MICRO-523: Optical Detectors

Week Three: Optical Methods –Selected Examples

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Outline

3.1 Superresolution microscopy

3.2 Optical amplification noise effect on detection

3.3 Rain sensor

3.3 Sun sensor

Exercise 3.1: Superresolution microscopy

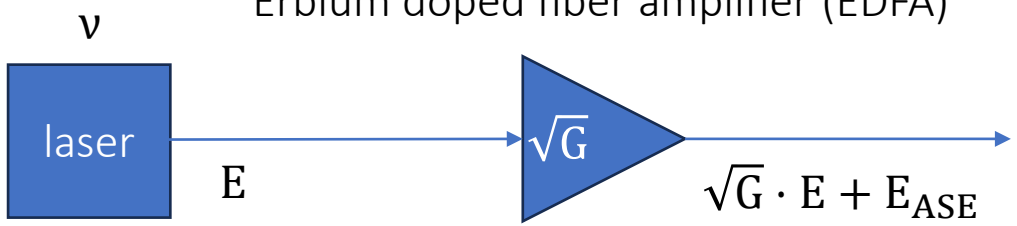
Questions

- Which kind of different microscope configurations exist (in particular widefield vs. Scanning confocal)?

  → Which kind of microscopy superresolution techniques exist?

- Which type of photonic detector would you use?

Exercise 3.2: Optical amplification noise effect on detection



ASE: amplified spontanoues emission

G: power gain

$\mathbf{n_{sp}}$: spontaneous emission factor

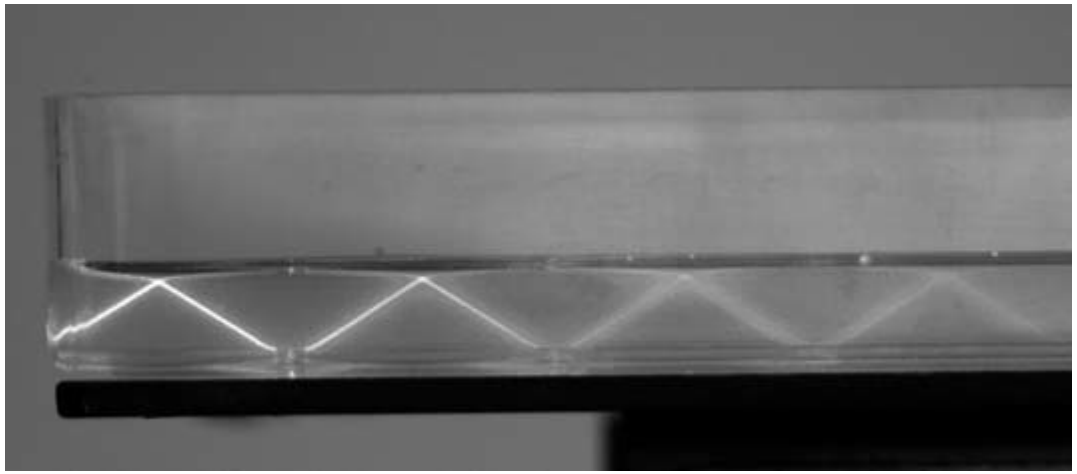
h: Planck's constant

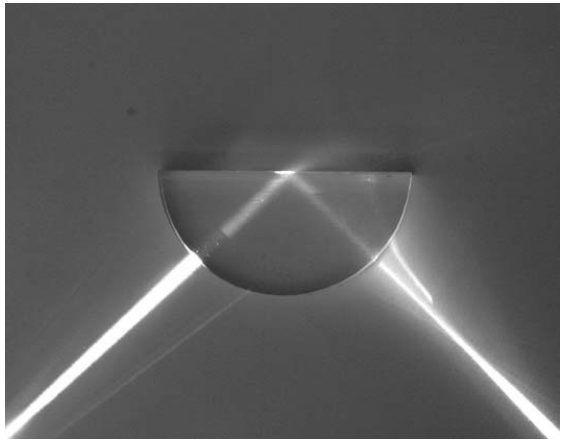
$\mathbf{B_o}$: optical bandwidth

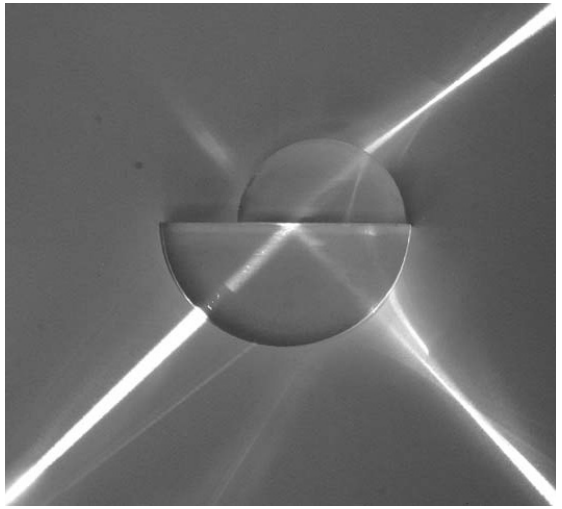
- Neglect all other noise terms apart from ASE
- Use for optical power $\mathbf{P = |E|^2}$
- **Sketch the power spectral density [Watt/Hz] and highlight $\boldsymbol{\nu}$, $\mathbf{P}$, $\mathbf{P_{ASE}}$, $\mathbf{B_o}$ for G=0, G=25 and G=100**
- **What is the ratio between the signal at frequency $\boldsymbol{\nu}$ and noise ? how can we improve the signal to noise ratio?**

Exercise 3.3: Rain Sensor

Design a rain sensor for a car windshield based on these experiments.

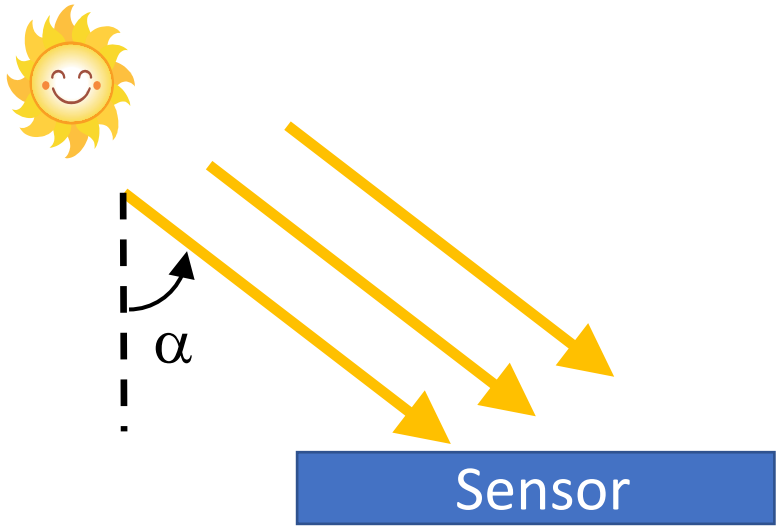






Hints: water presence → total internal reflection
What happens when there is a gap?

Exercise 3.4: Sun Sensor



Hint: sun at ∞, α to be determined
Make it as easy as possible → PSD?

Design a sensor to measure the azimuth and the elevation of the sun!

A potential application could be to guide a satellite.

1) Location sensor:
-S.W. Janson «micro/nanotechnology for picosatellites», 22nd Annual AIAA/USU Conference on small satellites, paper SSC08-VII-6

2) Camera:
-N. Xie, A. Theuwissen, «Low-power high-accuracy micro-digital sun sensor by means of a CMOS image sensor», Journal of Electronic Imaging 22(3), 033030 (Jul–Sep 2013)