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AN INITIAL RESEARCH FOR X-RAY & γ-RAY LASERS

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INTRODUCTION

A laser is a device that amplifies light and produces a high directional, high intensity beam that has a very pure frequency. Its powers vary from $10^{-}9$ to 1020 Watt and frequencies from 1011 to $10^{-}11$ Hertz. Lasers have pulse energies as high as 104Joule and pulse durations as short as $6\times10^{-}15$sec.They can easily drill holes in the most of durable materials and can weld detached retinas within the human eye.

Laser is used to measure speed, in CD players and in laser printers, laser guns etc. The power contained in laser is both fascinating and frightening. There is nothing magical about a laser. It can be thought of as just another type of light source. Furthermore, we will understand that how a laser light differs from ordinary light. Light is really an electromagnetic wave. This is also true for laser light but

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it is more parallel than any other source of light and beam diverge very little. [With a good laser an object at a distance of 1 km can be illuminated with a dot about (2.3 inches) in radius].As it is so parallel that the concentration of light energy becomes so great that you can cut and drill using it. Due to this property it is used in surgical appliances and in CD players.

Unlike an ordinary light source it can also be made highly monochromatic so that just one light wavelength is present in it. Due to high field strength of laser light it can interact with inter-atomic fields and very peculiar properties of the matter can be understood.

FUNDAMENTAL IDEAS INITIATED LASER

Initially at Bell Telephone Laboratories, the laser was often called the optical maser. In 1998 even Bell Labs uses the term laser. In 1917, Albert Einstein laid the foundation for the invention of the laser. In 1928, Rudolph W. Landenburg confirmed the existence of stimulated emission. In 1939, Valentine A. Fabrikant (USSR) predicted the use of stimulated emission to amplify “short waves”.

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In 1947, Willis E Lamb and R.C Rutherford found apparent stimulated emission in hydrogen spectra and made the first demonstration of stimulated emission. In 1950, Alfred Kastler (Nobel Prize For Physics 1966) proposed the method of optical pumping. A LASER is a MASER that works with higher frequency photons in the ultraviolet or visible light or infra-red spectrum region. As MASER stands for Microwave Amplification by Stimulated Emission of Radiation and LASER stands for Light Amplification by Stimulated Emission of Radiation

REVIEW OF LITERATURE

A laser is a coherent source of light which acts as an optical oscillator and an optical amplifier. The optical oscillator is to be made up of two plane parallel mirrors in which one of the mirrors acts as a window for energy output while other mirror is fully reflecting. The mirrors which acts as a window is partially reflecting so a part of the energy is fed back into the laser material. The laser material kept in the cavity acts as an optical amplifier. The optical gain or amplification is possible if the number of stimulated

emissions per unit volume per second is greater than the number of stimulated absorptions per unit volume per second. This requirement is achieved when material is in the state of population inversion (When the numbers of molecules or atoms are more in the excited state than in the ground state). Population inversion is to be induced by different pumping techniques or methods as per requirements of the laser.

RESEARCH HISTORY AND METHODOLOGY

X-ray laser research began in the early 1960s., but after over a decade British researchers found evidence for laser gain in highly ionized carbon. The first x-ray laser system was pumped by Nova internal confinement fusion (ICF) laser in United States. The development of a working laser in the x-ray spectral region offers a considerable challenge to present day technology. For a visible laser fast electrical circuitry feeding or a weakly ionized discharge can be used as a lasing medium. In contrast, x-ray requires either inner shell electronic transitions or highly stripped ions as medium, pumped by a source of duration much less than a picoseconds. In

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addition, transmission and reflection properties of materials are poor at these wavelengths. Lasing action at very short wavelengths will be very difficult to achieve because of the three main difficulties which were found not at higher wavelengths:

1. Matter has a high opacity at short wavelengths so that to achieve high population inversion enormous pumping powers will be required.
2. Pump Power density of the order of 1015 W/cm^2 is required which is as a subsidiary laser or a particular beam as a pump.
3. All materials have a low reflectivity for $\lambda < 10$ $^{\circ}_{A}$ and also to the fact an X-Ray Laser or γ-Ray Laser would operate at such a high flux level that any mirrors would be destroyed.

The buildings up of the lasers to operate on wavelengths much shorter than the ultraviolet part of the spectrum are very difficult indeed.

At present there is an emphasis on XUV (10-200 $^{\circ}_{A}$ and VUV (200-2000 $^{\circ}_{A}$ lasers where the pumping requirements are less stringent. Nevertheless, such things as x-ray lasers might prove extremely useful in research work and in many fields of application, such as weaponry.

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