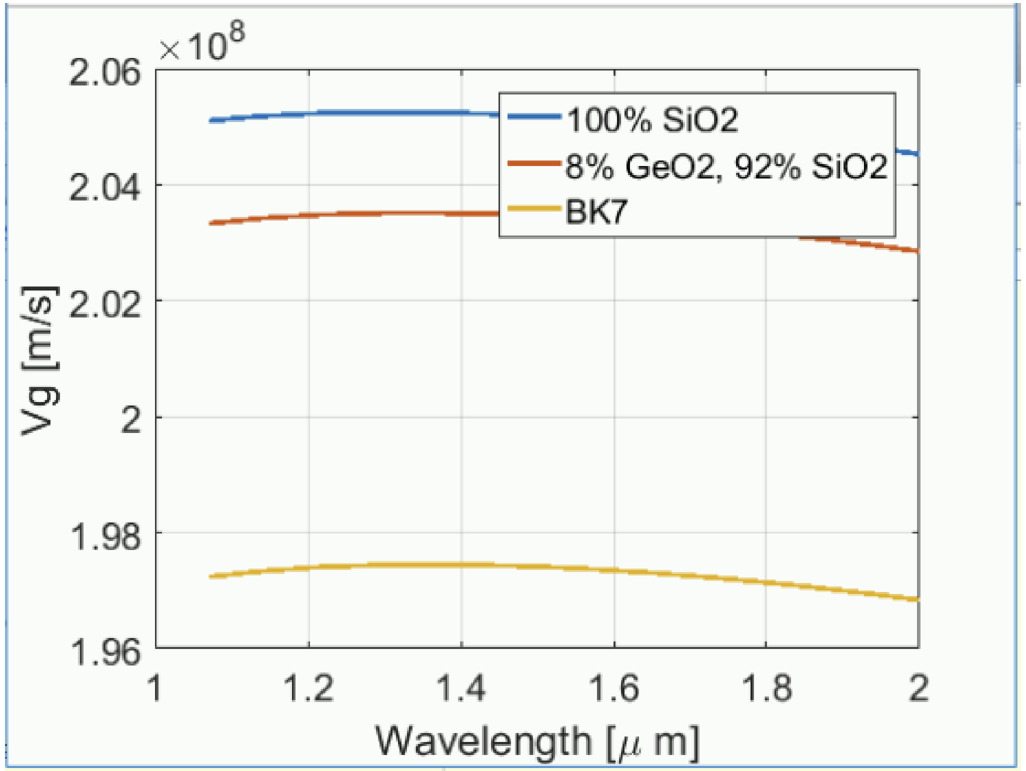


Figure 1.11: Group velocity for pure Silica and Silica doped with Germanium from the Sellmeier formula



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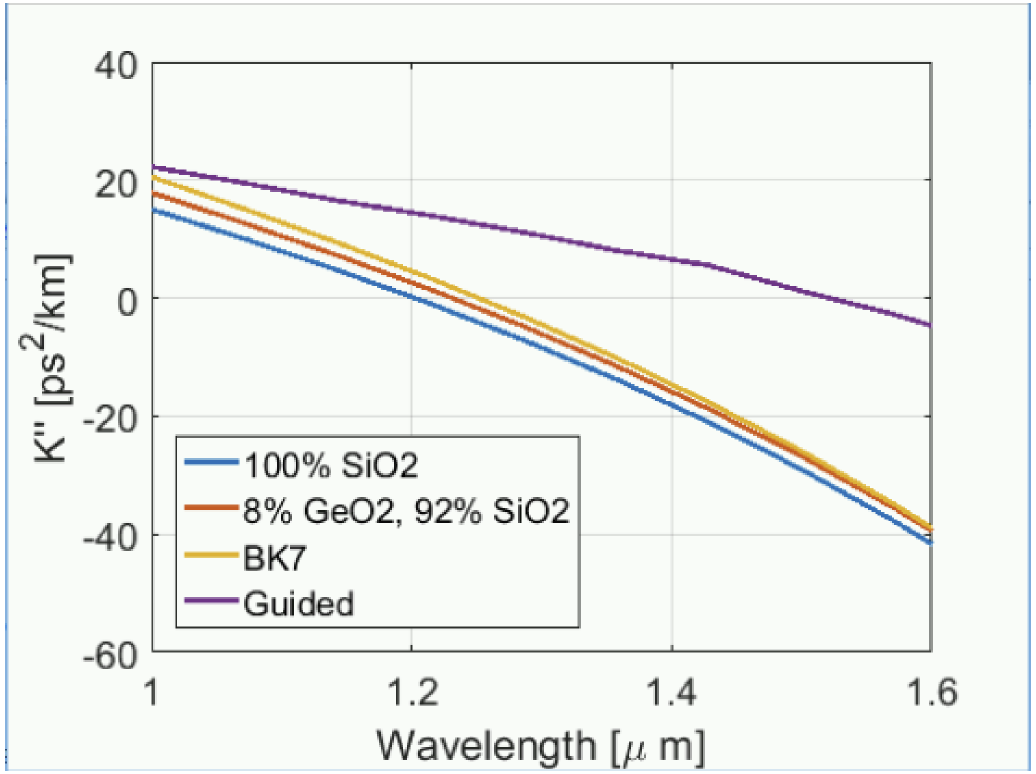

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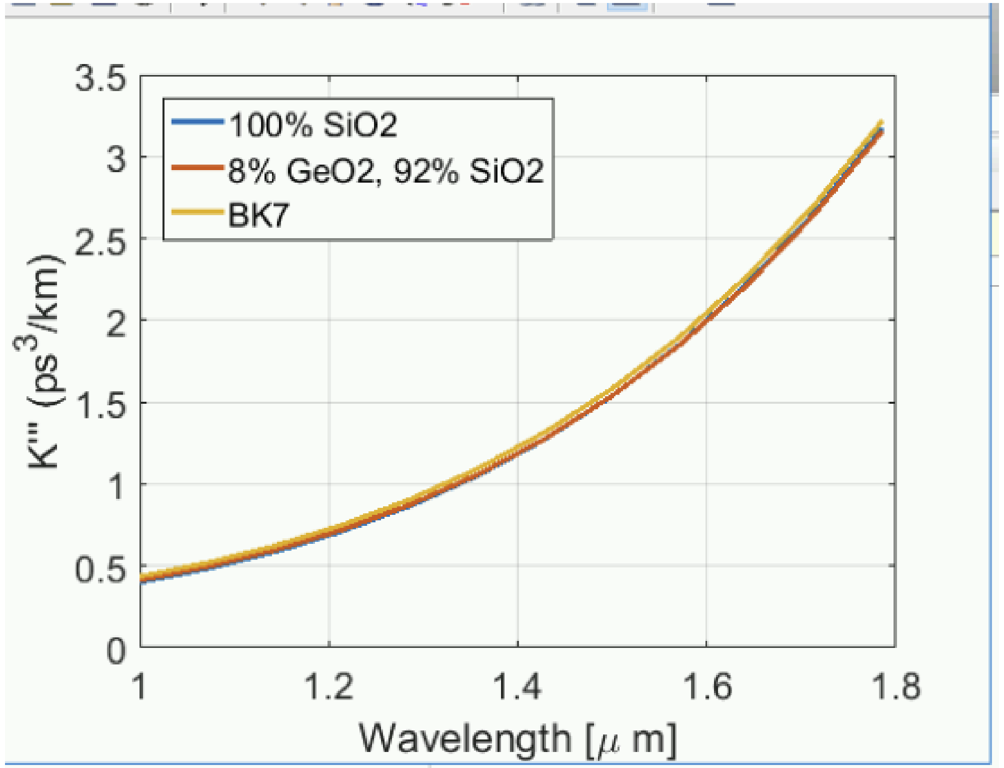


Figure 2.8: Graphical solution of the dispersion relation for the LP01 mode

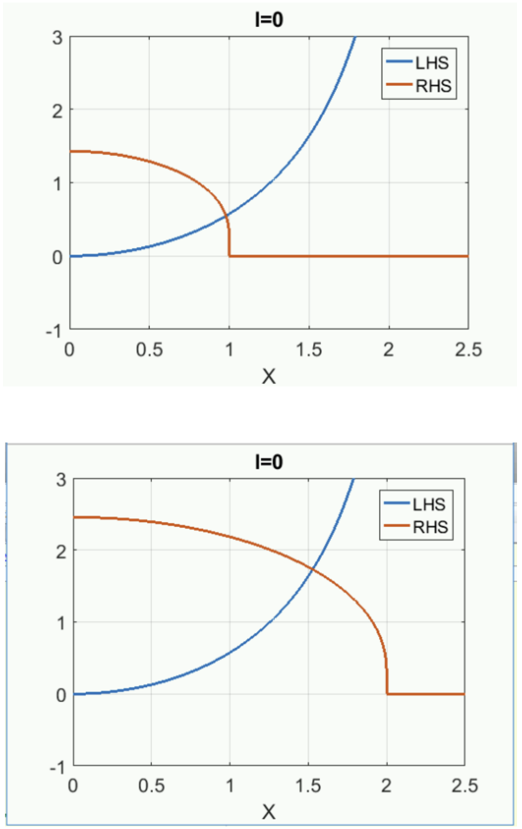


Figure 2.8: Mode profiles for 2 normalized frequencies

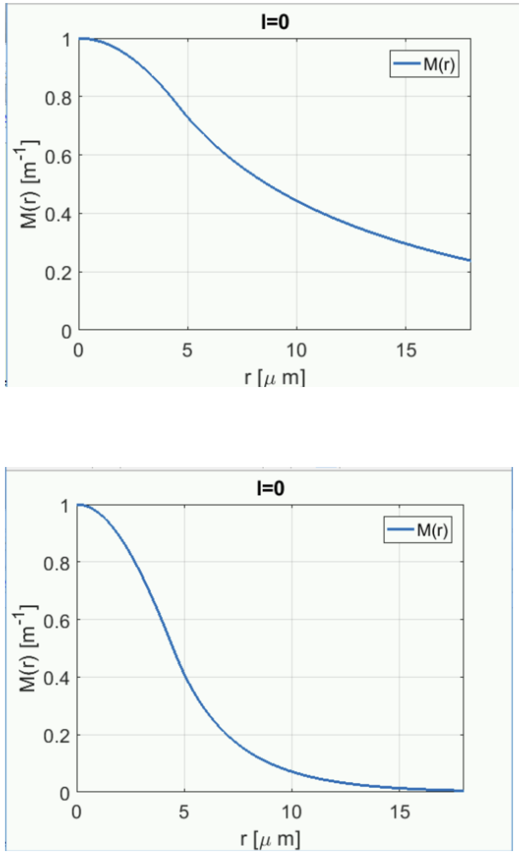
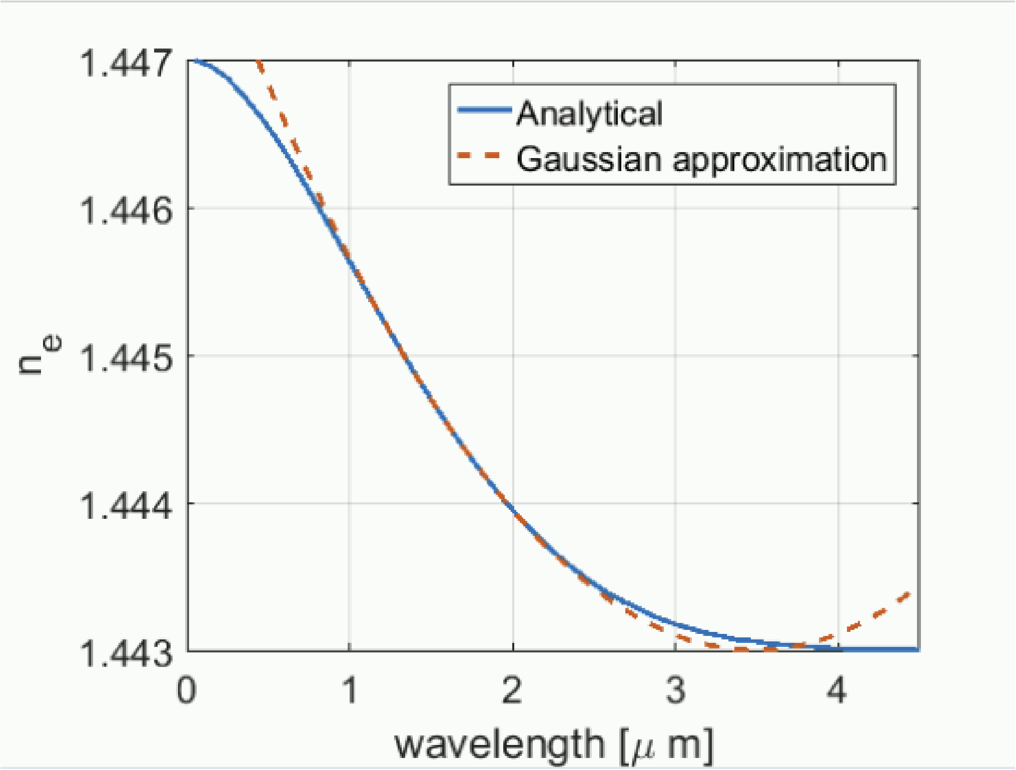


Figure 2.9: Effective refractive index for the L01 mode



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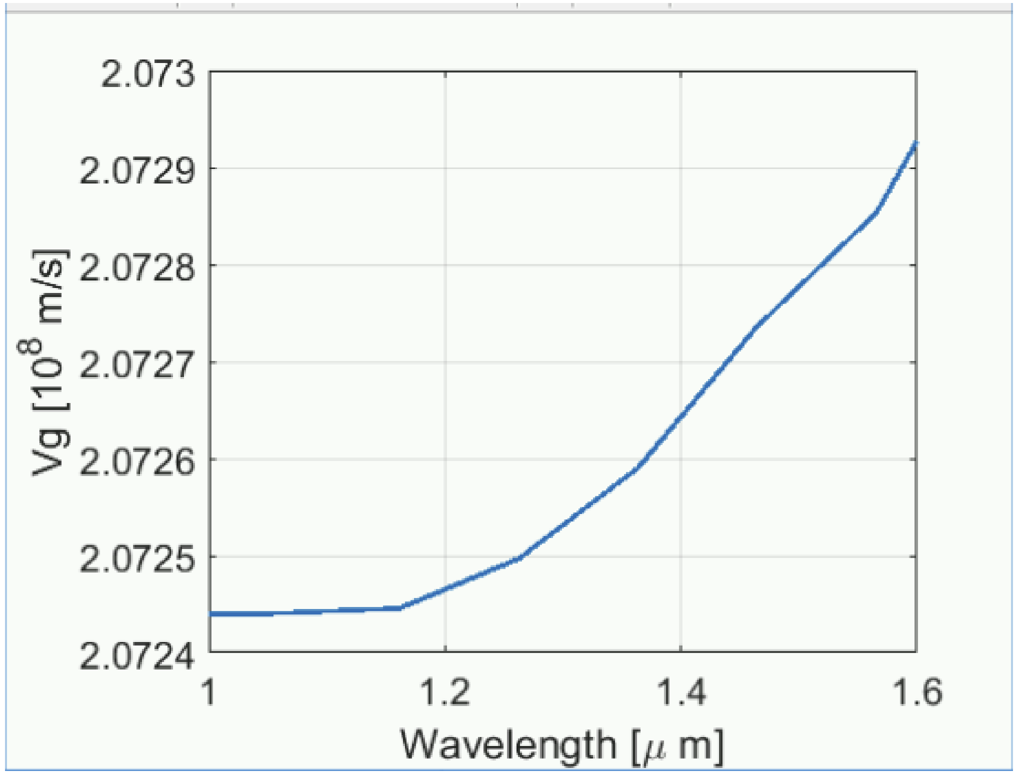

Figure 2.10: Mode profile for V=2

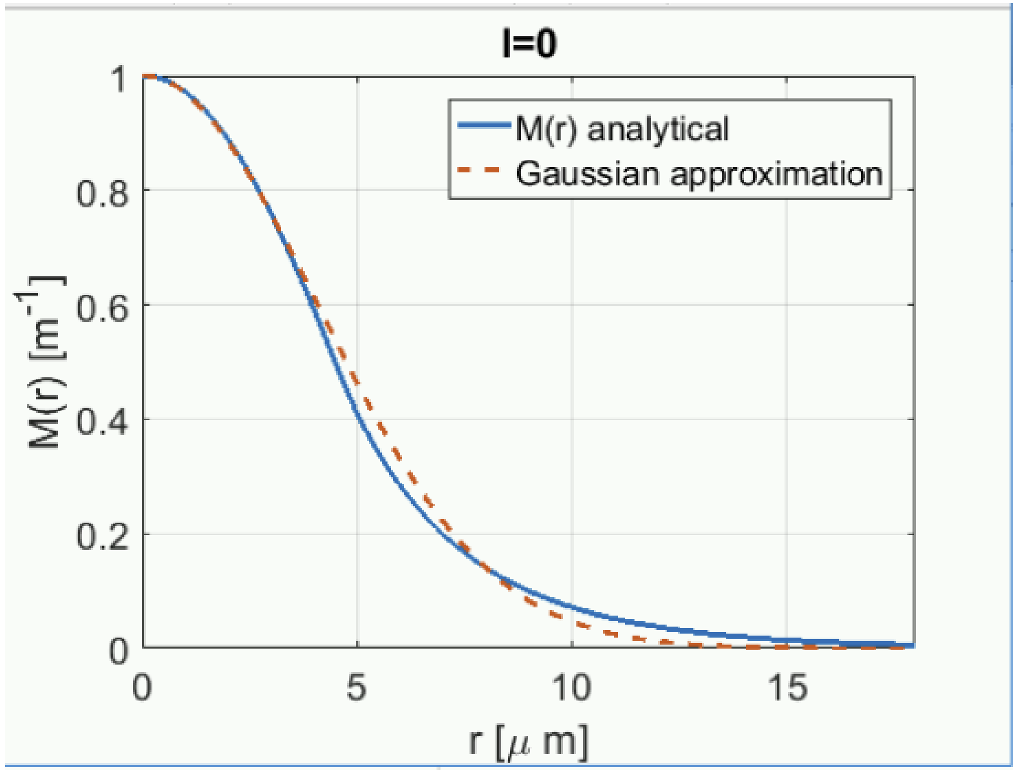

Figure 1.11: Effective refractive index