# Contents

Chapter 1 General Theoretical Methods and Experimental Techniques

11	Introduction					
1.2	Fauivalent permittivi		• laisma	•	•	•
1.2	Quasi-static approxim	ny or a p	asma	•	•	•
1.5	Cold plasma cylinde	nauon r in the d	• • • • • • •	tatia	•	
1.4	mation		luasi-s	static	appro	JX1-
15	Oscillations and you		•	1	•	•
1.5	uniform cold place		procee	iures	in n	on-
	a Quagi statio sasill	nas .	•	•	•	
	a. Quasi-static oscill	ations in	innon	ogene	eous d	cold
	plasmas .	•	•	•	·	·
1.0	b. Variational procea	ures.	•	•	•	•
1.0	Moments method	• •	·	·	•	•
	a. Dispersion relation	1.	•	·	•	•
	b. Approximations m	ade in the	? <i>mom</i>	ents r	netho	<i>d</i> .
1.7	Boltzmann–Vlasov ordinates	equation	in c	ylindı	rical	co-
1.8	Description of a way	m non-u	niforn	1 plas	ma v	vith
	tensorial perturbed	nressure		- 1-14	11100 1	
	a. Cylindrical case	- prossure	•	•	•	·
	h. Tensorial generaliz	 ration	•	•	•	•
1.9	Boundary conditions	anon	•	•	•	·
	a. Cold plasmas	•	•	•	•	•
	h Hot plasmas	•	•	·	•	•
1 10	Set-ups for studying		• ottorir	Var hv	nlaa	mo
	columns	, 11410 50	uttern	15 Uy	pias	ma
	a Method of measur	comont of	· a roft	• • vion	facto	• • in
	free snace	emeni oj	u reju	SAION	jucio	r ırı
	h Detailed resonand	· ·	•	vhihit	·	•
	plasma column		ит е. •		eu 0 <sub>.</sub>	y u
	c. Experiments in the	e waveguie	de			
	d. Multipole electrod	e configur	ations	· .		
1.11	Measurement of elect	ron plasn	na den	sities	by ca	vity
	perturbation techn	iques.			5	5
			•	•	•	•

18

Chapter 2	The	Uniform Plasma Slab-Condenser System
	2.1	Theory
		a. Equations of the plasma slab-condenser system . 43
		b. Cold plasma $(T = 0)$
		c. Warm plasma $(T \neq 0)$ 47
		d. Effect of collisions
		e. Summary
	2.2	Experiments
	2.3	High frequency plasmoids 60
	2.4	Impedance of a plasma slab using Vlasov's
		equation
		a. Boundary conditions
		b. Steady state response to $E_0(t) = E_0 e^{i\omega t}, t > 0$ . 60
Chapter 3	The	Hollow Cylindrical Plasma
	31	Theory 70
	3.2	Comparison between experiments and theory 73
	3.3	Measurement of average plasma densities by the
		main resonances of cylindrical structures
	3.4	Asymmetry effects in a hollow cylindrical plasma 80
		a. Theory
		b. Small eccentricity
		c. Comparison between theory and experiments . 86
		d. Conclusions
Chapter 4	Scat Colu	tering of a Plane Electromagnetic Wave by a Plasma umn in Steady Magnetic Fields (Cold Plasma
	App	
	4.1	Introduction
	4.2	Anisotropy effects
		a. General formulation 95
		b. Theory and experiments with $\mathbf{B}_0$ parallel to the
		axis
		c. Theory with $\mathbf{B}_0$ perpendicular to the axis . 104
	4.3	Magnetically induced asymmetry effects 109
	4.4	High-frequency effect due to axial velocity of the
		plasma column
		a. Incory
		c. Comparison with experimental adda 122
		c. rum remarks

## С

xii

#### Contents

### Chapter 5 Hot Non-uniform Plasma Column

5.1	Introduction			130								
5.2	Perturbed scalar pressure approximation			132								
	a. General formulation			132								
	b. Parabolic density profile			134								
	c. Tonks–Langmuir profile			142								
	d. Detailed structure of the secondary spectrum .											
	e. Damping effects			149								
	f. Noise spectrum			152								
	g. Asymmetry effects			154								
	h. Axial propagation effects			158								
	i. Conclusions			160								
5.3	Influence of steady axial magnetic fields		160									
	a. Low magnetic fields ( $\omega \gg \omega_c$ )	•		160								
	b. High magnetic fields ( $\omega = n\omega_c$ ; $n = 2$ ,	3, 4, .	)	161								
	c. Continuity between low and high magnet	ic fiel	ds									
	$(\omega_c \ll \omega \text{ to } \omega_c = \omega/2)$	•		165								
5.4	Non-linear effects	•		166								
	a. Non-linear temperature resonances .	•	•	166								
	b. Non-linear resonances of a cold plasma	•		168								
	c. Microwave scattering from density flu	ctuati	ions									
	resulting from temperature resonances	•		169								
	d. Strong non-linear effects and resonantly	sustai	ined									
	plasmas		•	171								

### Chapter 6 Metallic and Dielectric Resonance Probes. Plasma-dielectric Coated Antenna. General Considerations

6.1	Metallic resonance probe			173
6.2	High-frequency dielectric resonance probe			181
	a. Theory			182
	b. Experiments			187
6.3	Enhanced radiation from an antenna	co	oated	
	with dielectric and plasma			191
	a. Theory		•	192
	b. Experiments			196
	c. Non-linear behaviour			200
6.4	General considerations on resonances ar	nd	anti-	
	resonances of cold plasma systems .			201

## Appendix 1 Volume Theorems Useful in Stating Mathematical Boundary Conditions

	1. Gradient theorem				•				•		206	
	2.	Divergence theorem						•		•	•	207
	3.	3. Curl theorem .			•	•			•	•	•	202
	4.	Gree	en's th	eorem	ı.	•	•	•	•	•	•	208
References			•	•	•	•	• .	•	•	•	•	210
Index .					•		•		•			217