

CONTENTS

VOLUME X

<i>Preface</i>	v
<i>Ch. 1. Vortices in rotating superfluid ^3He, A.L. Fetter</i>	1
1. Introduction	3
2. Vortices in rotating superfluid ^4He	4
3. General properties of superfluid ^3He	10
4. Vortices in superfluid $^3\text{He-B}$	13
4.1. Structure of an individual vortex line	14
4.2. Textures in a rotating container	24
4.3. NMR in a rotating container	32
5. Vortices in superfluid $^3\text{He-A}$	42
5.1. General properties of $^3\text{He-A}$	42
5.2. Specific vortices in $^3\text{He-A}$	50
5.2.1. Singular and nonsingular textures	51
5.2.2. Textures in low magnetic fields	56
5.2.3. Textures in high magnetic fields	58
5.3. NMR in rotating $^3\text{He-A}$	63
5.4. Other detection schemes	67
6. Discussion	69
Note added in proof	69
References	70
<i>Ch. 2. Charge motion in solid helium, A.J. Dahn</i>	73
1. Introduction	76
2. Background	77
2.1. Description of vacancies and isotopic impurities in solid helium	77
2.2. Structure of ions	79
2.2.1. Structure of ions in liquid helium	79
2.2.1.1. Positive ions	79
2.2.1.2. Negative ions	80
2.2.2. Ion structures in solid helium	81
2.2.2.1. Positive ions	82
2.2.2.2. Negative ions	82
2.3. Experimental methods of measuring mobilities	84
2.3.1. Space-charge limited currents	85
2.3.2. Transient space-charge limited currents	86

2.3.3. Time of flight techniques	89
2.3.4. Comparison of techniques, and the effect of crystal strain on mobility measurements	90
3. Ionic mobilities	91
3.1. Early investigations	91
3.2. Mobility measurements	92
3.3. Theory	101
3.3.1. Negative ions	101
3.3.1.1. Vacancy-assisted mobility	101
3.3.1.2. Surface adatom diffusion	104
3.3.2. Positive ions	106
3.3.2.1. Hole hopping	106
3.3.2.2. Vacancy diffusion	106
3.3.3. Species-independent mechanisms	108
3.3.3.1. Phonon-assisted ion motion	108
3.3.3.2. Motion by a plastic flow mechanism	108
3.3.3.3. Vacancy-wave scattering of charged defects	108
3.3.3.4. Ions as quasiparticles	112
3.3.3.5. Bound ion-vacancion complexes	113
3.4. Ion velocities in large electric fields	114
3.5. Related phenomena	116
3.5.1. Ion-dislocation ring complexes	116
3.5.2. Motion of charged grain boundaries	119
3.5.3. Test for the collapse of the negative-ion cavity	121
3.5.4. Search for vacancy waves	122
3.5.5. Motion of charged droplets of liquid helium through the solid phase	123
3.5.6. Theory for positive-ion mobility in a dilute ^4He - ^3He solution	123
3.5.7. Theory for negative ions in an rf electric field	124
4. Discussion	125
4.1. General comments	125
4.2. Helium three	129
4.3. Helium four	130
5. Summary	132
References	134
<i>Ch. 3. Spin-polarized atomic hydrogen, I.F. Silvera and J.T.M. Walraven</i>	139
1. Introduction	147
1.1. General	149
1.2. Bose statistics	153
2. Single-atom properties	156
2.1. Hyperfine energies and states	156
2.2. Electron spin polarization	160
2.3. Magnetization	160
2.4. ESR and NMR transitions	162
3. Interatomic interactions	163

4.	Single-atom interactions with helium surfaces	174
4.1.	The surface adsorption potential	176
4.2.	Inelastic surface collisions	177
4.3.	Sticking probability	181
4.4.	Kapitza thermal resistance at the gas-liquid interface	182
4.5.	The hyperfine frequency shift of H	185
5.	Experimental developments	188
5.1.	Stabilization of H \downarrow	189
5.1.1.	Dissociation of H ₂	189
5.1.2.	Polarization	189
5.1.3.	Sustenance of polarization	191
5.1.4.	Confinement	192
5.1.4.1.	Magnetic compression	192
5.1.4.2.	Wall confinement, wall coverage, vapor compression and thermalization	194
5.1.5.	Detection of H \downarrow	196
5.1.5.1.	Bolometric detection	196
5.1.5.2.	Nondestructive detection	198
5.2.	The rate equations	200
5.2.1.	Effective rate constants	200
5.2.2.	Notation for rate constants	201
5.2.3.	General equations	201
5.2.3.1.	Thermal escape	203
5.2.3.2.	Decay of H \downarrow	203
5.2.3.3.	Decay of double-polarized hydrogen H $\downarrow\ddagger$	203
5.3.	Stabilization of D \downarrow	204
5.4.	Measurement of the surface adsorption energy	205
5.5.	Two-body surface recombination rate constants	208
5.5.1.	Deuterium	209
5.5.2.	Hydrogen	209
5.5.2.1.	Magnetic-field dependence	209
5.5.2.2.	The value of K ^s	213
5.6.	Double polarization: H $\downarrow\ddagger$	214
5.7.	Measurement of K ^s _{aa} and K ^s _{ab}	217
5.8.	Nuclear relaxation	218
5.8.1.	Intrinsic relaxation	218
5.8.2.	Impurity relaxation	220
5.8.3.	Relaxation and the boson nature of H \downarrow	222
5.9.	Electronic relaxation	223
5.10.	Nuclear magnetic resonance	224
5.11.	Electron spin resonance	227
5.12.	Compression experiments	229
6.	Theoretical aspects of stability: recombination and relaxation	235
6.1.	Recombination	236
6.1.1.	Resonance recombination	239
6.1.2.	Second-order recombination	241
6.1.2.1.	Van der Waals recombination	241
6.1.2.2.	Van der Waals recombination on the surface	255
6.1.2.3.	Relationship to phenomenological experimental rates	257
6.1.3.	Third-order recombination	259

6.1.3.1. General	259
6.1.3.2. Exchange recombination	262
6.1.4. Dipolar recombination	280
6.1.4.1. bb -He recombination	280
6.1.4.2. The KVS mechanism	282
6.1.4.3. The KVS mechanism on the surface	290
6.1.5. Relationship to phenomenological experimental rates	294
6.2. Relaxation	296
6.2.1. Introduction—Volume and surface processes	297
6.2.2. Spin-exchange relaxation	303
6.2.2.1. Relation to the rate equations	309
6.2.3. Dipolar relaxation	311
6.2.3.1. Dipolar relaxation—general	312
6.2.3.2. Nuclear spin relaxation in the bulk gas	314
6.2.3.3. Nuclear spin relaxation on the surface	317
6.2.3.4. Electronic spin relaxation	319
7. Thermodynamic properties	320
7.1. Quantum theory of corresponding states	320
7.2. Ground-state calculations	327
7.2.1. The boson case	328
7.2.2. The fermion case	331
8. Many-body static and dynamic magnetic properties	334
8.1. Static magnetic properties	335
8.1.1. Noninteracting gases	335
8.1.2. The weakly interacting Bose gas	337
8.2. Dynamical properties: spin-waves	340
8.2.1. General	340
8.2.2. Nuclear spin-waves in $H\downarrow\uparrow$	341
9. Many-body effects on the surface	346
9.1. Adsorption isotherms	347
9.2. Two-dimensional superfluidity	351
9.3. Hydrodynamic modes of two-dimensional $H\downarrow$	352
10. Prospects for spin-polarized hydrogen	355
10.1. Applications	356
10.2. Goals in the study of quantum fluids	356
10.2.1. Compression of bubbles	358
10.2.2. Traps for low-field seekers	360
10.2.3. Traps for high-field seekers	362
10.2.4. Two-dimensional superfluidity	363
References	365
<i>Ch. 4. Principles of ab initio calculations of superconducting transition temperatures, D. Rainer</i>	371
1. Introduction	373
2. Many-body aspects, diagram analysis	377
2.1. Technical preliminaries, notations	379

2.2. Classification and calculation of self-energy diagrams	383
3. The low-energy equations	391
3.1. Bloch-function representation	394
4. Band-structure theory and the electron–phonon interaction	401
4.1. The electron-phonon coupling parameters	402
5. Strong-Coupling Theory of the transition temperature	411
5.1. The linearized Eliashberg equations	412
5.2. Calculation of T_c from Eliashberg's equations	417
6. Conclusion	419
References	421
 <i>Authors Index</i>	425
 <i>Subject Index</i>	439