STUDY OF THE SATURATION EFFECT AND OUTPUT POWER OF OPTICALLY PUMPED FIR LASER

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Abstract

In this paper, the density matrix equation of a six-level system has been solved, in case of the FIR wave signals in the system were not small enough to be neglected. The output power density of the laser system has been calculated by means of the iteration method. The saturation effect of the system has been revealed by the numerical calculation. Several sets of curves of laser output power vs. the length of laser with different pumping detuning and the optimum operating pressure under certain condition have been obtained. These calculated values were in good agreement with the data provided in the literatures.

1. Introduction

The FIR emission can be obtained from gyrotrons and free-electron lasers, but recently, many FIR signals
were obtained from quantum transitions between rotational energy levels of optically pumped molecular gas under a certain condition. Thousands of spectral lines ranging from 12 \( \mu \text{m} \) to 2 \( \text{mm} \) have been observed in optically pumped FIR lasers\(^1\) with different kinds of operating gas. The continuously tunable optically pumped molecular gas lasers have been studied experimentally and theoretically, and a great development has been achieved. It is possible now to have optically pumped lasers which are continuously tunable, and cover above wave band fully.

The theory of the optically pumped lasers has explained many phenomena produced by the lasers, and has also predicted some effects that haven't occurred before. The theory, however, had its own limitation, because the FIR signal in the laser system was assumed small enough to be neglected. In consequence, the gain coefficient calculated by theory was much greater than that measured experimentally. Therefore, the early theory could only explain or predict some strong effects in the optically pumped FIR lasers, but could not be used to design the real lasers and to study the multiphoton processes and their interactions in the system.