

University of Virginia

Department of Physics

Physics 606: How Things Work II

Lecture #31 Slides:

Lasers

Lasers

Question:

In movies, laser beams are always shown as bright pencils of light streaking through the air or space. If you were to look from the side at a beam from a powerful laser, would you be able to see that laser beam as it travels past you?

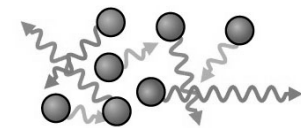
1. Yes
2. No
3. Yes in air, No in space

Observations About Lasers

- They produce narrow beams of intense light
- They often have pure colors
- They are dangerous to eyes
- Reflected laser light has a funny speckled look

Spontaneous Emission

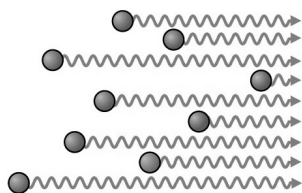
- Excited atoms normally emit light spontaneously
- Photons are uncorrelated and independent
- Incoherent light



Incoherent radiation from excited atoms

Stimulated Emission

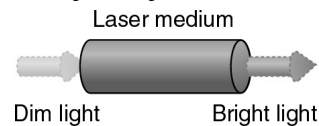
- Excited atoms can be stimulated into duplicating passing light
- Photons are correlated and identical
- Coherent light



Coherent radiation from excited atoms

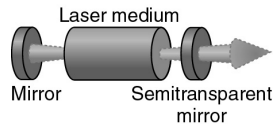
Laser Amplification

- Stimulated emission can amplify light
- Laser medium contains excited atom-like systems
- Photons must have appropriate wavelength, polarization, and orientation to be duplicated
- Duplication is perfect; photons are clones



Laser Oscillation

- Laser medium in a resonator produces oscillator
- A spontaneous photon is duplicated over and over
- Duplicated photons leak from semitransparent mirror
- Photons from oscillator are identical



Properties of Laser Light

- Coherent – identical photons
- Controllable wavelength/frequency – nice colors
- Controllable spatial structure – narrow beams
- Controllable temporal structure – short pulses
- Energy storage and retrieval – intense pulses
- Giant interference effects
- Apart from these issues, laser light is just light

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Types of Lasers

- Gas (HeNe, CO₂, Argon, Krypton)
 - Powered by electricity
- Solid state (Ruby, Nd:YAG, Ti:Sapphire, Diode)
 - Powered by electricity or light
- Liquid (Dye, Jello)
 - Powered by light
- Chemical (HF)
- Nuclear

Cameras

Question:

If you're building a camera and want to make a larger image (a telephoto lens) you should:

1. increase the diameter of the lens
2. decrease the diameter of the lens
3. increase the curvature of the lens
4. decrease the curvature of the lens