Unit-3

Lecture -6

LASER, Operation, Emission Process, classification, Injection Laser

The LASER

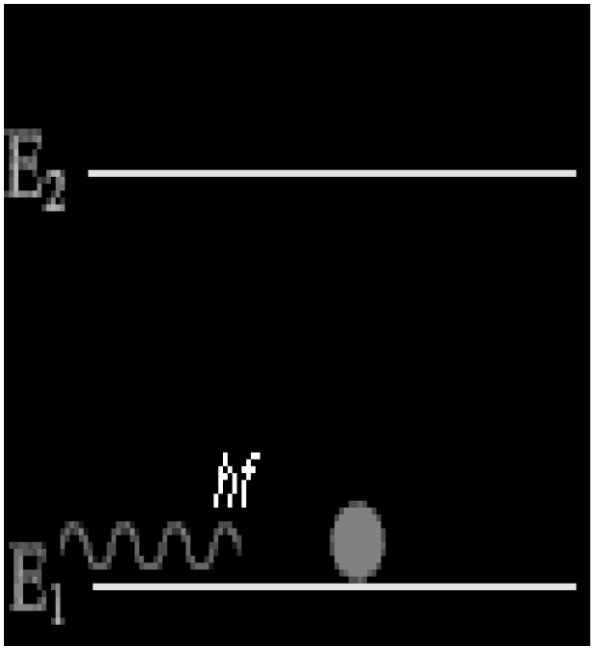
- Light Amplification by 'Stimulated Emission' and Radiation (L A S E R)
- Coherent light (stimulated emission)
- Narrow beam width (very focused beam)
- High output power (amplification)
- Narrow line width because only few wavelength will experience a positive feedback and get amplified (optical filtering)

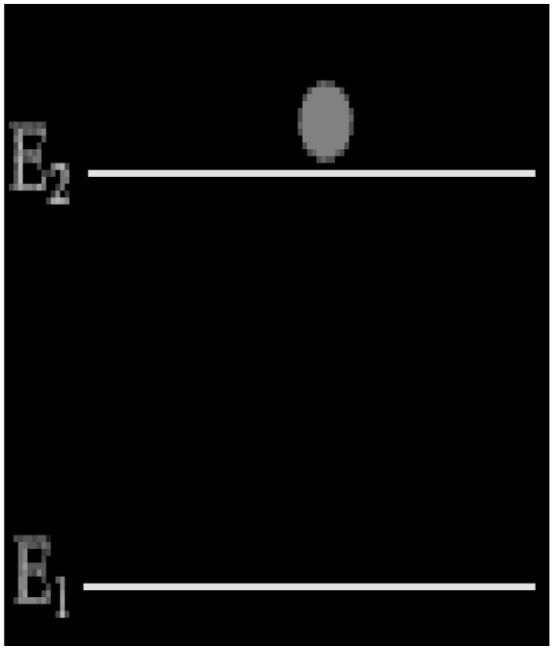
Fundamental Lasing Operation

- **Absorption:** An atom in the ground state might absorb a photon emitted by another atom, thus making a transition to an excited state.

- **Spontaneous Emission:** Random emission of a photon, which enables the atom to relax to the ground state.

- **Stimulated Emission:** An atom in an excited state might be stimulated to emit a photon by another incident photon.


E_2
hf
E_1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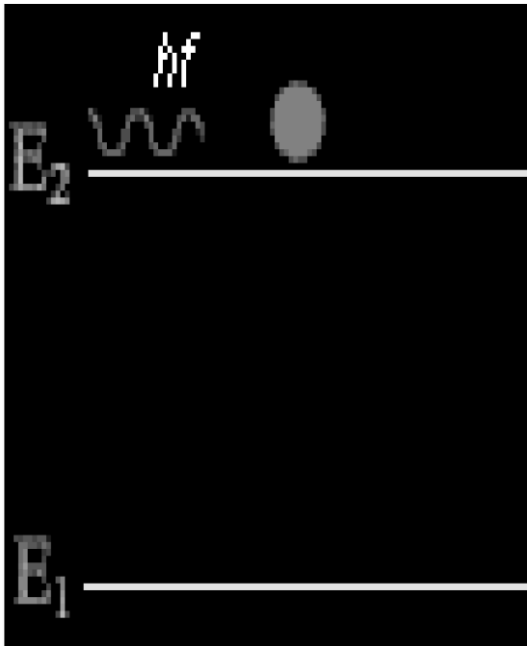
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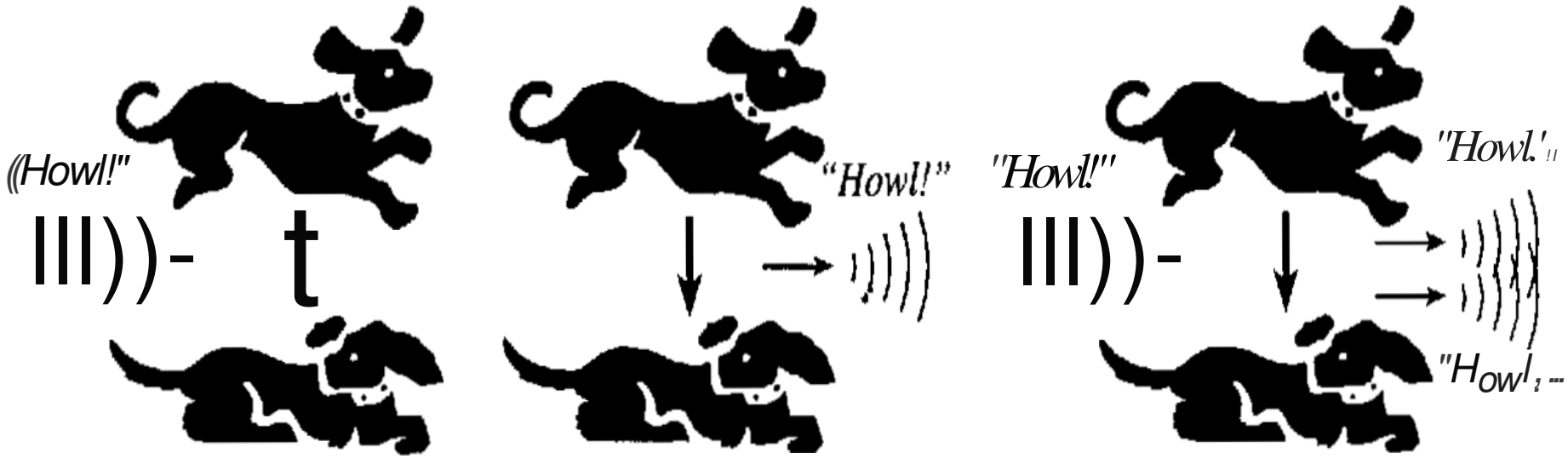
Howling Dog Analogy

1. absorption: a dog in the ground state might hear the howl from another dog and become excited, thus making a transition to the excited state.

2. spontaneous emission: a dog in the excited state might randomly let out a howl, which, through release of tension, enables him to relax to the ground state.

3. stimulated emission: a dog in the excited state might be stimulated to let out a howl when he hears the howl from another dog. The single howl becomes two howls voiced simultaneously, thus sounding like one howl with twice the intensity!

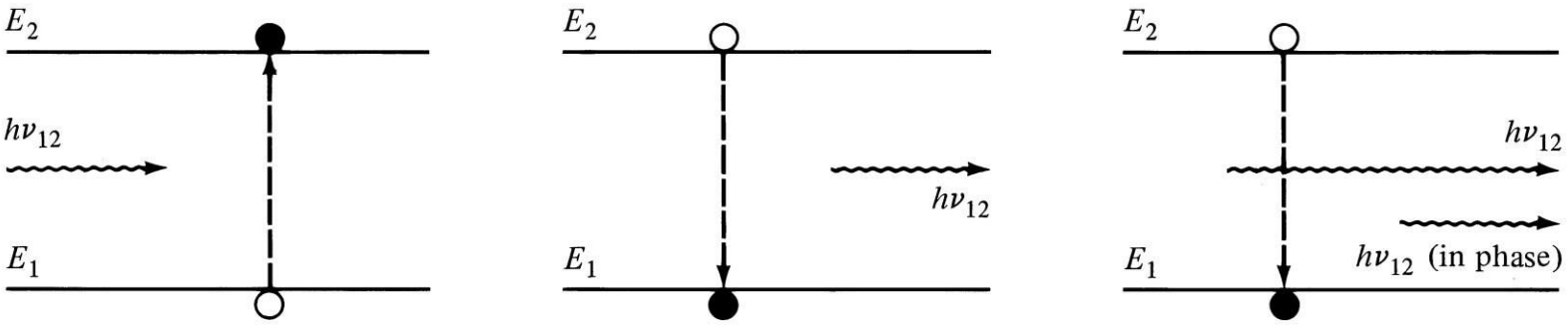


absorption spontaneou emmi t}a stimulated emission

In Stimulated Emission incident and stimulated photons will have

- Identical energy → Identical wavelength → Narrow linewidth
- Identical direction → Narrow beam width
- Identical phase → Coherence and
- Identical polarization

Laser Transition Processes (Stimulated and Spontaneous Emission)

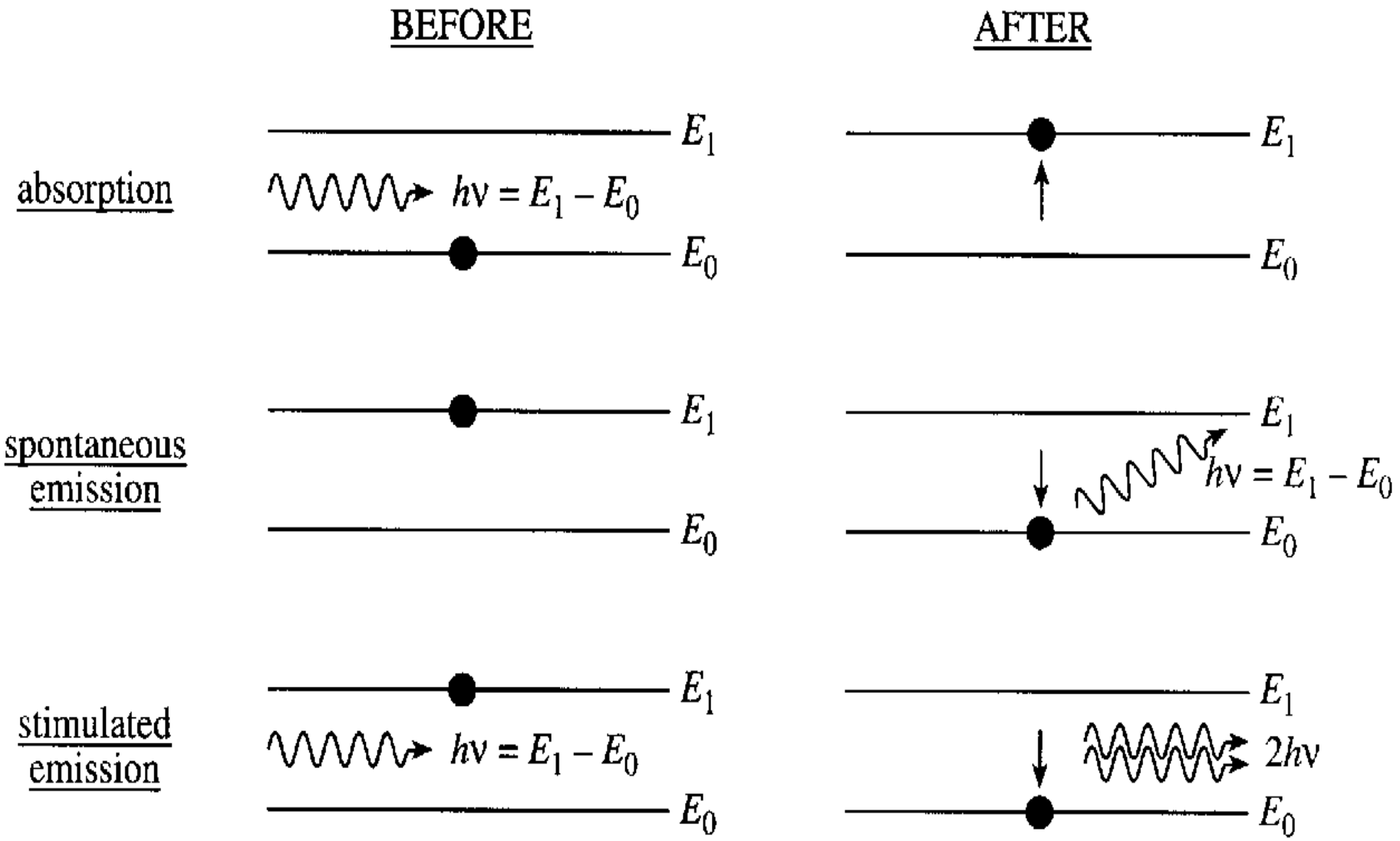


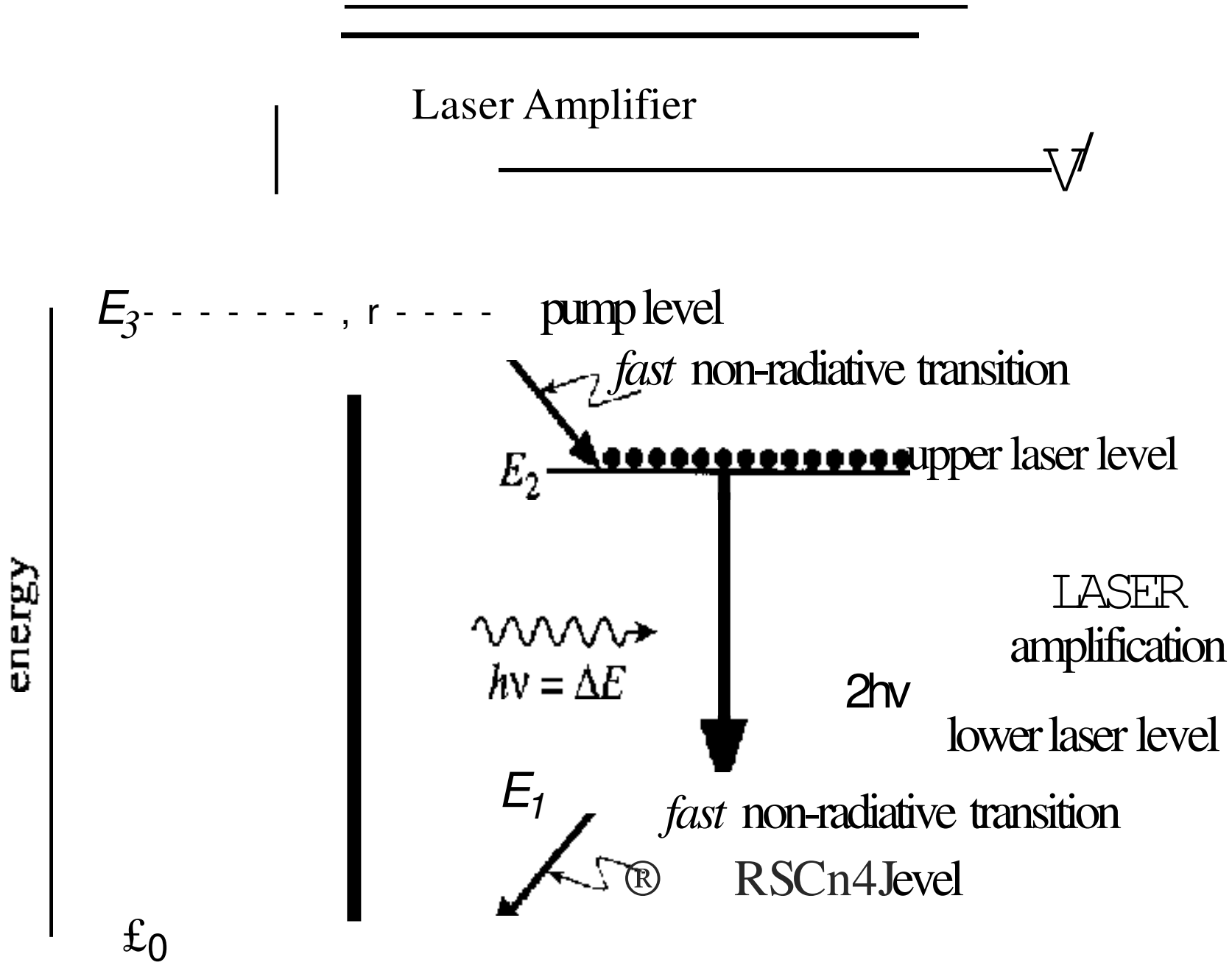
Energy absorbed from the incoming photon

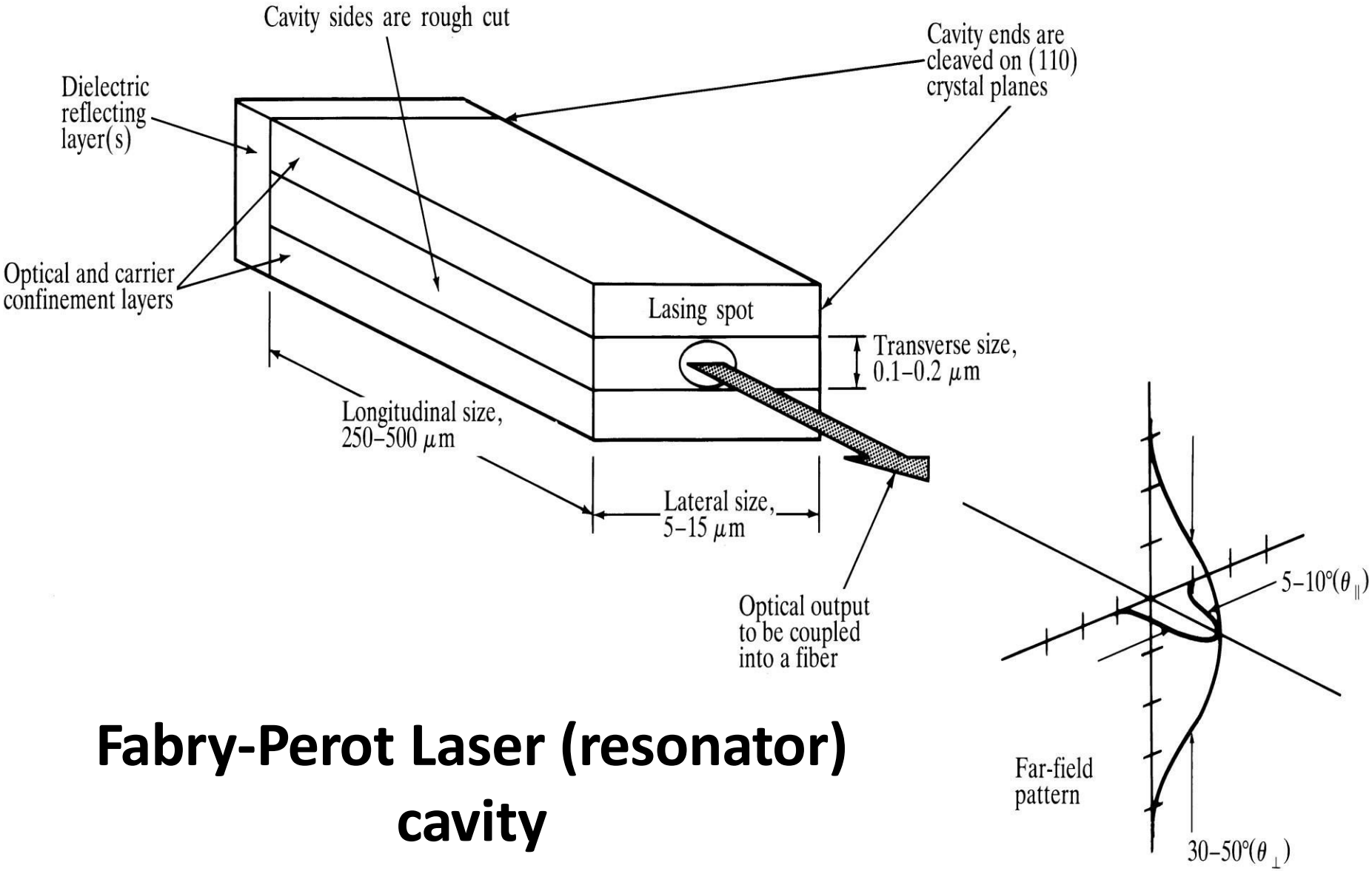
Random release of energy

Coherent release of energy

Stimulated Emission




Laser Amplifier
E_3
pump level
fast non-radiative transition
E_2
upper laser level
energy
LASER
amplification
$h\nu = \Delta E$
2hv
lower laser level
E_1
fast non-radiative transition
RSCn4Jevel
£0



Fabry-Perot Laser (resonator) cavity

Mirror Reflections