2021.04.28

Quiz #5

Name:

1. A monochromator (spectrometer) is used to obtain quasi-monochromatic light from a tungsten lamp. The linear dispersion of the instrument is 1 nm/mm and the exit slit of 200 μm is used. What is the coherence time τ_0 and length l_c of the light from the monochromator when set to give light of mean wavelength 500 nm?

2. This light is used to form fringes in an interference experiment in which the light is first amplitude-split into two equal parts and t hen brought together again such as in a Mach-Zehnder interferometer or a Michelson interferometer. If the optical path difference between the two paths is 0.5 mm, calculate the magnitude of the normalized correlation function $|\gamma|$ and the visibility V of the resulting fringes.

Sol.)

1. $\Delta\lambda = \left(1\ \text{nm/mm}\right)\left(200\ \mu\text{m}\right) = \left(\frac{10^{-9}}{10^{-3}}\right)\left(2\cdot10^{-4}\right) = 0.2\ (\text{nm})$

$l_c = \frac{\lambda^2}{\Delta\lambda} = \frac{(5\cdot10^{-7})^2}{(0.2)(10^{-9})} = 1.25\ (\text{mm})$

$\tau_0 = \frac{l_c}{c} = 4.17\ (\text{ps})$

2. $|\gamma| = 1 - \frac{\tau}{\tau_0} = 1 - \frac{\Delta l}{l_c} = 1 - \frac{0.5}{1.25} = 0.6$

$V = |\gamma| = 0.6$