THE USE OF LASERS IN PEDIATRIC SURGERY

Thesis

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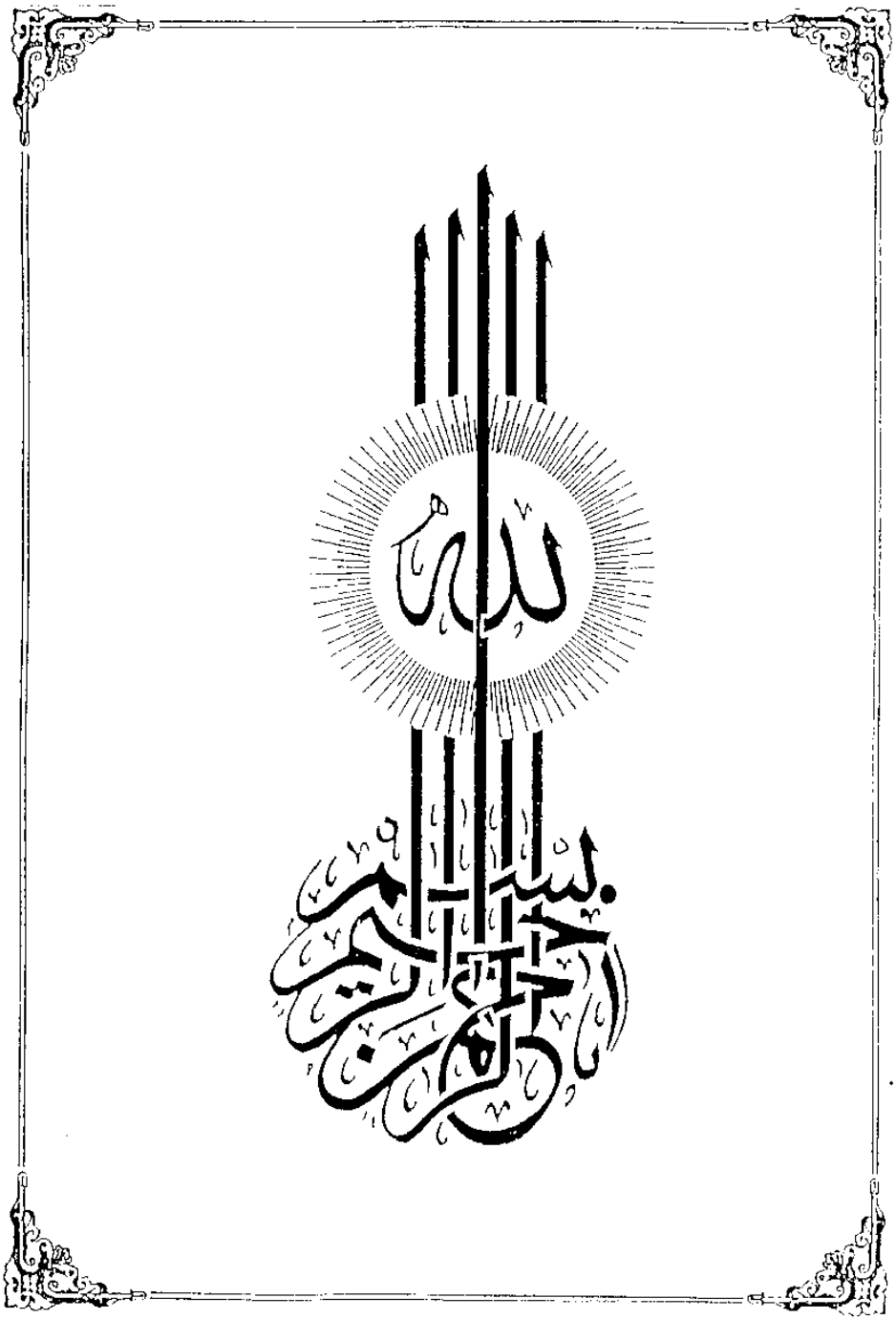

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Laser Physics

Laser is an acronym derived from the phase light amplification by stimulated emission of radiation. Laser thus refers to a process by which light waves are amplified and not merely to the device that produces this effect.

History of laser

The process of stimulated emission was first described by Albert Einstein in the early 1900s as an offshoot of his quest to show the inherent singular nature of the four basic forces of the universe.

Quantum theory of radiation (1917)

Einstein [24] stated that under certain circumstances an atom can absorb light or other forms of radiation and then be stimulated to give back its borrowed energy. He defined light (traveling electromagnetic wave) as a form of energy particles, and photon as a unit of this energy (Maimon & Gebson [58] 1986). The practical significant of Einstein's discovery was in 1953. Townes constructed the first laser as an acronym for microwave amplification by stimulated emission of radiation .

The first laser was constructed by Theodore Maimon [57] in 1960 (fig 1). He used a small rod of synthetic ruby as laser medium. Ruby is predominantly AL_2O_3 with a small percentage of Cr_3O_4 held in the crystal lattice.

In 1961 Gonson developed the ND: YAG (neodymium doped yttrium aluminum garnet) laser. In the same year, Javen et al.

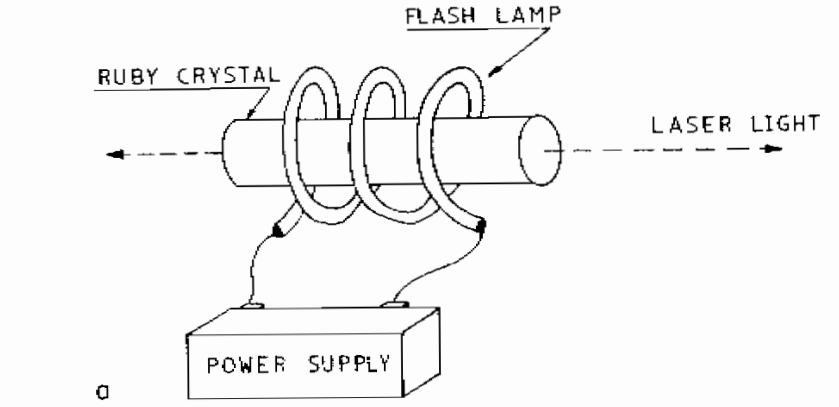

FIGURE 1 (a) Schematic drawing of the first laser. (b) Photograph of the first laser. (Courtesy of Dr. T. Maiman.)

developed the first gas laser and demonstrated the first continuously operating laser using a mixture of helium and neon (Fuller [30] 1987). In 1962 an Argon laser wave was developed by Bennet [14] et al. The carbon dioxide laser was introduced by Patel [69] et al in 1964. Following this there was a great advancement in the use of laser in many fields including surgery [70].

Basic principles to understand what is meant by laser

It is first necessary to gain an understanding of the nature of light itself. ***Light*** is only one small portion of a continuum of electromagnetic energy that goes from cosmic rays to radio waves (fig. 2).

The term light is used to refer to an electromagnetic wave. These waves are characterized by four qualities: wavelength (λ), frequency (f), velocity (v), and amplitude (A) (fig. 3).

The ***wavelength*** is the distance between two successive crests. The wavelength of visible light waves range from about 385 to 760 nanometers (nm) (fig. 2). The color of visible light is determined by the wavelength. The chart of the electromagnetic spectrum is organized according to wavelength. We usually speak of the wavelength of laser light in terms of nanometers (nm) and at times in terms of micrometers (μm) or angstrom units (A).

Amplitude refers to the height of the wave form.

The ***frequency*** of a wave is the number of waves passing a given point per second and is usually expressed in cycles per second, or

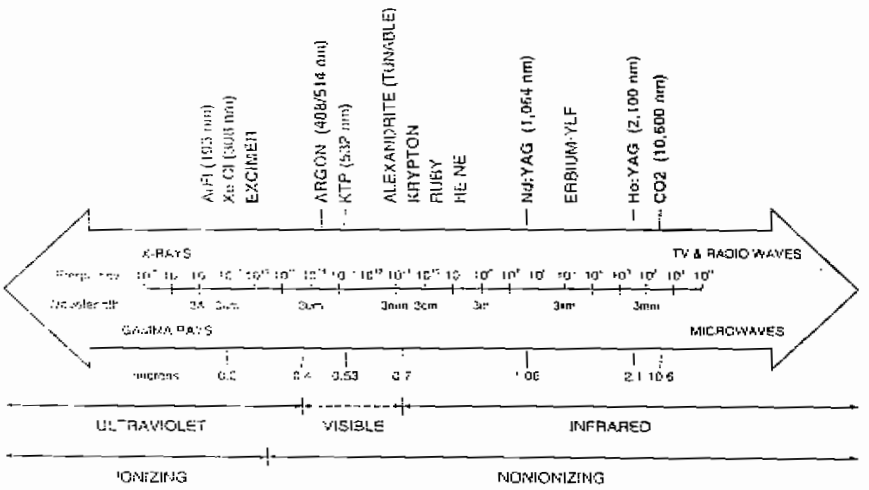

FIGURE 2 The accepted electromagnetic (EM) spectrum. All lasers are represented on the EM spectrum depending on their specific wavelength.

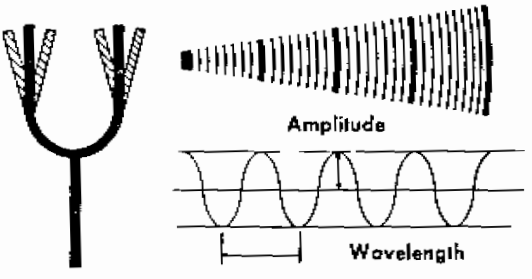

Fig 3 —Wave characteristics.