

Contents

1	Introduction	1
1.1	Introduction to Relativistic Laser-Plasma Interaction	1
1.1.1	Development of Laser Technology and Corresponding Research Areas	1
1.1.2	Typical Parameters and Characteristics	2
1.1.3	Theories and Simulation Methods	9
1.2	Main Areas in Relativistic Laser-Plasma Interaction	14
1.2.1	Laser “Fast Ignition” Fusion	14
1.2.2	Electron Heating and Acceleration	16
1.3	Laser Ion Acceleration	18
1.3.1	Target Normal Sheath Acceleration (TNSA)	19
1.3.2	Electrostatic Shock Acceleration (ESA)	22
1.3.3	Light Sail Acceleration (LSA)	26
1.3.4	Wakefield Ion Acceleration	29
1.4	Intense High-Order Harmonics and Attosecond Pulses	30
1.4.1	Relativistic Oscillating Mirror Model	31
1.4.2	Intense Attosecond Pulses	32
1.4.3	Multi-dimensional Effects	33
	References	35
2	Ion Acceleration I: Efficient Heavy Ion Acceleration by ESA	41
2.1	Introduction	41
2.2	CP Laser Interacting with Multispecies Target	42
2.3	Analytical Modeling	43
2.4	Generating Monoenergetic Heavy Ion Beam	45
2.4.1	“Sandwich” Target in One-Dimensional Simulation	45
2.4.2	Microstructured Target in Three-Dimensional Simulation	47
2.5	Summary and Discussion	47
	References	49
3	Ion Acceleration II: The Critical Target Thickness in Light Sail Acceleration	51
3.1	Introduction	51

3.2	Estimation for Critical Thickness.	51
3.3	Analysis on One-Dimensional Particle-in-Cell Simulations.	53
3.4	Summary and Discussion	55
	References	55
4	Extreme Light Field Generation I: Quasi-Single-Cycle Relativistic Laser Pulse	57
4.1	Introduction	57
4.2	Quasi-Single-Cycle Pulse from Laser (CP)-Foil Interaction.	58
4.3	Nonlinear Modulation of Foil Transparency	59
	4.3.1 Stationary Solution	59
	4.3.2 Modulation Mechanism and Parametric Study	61
4.4	Two-Dimensional Simulation	63
4.5	Summary	64
	References	64
5	Extreme Light Field Generation II: Short-Wavelength Single-Cycle Ultra-Intense Laser Pulse	65
5.1	Introduction	65
5.2	Intense Chirped Pulse Generated by Double-Sided Laser (CP)-Foil Interaction	65
5.3	Analysis	67
	5.3.1 Characteristics and Manipulation of the Chirped Pulse	67
	5.3.2 Parametric Conditions	69
5.4	Two-Dimensional Simulation	70
5.5	Discussion	71
5.6	Summary	71
	References	72
6	Extreme Light Field Generation III: Ultra-Intense Isolated Attosecond Pulse	73
6.1	Introduction	73
6.2	CP Laser Field Reflected by Plasma Boundary	74
6.3	Analysis	74
	6.3.1 Interacting Model	74
	6.3.2 Comparison with Simulations.	76
	6.3.3 Effects of Target Density and Pulse Duration.	76
	6.3.4 Comparison with LP Laser.	78
6.4	Two-Dimensional Simulation	79
6.5	Summary	81
	References	81
7	Summary.	83