

Çankaya University – ECE Department – ECE 635 (FE)

Student Name :

Date : 17.01.2012

Student Number :

Open book exam

Questions

1. (70 Points) Download the MATLAB m file “ParCoh_SinoHypR.m” from ece635 course webpage. The code given there is based on the equation (PC15) on pp. 17 of “Notes for ECE635_Eylul 2011.pdf” which is also available on the ece635 course webpage. Using the m file “ParCoh_SinoHypR.m”, analyse the followings cases by plotting the corresponding figures

- The impact of partial coherence parameter, σ_s on intensity profiles at $\sigma_s = 1 \text{ m}, 1 \text{ cm}, 1 \text{ mm}$ for cos, sine, cosh and sinh Gaussian beams.
- The impact of Gaussian source size, α_s on intensity profiles at $\alpha_s = 1 \text{ mm}, 1 \text{ cm}, 5 \text{ cm}$ for cos, sine, cosh and sinh Gaussian beams.
- The impact of displacement parameter, D_s on intensity profiles at $D_s = 100 \text{ m}^{-1}, 200 \text{ m}^{-1}, 500 \text{ m}^{-1}$ for cos, sine, cosh and sinh Gaussian beams.
- The impact of wavelength, λ on intensity profiles at $\lambda = 1 \text{ }\mu\text{m}, 1.55 \text{ }\mu\text{m}, 2 \text{ }\mu\text{m}$ for cos, sine, cosh and sinh Gaussian beams.

When not subjected to variations, the parameters should be kept at

$$\alpha_s = 1 \text{ cm}, D_s = 200 \text{ m}^{-1}, \sigma_s = 1 \text{ cm}, \lambda = 1.55 \text{ }\mu\text{m}, L = 200 \text{ m}, 500 \text{ m}, 1 \text{ km}, 5 \text{ km} .$$

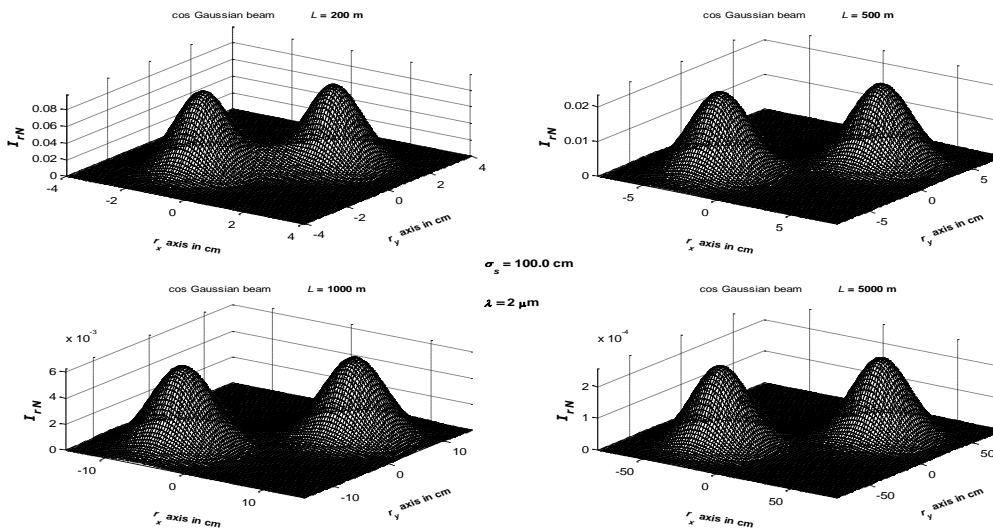
Write your comments about these plots on the exam paper. Send these plots (copied into one single file in tiff format) to h.eyyuboglu@cankaya.edu.tr address together with appropriate labeling.

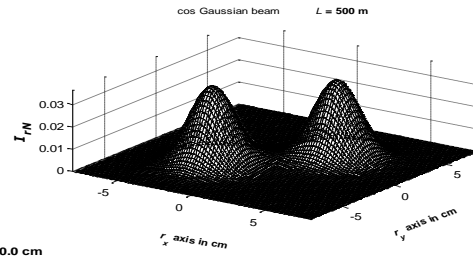
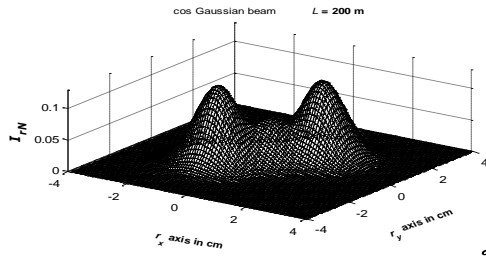
Solution : The plots can be obtained by running ParCoh_SinoHypR.m at the specified source and propagation settings. From there, we observe that

- The impact of partial coherence parameter, σ_s on intensity profiles at $\sigma_s = 1 \text{ m}, 1 \text{ cm}, 1 \text{ mm}$ for cos, sine, cosh and sinh Gaussian beams. Since $\sigma_s = 1 \text{ m}$ is much greater than the source size of $\alpha_s = 1 \text{ cm}$, the sources essentially resemble fully coherent sources. The effect of this level of partial coherence would only be felt at extremely long propagation distances. On the other hand $\sigma_s = 1 \text{ cm}$ makes the source partially coherent, since $\sigma_s = 1 \text{ cm}$ is actually comparable with the source size of $\alpha_s = 1 \text{ cm}$. In this case, more spreading at $L = 1 \text{ km}, 5 \text{ km}$ is experienced. Finally at

$\sigma_s = 1 \text{ mm}$, the source become almost incoherent, hence spreading effects are felt even starting from, $L = 200 \text{ m}$.

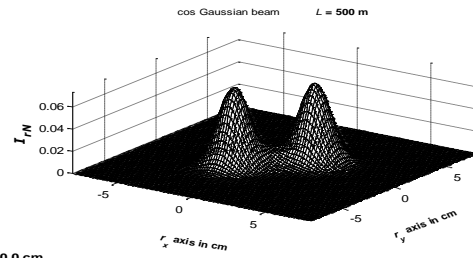
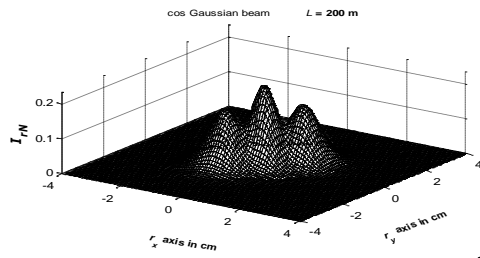
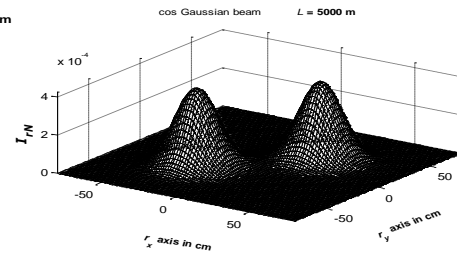
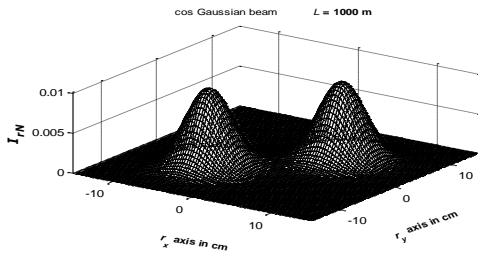
- b. The impact of Gaussian source size, α_s on intensity profiles at $\alpha_s = 1 \text{ mm}$, 1 cm , 5 cm for cos, sine, cosh and sinh Gaussian beams. Here the main rule that, beams with smaller source size suffer more diffraction, while beams of large sources diffract less, will apply.
- c. The impact of displacement parameter, D_s on intensity profiles at $D_s = 100 \text{ m}^{-1}$, 200 m^{-1} , 500 m^{-1} for cos, sine, cosh and sinh Gaussian beams. If all other parameters are kept the same, varying the displacement parameter will cause the creation of more lobes in cos, and sine Gaussian beams, while in cosh and sinh Gaussian beams, the separation between the two main lobes increases with increasing displacement parameter.
- d. The impact of wavelength, λ on intensity profiles at $\lambda = 1 \mu\text{m}$, $1.55 \mu\text{m}$, $2 \mu\text{m}$ for cos, sine, cosh and sinh Gaussian beams. As seen, from the following three graphs, as wavelength increases, more spreading occurs, such a finding is in compliance with the literature at "Average intensity and spreading of cosh-Gaussian laser beams in the turbulent atmosphere", *Applied Optics*, **44**(6), 976-983 (2005).





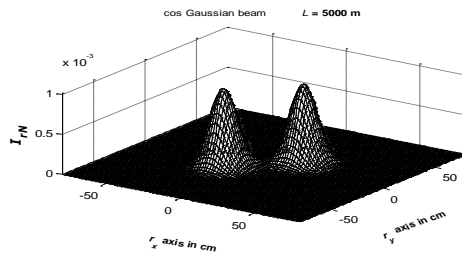
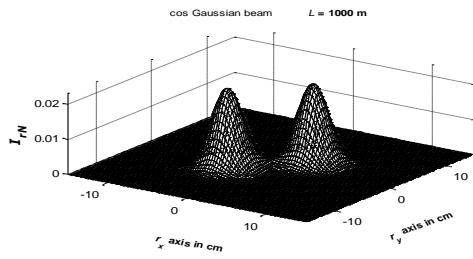
$\sigma_s = 100.0$ cm

$\lambda = 1.55$ μm



$\sigma_s = 100.0$ cm

$\lambda = 1$ μm



2. (30 Points) Answer the following questions as **True** or **False**. For the **False** ones give the correct answer or the reason. For the **True** ones, justify your answer.

- a) Sine and sinh Gaussian beams have zero intensity at $r=0$ on the receiver plane : True, if propagation is in free space and the source is fully coherent. Otherwise we cannot see zero intensity at $r=0$.

- b) In annular Gaussian beam, the source size of the first beam is smaller than the source size of the second beam : False, the reverse is true, that is the source size of the first (primary) beam is larger than the source size of the second (secondary) beam.

- c) Huygens Fresnel integral is used to find the area on receiver plane : False, Huygens-Fresnel integral is used to find receiver field or intensity. If we take the integral of intensity over the transverse plane, then we arrive at power.

- d) Cos and cosh Gaussian beams have similar properties : Not exactly, they just have reciprocity relationship upon propagation, that is they are converted to each other after propagation.

- e) As propagation distance increases, the profile of the beam on the receiver plane becomes more spread : True, this is because of diffraction effects.