Nd³⁺ : YAG laser

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Abstract:

This article is about the Nd^{3+} : YAG laser system.

This is one of the popular four level laser systems where the trivalent neodynium Nd^{3+} ion is doped in Ytrium-Aluminium-Garnet($Y_3Al_5O_{12}$), an optically isotropic crystal, commonly known as YAG. The active centres are the Nd^{3+} ions and except housing the Nd^{3+} ions The crystal atoms have no for the role in the lasing action.

Construction:
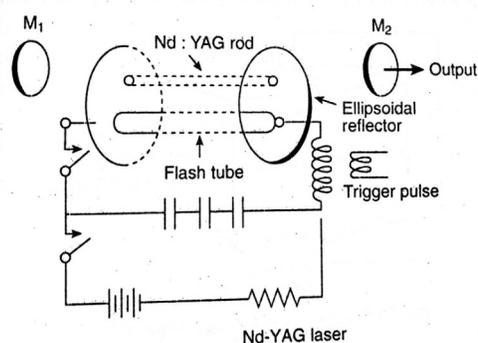
A typical Nd: YAG laser is illustrated in the figure below.

It consists essentially of an elliptically cylindrical reflector about 10 cm in length and 12 mm in diameter, in which the laser rod recides along one of its focal lines.

Along the four other focal line, the flash tube placed. Both ends of the laser rod are appropriately polished and silvered so as to serve as an optical resonator. The light that leaves one of the foci of the ellipse passes through the other focus on reflection from the silvered surface of the reflector. The whole of the radiation of flash tube is thus focussed on the laser rod.

Action:

It is essentially a four level system with terminal laser level E2 much above the ground level. The optical pumping is made with light having wavelength ranging from 500 to 800 nm from a Krypton arc lamp when the ground state Nd^{3+} ions are excited to the multiple energy level at E4. The metastable level E3 is the upper laser level while E2 is the lower laser level. As the excited Nd^{3+} ions make quick downward transitions from the upper energy bands, E3 gets rapidly populated. E2 being much above the ground level it cannot be populated by Nd^{3+} ions through thermal transition

from the ground level. Thus population inversion occurs readily between E3 level and E2 level. The laser emission is in infrared region having $\lambda \approx 1.06$ μm. Being a four level laser, population inversion can be sustained in the face of continuous lasing.

Four-level laser system and transitions in Nd-YAG laser
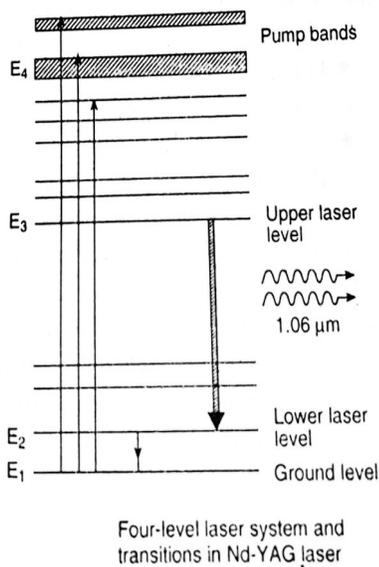
References:

Modern atomic and nuclear physics-AB Gupta