INTERACTION OF INTENSE ELECTROMAGNETIC BEAMS WITH PLASMAS

by

Bansi Lal Patheja

Thesis submitted to the Indian Institute of Technology, Delhi
for the award of the Degree of
DOCTOR OF PHILOSOPHY

Department of Physics
Indian Institute of Technology, Delhi

September, 1978

ACKNOWLEDGEMENT

I take this opportunity to express my deep sense of gratitude to Professor M.S.Sodha and Dr. T.P.Tewari for their valuable guidance and encouragement during the course of this work, without which the present work would not have been possible.

I feel indebted to Prof. A.K.Ghatak and Dr. V.K.Tripathi for their keen interest in the work. I also wish to express my sincere thanks to Dr. R.P.Sharma and Dr. S.C.Kaushik for the valuable suggestions and discussions which contributed a lot to this work.

Thanks are due to Mr. D.SubbaRao, Mr. G.Umesh, Mr. L.A.Patel, Dr. N.C.Srivastava and other colleagues of the Electrophysics Group for their full cooperation in all respects. I am thankful to Mr. T.N.Gupta for the efficient typing of the thesis.

Financial assistance by C.S.I.R. (India), I.I.T. Delhi and N.S.F. (USA) is gratefully acknowledged.

Bansi Lal

(Bansi Lal Patheja)

ABSTRACT

The present thesis deals with some aspects of the interaction of intense electromagnetic (e.m.) beams with plasmas which has acquired prime importance because of its relevance to controlled thermonuclear fusion. In Chapter I, the possibility of confining a plasma in a rectangular waveguide excited in TE_{20} mode has been investigated. The principal idea is that because of the ponderomotive force or due to non-uniform heating, the plasma can redistribute itself to concentrate around intensity minima. In Chapter II, the spatial growth of small fluctuations in the intensity profile of a uniform plane e.m. wave that can break the plasma into filaments has been investigated. It is seen that the presence of magnetic field makes the plasma more prone to filamentation instabilities. In the field of laser induced fusion, the basic problem is of the efficient coupling of laser beam energy with the plasma. In a hot plasma, absorption takes place by conversion of e.m. waves into electrostatic waves which can suffer Landau damping and in turn heat the plasma. In the third and fourth Chapters, excitation of an upper hybrid wave and of a plasma wave in a magnetoplasma by a Gaussian e.m. beam has been investigated. The excitation of these electrostatic waves is highly nonuniform because of self focusing of the e.m. beam and is quite sensitive to magnetic field strength. In the last Chapter, the possibility of self focusing of e.m. beams in parabolic and non-parabolic semiconductor plasmas has been investigated when the dielectric function may have arbitrary nonlinearity.

CONTENTS