# Exercise II



## Problem 1

- Show that the visibility of the Hong-Ou-Mandel (HOM) interference between two photons is just the lower limit of indistinguishability.
- Show that visibility is the same as the indistinguishability when the two photons are in pure state.

## Problem 2

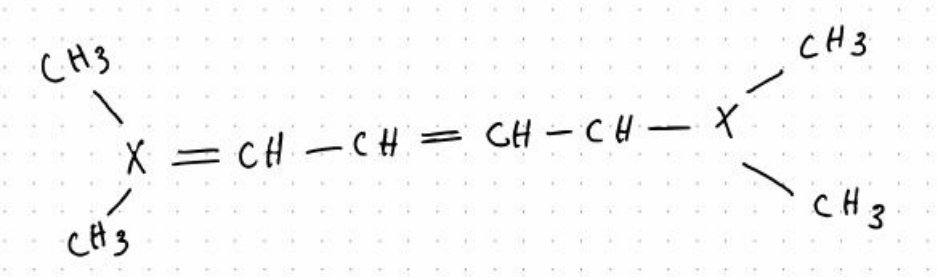
- Describe the working principle of Write-Read based Heralded deterministic single-photon sources (use $\Lambda$ - type three level atomic system).
- Can you make the schematics of the experimental setup.
- How the Stoke photons can propagate through the atomic ensemble with little or no absorption.

## Problem 3

- Describe the physics behind the size dependent optical and electronic properties of semiconductor nanoparticles used for single-photon sources.
- What are quantum well, quantum wire and quantum dots.

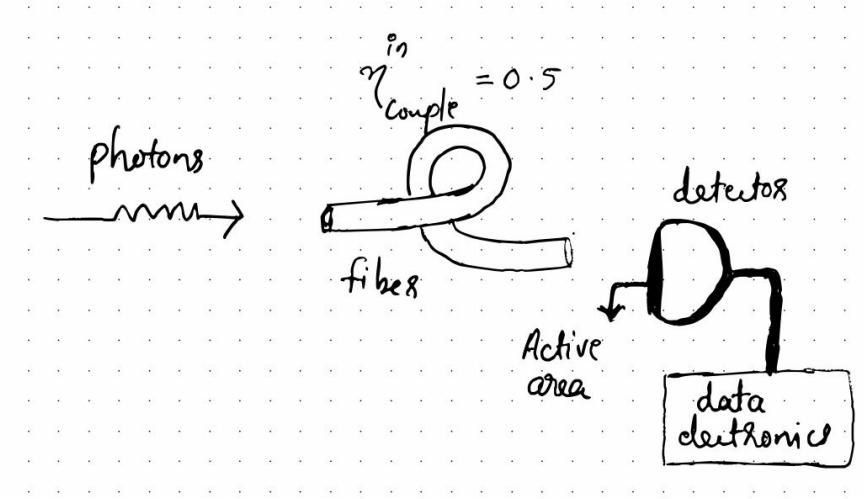
## Problem 4

- Explain how $\pi$- conjugated molecules ($SP_2$-hybridized orbitals) leads to quantum confinement of delocalized electronics and used as a single-photon sources.
- Is it possible to tune their emission properties, if so explain how ?. Consider the following fluorescence dye molecule.




## Problem 5

- Silicon-vacancy based single-photon source, emission wavelength at 738 nm, emits photons at a rate of $10^6 s^{-1}$. The photons are detected using a fiber coupled detector. The




parameters associated with the detector and those associated with the experiment is given below. Determine the detection efficiency ?

The fiber transmission $\eta_{fiber} = 0.6$ at 738 nm, the outcoupling efficiency is $\eta^{out}_{coupl} = 0.4$. The absorption efficiency $\eta_{absor}$ of the detector is 0.5. The internal quantum efficiency $\eta_{QE}$, that measure the fraction of absorbed photons that yield an output electric signal is 0.4. The readout electronics threshold efficiency, $\eta_{thresh}$, qunatifies the efficiency with which the output electronic signal is represented by external counting or timing electronic is 0.95.

- What will be the detection efficiency if we use free-space coupling.