LASER APPLICATIONS IN UROLOGY

An Essay
Submitted in Partial Fulfilment
for the Degree of M.Sc. in Urology

By

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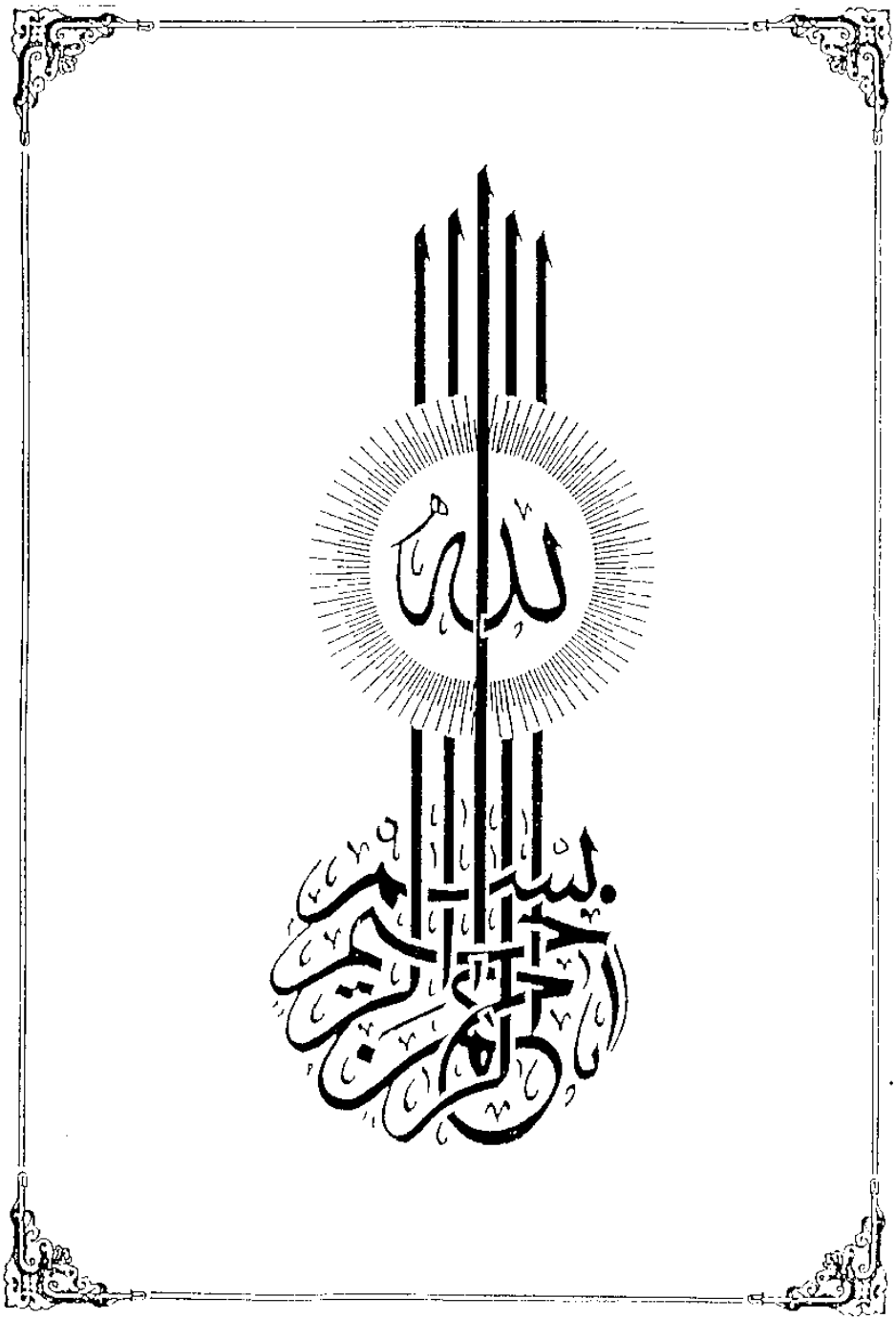
1995

بسم الله الرحمن الرحيم

وفوق كل ذي علمٍ عليم

صدق الله العظيم



To My Parents
and Sisters,
No words could express my gratefulness for your support.

To My Wife,
This work would have never seen the light without you

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Tarek Osman

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INTRODUCTION

INTRODUCTION AND AIM OF THE WORK

Over the last decade, laser proved to be an efficient tool in management of many urologic diseases such as bladder tumours, benign prostatic hyperplasia and urinary calculi.

The unique property of laser in applying energy in a quite precise, accurate and well-controlled manner to the intended surface area made laser technology successfully used in many urologic procedures.

Our aim in this study is to emphasize the physical properties and mechanisms of action of each type of laser and its clinical applications in urologic practice. This will be according to the most recent and acceptable controlled studies and clinical trials in this field.

LASER PHYSICS AND TISSUE INTERACTIONS

LASER PHYSICS

The word "**laser**" is an acronym which stands for "**Light Amplification by Stimulated Emission of Radiation**".

Laser is light energy that is part of the electromagnetic wave spectrum (Fig. 1.1). Most of the commercially available lasers are either in the visible or infrared spectrum of light ***(Smith and Dixon, 1985).***

* Principles of Spontaneous and Stimulated Emission:

In a normal population of atoms, electrons occupy certain energy states. Most of them occupy the lowest energy state "**the ground state**" (E_o), less number of electrons occupy the higher energy state (E_1), less occupy E_2 and so forth (E_0, E_1, E_2, E_3, ...) (Fig. 1.2).

When an atom is excited, one or more of its electrons move into states of higher energy and as excitation continues, more electrons will move into higher energy states (Fig. 1.3).

When the number of electrons occupying the higher energy states are more than those occupying the lower energy states, the population of the atom will be called an **inverted population** (the phenomonon of population inversion, first described by Boltzman, 1941) (Fig. 1.3).

As the state of population inversion is an unstable state each excited electron will eventually drop down to the ground state. As it is jumping from a higher energy level to a lower one, it spontaneously emits energy, a process known as **spontaneous emission** (Fig. 1.4). When this takes place, the amount of the emitted energy (photon) will be equal to the difference between the energy of the upper level and that of the lower level.

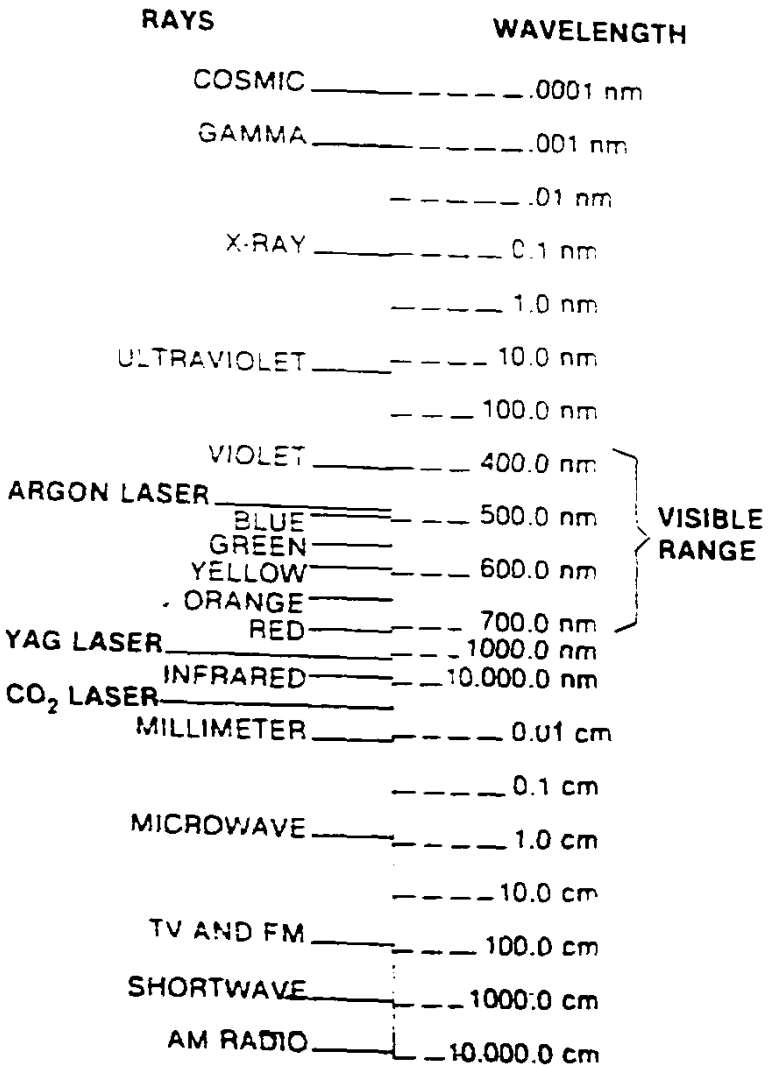

Figure 1.1 Electromagnetic wave spectrum showing location of medical laser wavelengths. (Stein, 1986)

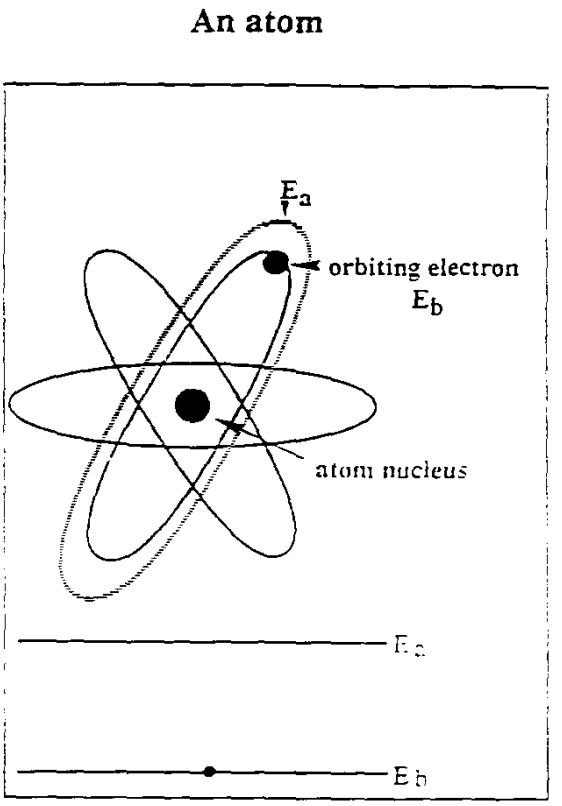

Fig 1.2a : Basic diagram of an atom.

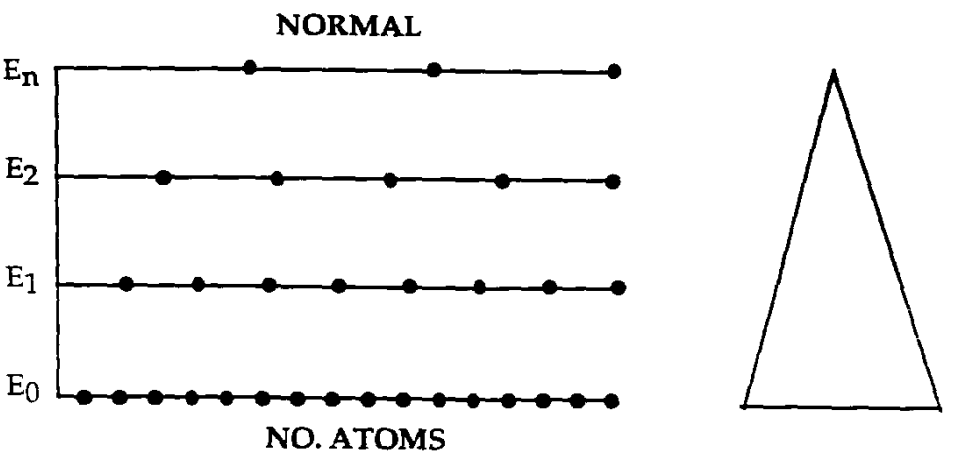

Fig 1.2b: Energy state of normal population of atoms.
(Stein and Kendall, 1984)

Excited atom (absorption)

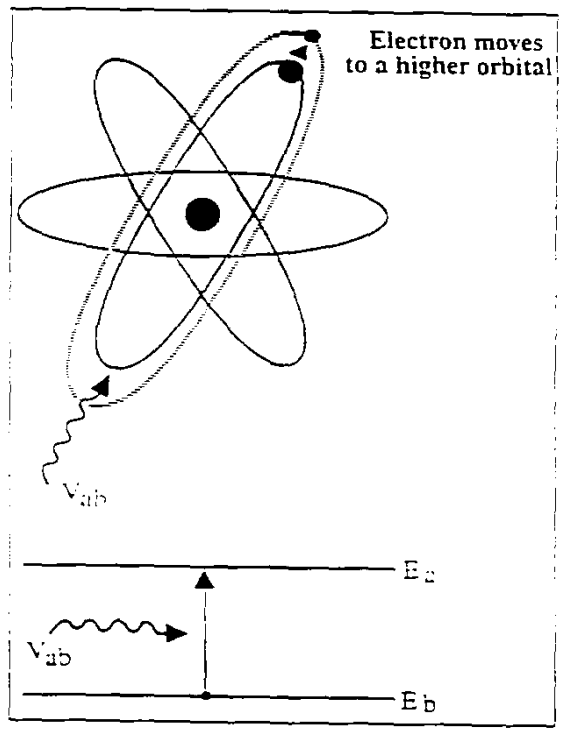

Fig 1.3a : Diagram of an excited atom.

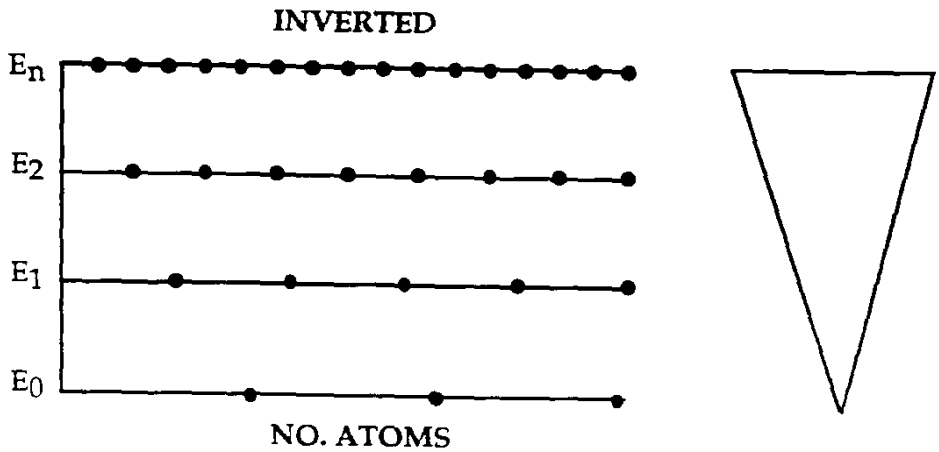

Fig 1.3b: Energy state of inverted population of atoms with most atoms at higher energy levels. (Stein and Kendall 1984).