

MICRO-523: Optical Detectors

Week One: Light - Exercises

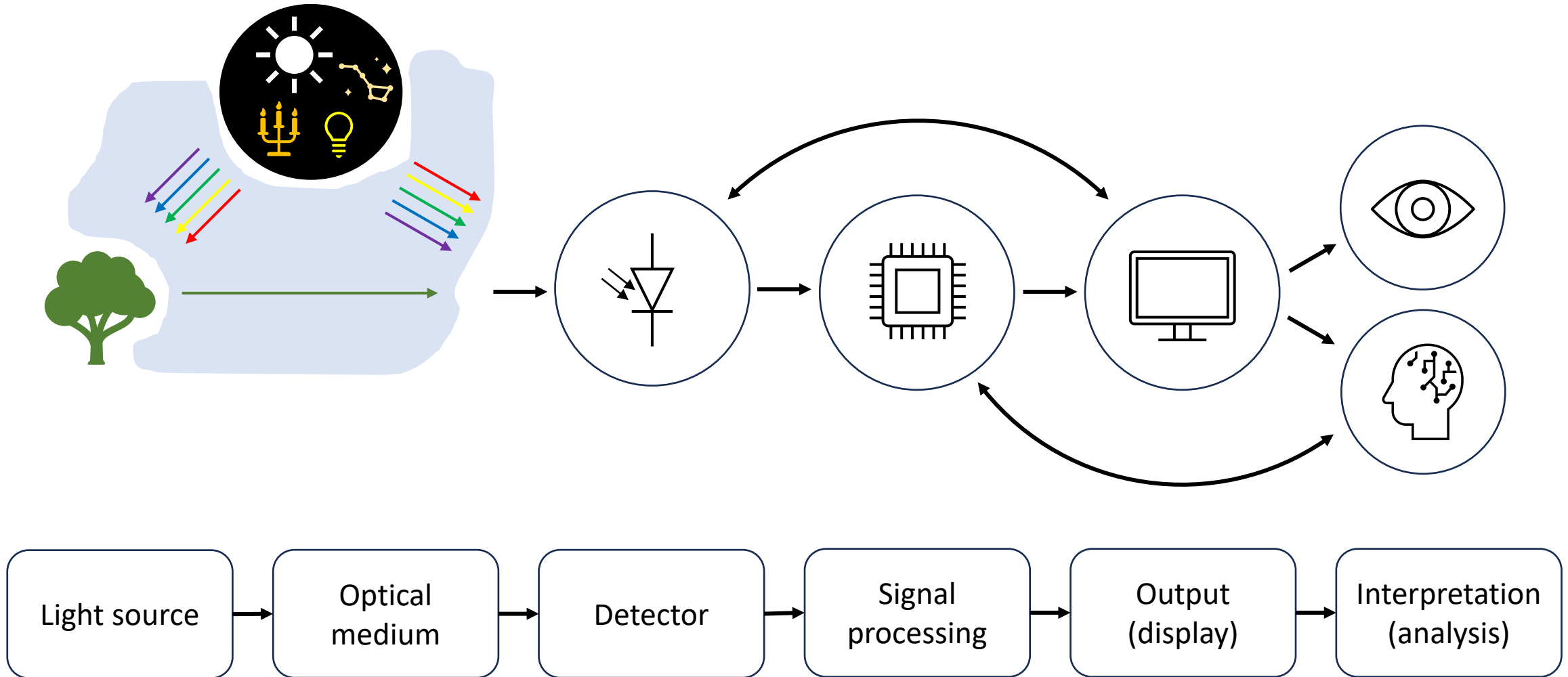
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Exercise 1.1: Components of an optical system



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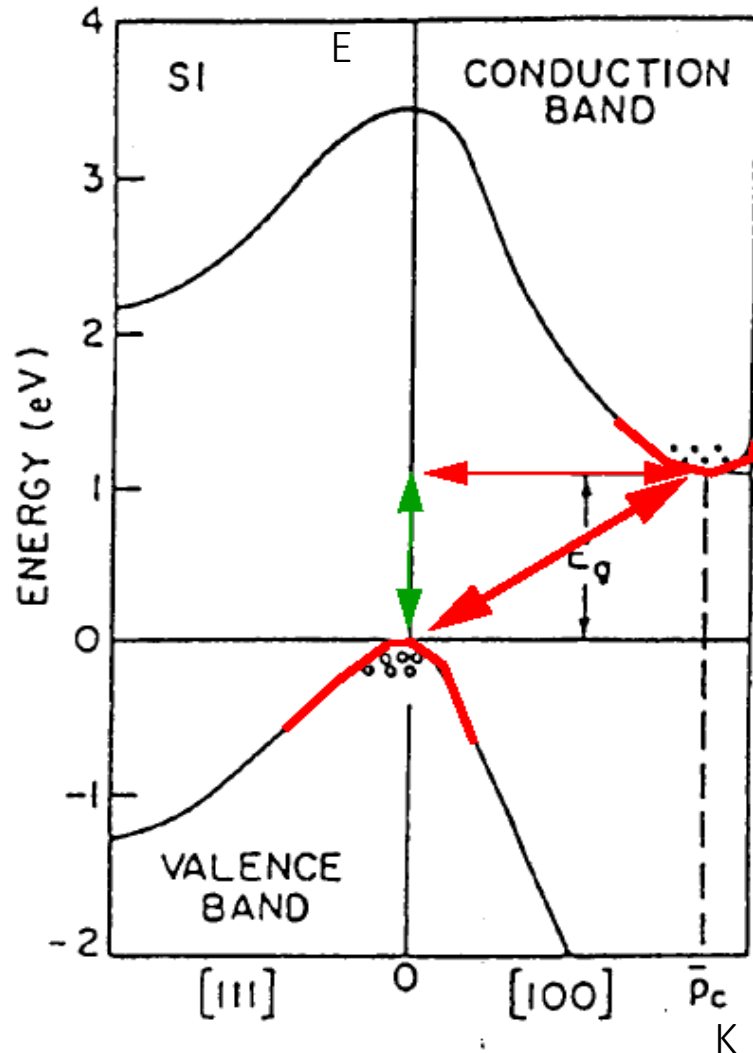
Select 1-2 key blocks in the previous slide:

- What are their main parameters?
- Can you think of examples?

Ideas:

- **Light source:** laser vs thermal light, CW vs pulsed operation, wavelength, ...
- **Optical medium:** air, tissue, ..., close by, far, ...
- **Detectors:** single-point vs 2D camera, all-solid-state vs photomultiplier tube, size, number of pixels, ...
- **Signal processing:** one single image vs a movie, averaging (mean value) vs peak finding, ...
- **Output (display):** human eye vs screen, colour palette, bit depth, ...
- **Interpretation:** simple intensity, time of arrival = distance, multispectral -> fruit ripening, ...

Exercise 1.2: Band structure: photons and acoustic phonons



Questions

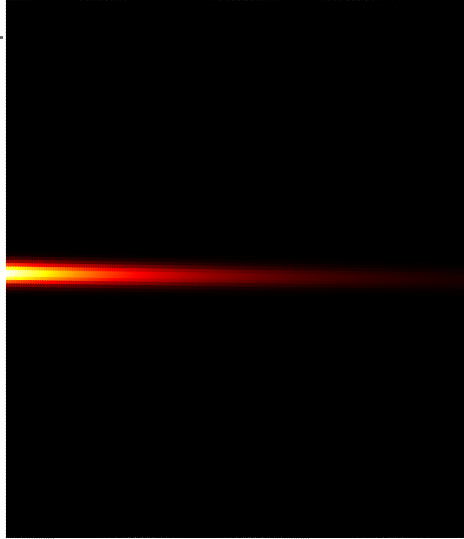
Consider a semiconductor with an indirect bandgap, for example silicon:

- 1) What is the maximum value of the horizontal axis (wave vector K) for a crystal with spacing $a_p = 3 \text{ \AA}$? (the spacing a_p corresponds to the spacing of the primary cell, i.e. to half of the crystal lattice).
- 2) What are the wave vector K and the energy E (in eV) of a photon of wavelength $\lambda = 1 \text{ \mu m}$?
- 3) An acoustic phonon is a crystal vibration that propagates at the speed of sound (about $v_a = 1500 \text{ m/s}$). What is the energy of such a phonon, knowing that its wave vector is at its maximum value (see question 1)?

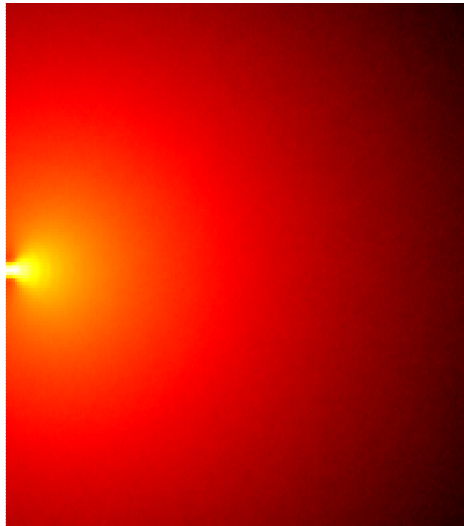
Exercise 1.2: Summary Table (to be completed)

	Photon	Phonons
Wavelength		
Speed		
K		
E/q in [eV]		

Exercise 1.3: Beer-Lambert in tissue



Absorption



Scattering

Questions

In tissue, scattering can represent an important component in addition to absorption

- Can you think of the related implications?
- Which kind of measurement set-up could be used?
- Which kind of illuminator could be used?
- Which kind of detector?