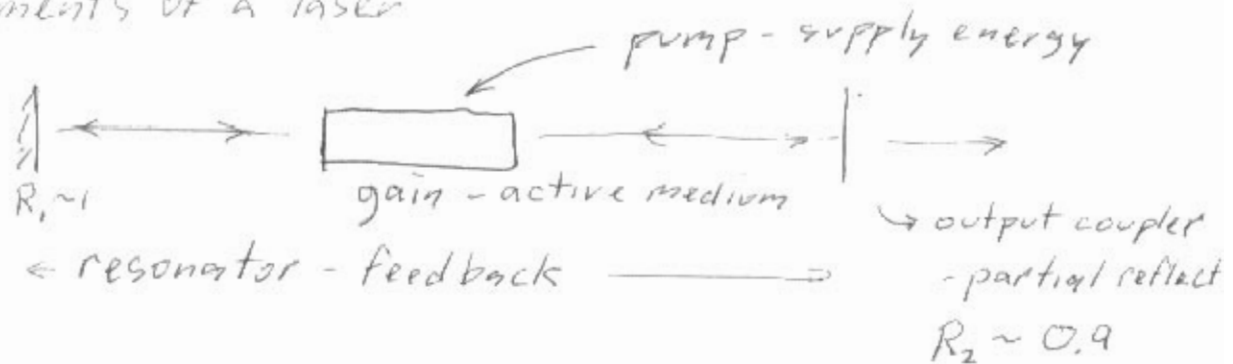


# Laser Physics.

What is a laser?

Light amplification by stimulated emission of radiation  
originally demonstrated in microwave: maser.

elements of a laser



steps.

- 1) pump source supplies energy to gain medium
- 2) gain medium gives off light
- 3) resonator directs light back thru gain → amplify
- 4) output coupler lets some out

w/ initial seed energy  $E_0$

after one round trip:  $E_0 G_0^2 R_1 R_2$

at "threshold" round-trip gain  $> 1$   
laser "oscillates", "lases"

$$G_0^2 R_1 R_2 > 1$$

laser oscillator generates laser beams

- continuous wave (CW)
- pulsed.

laser amplifier:

- just gain:



### Range of lasers

duration { CW - can make single-frequency, stabilized lasers  
femtosecond - as short as 0.5 - 2 cycles

average power:

HeNe, laser pointer ~ mW

welding - CO<sub>2</sub> lasers > 10 kW (CW)

military - COIL > MW (long pulse)

single atom lasers - photon-on-demand (almost)

peak power: pulse energy / pulse duration

> PW (petawatt = 10<sup>15</sup> W) in a "chirped pulse amplifier"  
CPA

wavelength / gain media

microwave (maser): ammonia NH<sub>3</sub>

LWIR: CO<sub>2</sub> 10.6 μm

MWIR: "quantum-cascade" 3-7 μm

near-IR: Nd:YAG 1.06 μm

Er, Ho fiber, bulk

laser diodes: 750 nm - 1600 nm

visible: dye lasers, ion lasers Ar<sup>+</sup>, Kr<sup>+</sup>

HeNe, Cu vapor

UV excimer

X-ray

pumping schemes:

electrical (diode lasers)

Flashlamp

arc lamp

laser

Solar

chemical

discharge - glow or arc.

plasma.

Laser jock's motto: "If you pump it hard enough,  
it will lase!"