

THEORETICAL AND SIMULATION STUDIES ON LASER INTERACTING WITH MAGNETIZED PLASMA

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Theoretical and Simulation Studies on Laser Interacting with Magnetized Plasma

by

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Submitted

in fulfillment of the requirements of the degree of Doctor of Philosophy

to the



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Dedicated to my parents

Certificate

This is to certify that the thesis entitled “**Theoretical and Simulation Studies on Laser Interacting with Magnetized Plasma**”, submitted by **LAXMAN PRASAD GOSWAMI** to the Indian Institute of Technology Delhi, for the award of the degree of **Doctor of Philosophy** in PHYSICS, is a record of the original, bona fide research work carried out by him under my supervision and guidance. The thesis has reached the standards fulfilling the requirements of the regulations related to the award of the degree.

The results contained in this thesis have not been submitted in part or in full to any other University or Institute for the award of any degree or diploma to the best of my knowledge.

Prof. Amita Das
Department of Physics,
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Date:

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Abstract

This thesis makes an important contribution to the field of laser interaction with magnetized plasma. The study examines new laser energy absorption schemes aided by the application of an external magnetic field. These absorption schemes are essentially premised on the generation of electrostatic fields in the plasma, which ultimately transfer their energy to particles. The role of ponderomotive force (both longitudinal and transverse) and diamagnetic effects due to plasma inhomogeneity for the generation of electrostatic waves has been studied. Some other interesting and novel features of the magnetized regime have also been explored. This includes the demonstration of parametric processes such as the Brillouin scattering in the context of magnetized plasma response.

Furthermore, the transparent propagation of the incident radiation in plasma at extremely strong magnetic field strengths (where both the electron and ions display magnetized response at the radiation frequency) has been demonstrated. Though such strong magnetic fields are not available in the laboratory, their presence in an astrophysical context is plausible. These studies have been performed with the help of the Particle-In-Cell (PIC) simulations technique using OSIRIS-4.0 and the EPOCH-4.17.10 platform.

Contents

Certificate	i
Acknowledgements	ii
Abstract	iv
Contents	v
List of Figures	viii
List of Tables	xi
Abbreviations	xiii
1 Introduction	1
1.1 Introduction	1
1.2 Electromagnetic wave interaction with plasma	5
1.3 Laser energy absorption in plasma	8
1.4 Fundamental processes operative in laser-plasma interaction	9
1.5 Methodology	10
1.6 Organisation of the thesis	13
2 Electrostatic disturbances generated by laser longitudinal pondero-	
motive force in plasma	17
2.1 Introduction	17

2.2	Simulation Details	19
2.3	Observations	21
2.3.1	Electron Magnetization	22
2.3.2	Magnetizing both Electrons & Ions	25
2.4	The genesis of electrostatic excitation	28
2.5	Relativistic Studies	35
2.6	Conclusion	36
3	Two-dimensional effects of laser interacting with magnetized plasma	37
3.1	Introduction	38
3.2	Theoretical Description	38
3.2.1	Electrostatic Wave Excitation	39
3.2.2	Expression of Ponderomotive Force	41
3.2.3	Diamagnetic Drift	42
3.3	Simulation Setup	45
3.4	Transverse Ponderomotive Effects	46
3.4.1	Simulation Geometry	47
3.4.2	Observations and discussion	48
3.5	Diamagnetic Drift Effects	52
3.5.1	Simulation Geometry	52
3.5.2	Observations and discussion	53
3.6	Combined 2D effects	57
3.6.1	Simulation Setup	58
3.6.2	Observations and discussion	58
3.7	Conclusion	60
4	Observation of Brillouin scattering in Particle-In-Cell simulations for laser pulse interacting with magnetized overdense plasma	63
4.1	Introduction	64
4.2	Simulation Details	67
4.3	Observations	69
4.4	Characterization of the observed excitations	77
4.5	Role of Ponderomotive pressure	80
4.6	Nonlinear Phase	84
4.7	Conclusion	86
5	Electromagnetic wave transparency in strongly magnetized plasma	87
5.1	Introduction	88
5.2	Simulation Details	90
5.3	Observations	91
5.4	Discussion	94

5.5	Particle Dynamics in High Magnetic Fields and Implications for Magnetic Transparency	97
5.6	Conclusion	100
6	Summary and future scope	101
6.1	Summary	102
6.2	Future scope	104
6.2.1	Oblique incidence and higher dimensionality	104
6.2.2	Surface phenomenon	104
6.2.3	Magnetic Field Generation in Laser Plasma Interaction	105
6.2.4	Experimental verification of the proposed mechanisms	106
A	Ponderomotive Force in magnetized plasma for elliptically polarized laser	133
A.1	General derivation	133
A.2	Ponderomotive force in different geometries	138
A.2.1	Un-magnetized case	138
A.2.2	RL-mode geometry	139
A.2.3	X-mode geometry	139
A.2.4	O-mode geometry	139
	References	140
	List of Publications	141
	Bio-data	146

List of Figures

1.1	Two-step process of laser energy absorption to ions.	2
1.2	Magnetized plasma geometries	3
2.1	Schematics for longitudinal ponderomotive force studies	19
2.2	Time evolution for R-wave propagation	23
2.3	Time evolution of R and L-waves in plasma	24
2.4	Verification of R and L wave Polarisation	26
2.5	Space and time FFT of the EM waves	26
2.6	R and L-waves dispersion curves for different magnetic field values . .	27
2.7	Space and time FFT of the ES waves	27
2.8	Effect of external magnetic field on ES wave excitation	30
2.9	Comparison for the ES and EM energies	31
2.10	Ponderomotive force studies with relativistic laser pulse	32
2.11	Polarization of EM wave for relativistic studies	33
2.12	Space and time FFT of EM and ES field for relativistic case	34
3.1	Dispersion plot for X-mode configuration	39
3.2	Schematics for transverse ponderomotive studies	47
3.3	Charge density fluctuations and transverse electric field excitation due to transverse laser profile	49
3.4	Charge density fluctuations and electric field are absent for electron- positron plasma	50
3.5	Percentage energy absorption in X-mode and RL-mode configuration with both plane and Gaussian laser transverse profile	51
3.6	Schematics for diamagnetic drift studies	53
3.7	Time evolution of magnetic field B_z , charge density, current density J_x , and electric field E_x in O-mode configuration	54

3.8	Percentage energy absorption as a function of plasma temperature and laser intensity	55
3.9	Effect of external magnetic field on percentage energy absorption and diamagnetic drift	56
3.10	Percentage energy absorption for electron-positron plasma	56
3.11	Time evolution of magnetic field B_z , charge density, current density J_x , and electric field E_x for X-mode configuration	59
3.12	Percentage energy absorption as a function of laser intensity factor a_0 for X-mode configuration	61
4.1	Schematics of Parametric scattering process	67
4.2	RL-mode dispersion plots for different values of magnetic field	71
4.3	Time evolution of Electromagnetic wave	72
4.4	Time evolution of Electrostatic wave	74
4.5	Plasma charge density during parametric scattering	75
4.6	Growth rate of parametric instability with R-wave	76
4.7	Growth rate of parametric instability with L-wave	76
4.8	Verification for momentum conservation in parametric scattering process	77
4.9	Phase-space plot for electron and ion momentum with both R and L-waves	81
4.10	Momentum distribution of electrons and ions	82
4.11	Effect of incident laser profile on the parametric instability growth rate	83
4.12	Spatial variation of Brillouin scattering with separation from the pump wave	85
5.1	Schematics for magnetic field induced transparency in RL-mode configuration	89
5.2	Electromagnetic wave propagation in RL-mode configuration at different external magnetic field values in 1-D simulations	92
5.3	Electromagnetic wave propagation in RL-mode configuration at different external magnetic field values in 2-D simulations	93
5.4	Change in laser polarization for different magnetic field strengths . .	94
5.5	RL-mode dispersion curve for different strengths of external magnetic field	95
5.6	Effect of external magnetic field on Electrostatic energy	97
5.7	Particle trajectories as a function of the magnetic field	98
6.1	Schematic for the possibility of surface oscillations	105

List of Tables

1.1	Physical quantities with symbol and normalization	12
2.1	Simulation parameters for longitudinal Ponderomotive force studies .	22
3.1	Summary for the applicability of different drifts in laser-plasma interaction	40
3.2	Simulation parameters for transverse ponderomotive force studies . .	46
4.1	Simulation Parameters	69
4.2	Four cases of incident laser polarization	70
4.3	Relation between EM wave group velocity and scattering growth rate	79
5.1	Simulation parameters	91
5.2	Percentage of energy absorption as a function of the external magnetic field	99

Abbreviations

PIC	P article I n C ell
SAM	S pin A ngular M omentum
EM	E lectro M agnetic
ES	E lectro S tatic
EW	E xa W att
PW	P eta W att
KT	K ilo T esla
KeV	K ilo electron V olts
MeV	M ega electron V olts
CPA	C hirped P ulse A mplification
ICF	I nertial C onfinement F usion
RL-mode	R ight L eft C ircularly P olarized M ode
X-mode	E xtraordinary M ode
O-mode	O rdinary M ode
LH	L ower H ybrid
SRS	S timulated R aman S cattering
SBS	S timulated B rillouin S cattering
EPW	E lectron P lasma W ave
IAW	I on A coustic W ave
1D	O ne D imensional
2D	T wo D imensional
3D	T hree D imensional
MLK	M orales L ee K aw
FFT	F ast F ourier T ransform