Lecture 01-12

How to find and evaluate scientific papers

- READ THE ABSTRACT
- Check out the diagrams and plots
- Jumping to “Results” or “Conclusion” can help you determine if its worth reading more thoroughly

Places to look:

- https://www.spiedigitallibrary.org/
- https://opg.optica.org/
- https://journals.sagepub.com/home/aspc

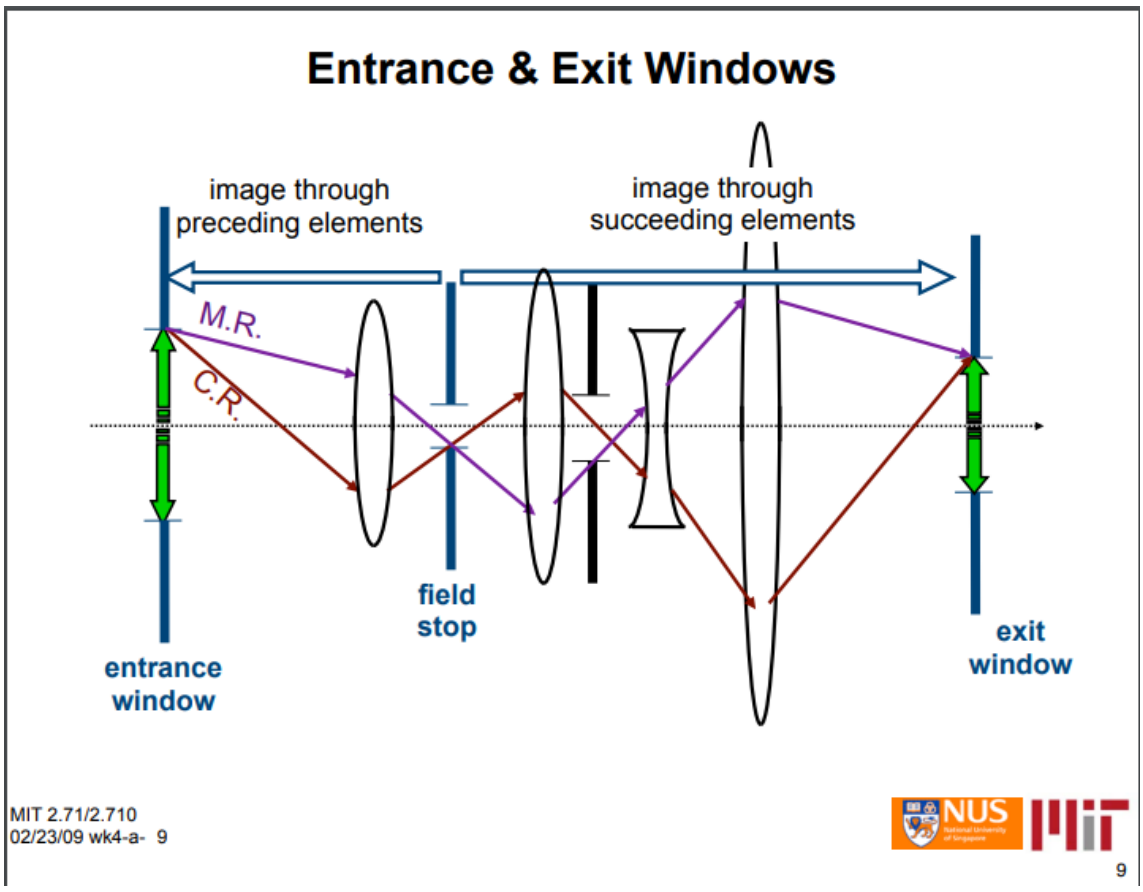
Use Web of Science! Like google scholar but more results

https://www.webofscience.com/

Image Formation

Terms to know:

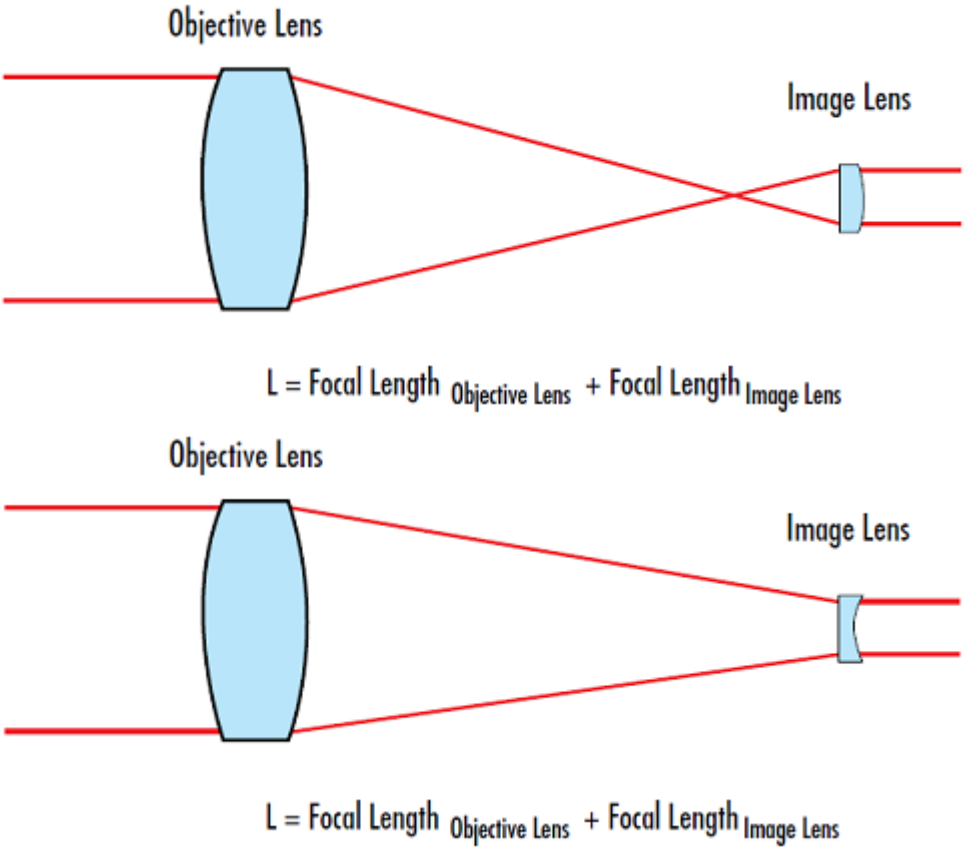
- **Converging lens:** Bends light towards a positive focus, forms a real image
- **Diverging lens**: light appears to diverge or emanate from a virtual image at the focal plane
- **Aperture Stop:** Limits the amount of energy that can enter the optical system, limits area that can enter
- **Field Stop:** limits the angle through which light can enter



Shamelessly stolen from MIT OCW

A focal systems and beam expanders

- Sometimes your laser beam is too small (or too big) to illuminate your target appropriately
- You need to embiggen it or shrink it



- No image is formed at the output
- Expanding the beam lowers the divergence, and paradoxically keeps the beam together better at longer distances

Light sources

- Narrowband
  - Lasers!!!!
- Broadband Sources
  - Lamps
  - LEDs
  - Supercontinuum sources

Lasers and how they work

- Lasers work via stimulated emission
  - Photon goes in and it picks up another photon that goes in lock step with it
- We don’t get photons for free!
  - We need to pump the material so there is a population inversion
  - Light kicks electrons up into a higher energy level and the photons are emitted as the electrons fall into a lower energy level
- To get oscillation from amplification we need feedback!
  - Put mirrors at both ends of the amplifier with one mirror slightly more transparent so that a little bit of light leaks out of the cavity!

Why do you want a laser?

- Low divergence!
  - The light goes in the same direction and doesn't spread out much
- Monochromatic!
  - Very narrow linewidth limited by the cavity resonance and the material that's lasing on the order of angstroms
- Brightness!
  - Lots of light per square area!
- Coherence!
  - Photons are spatially and temporally in lockstep. Can be used for holography or techniques requiring high intensity

Broadband Sources

- Lamps:
  - Really broadband!
  - Low coherence
  - Total power can be high, but W/nm can be relatively low
  - They get hot!
- LEDs:
  - Semiconductor sources
  - Wider bandwidth than lasers, but significantly smaller than lamps, ~10nm in visible and NIR
  - High brightness
- Supercontinuum sources:
  - (My favorite)
  - Highly coherent source driven by a laser
  - Cascaded nonlinear interactions lead to broad bandwidth
  - 100nm-2um bandwidths

When would it make sense to use a lamp vs a laser?