

CONTENTS

PREFACE	v
CONTENTS	vi
GENERAL INTRODUCTION AND PLAN	1

I. ALGEBRAIC METHODS

1. Introduction	6
2. Perturbation theory as a search for the poles of the Green's Function	7
2a. Some special cases	10
3. Modifications to Brillouin-Wigner perturbation theory	13
3a. Variation-iteration procedure	14
3b. Properties of Brillouin-Wigner series and related variational principles under certain transformations	17
3b (i). Change of scale of unperturbed spectrum	18
3b (ii). Displacement of the origin of unperturbed spectrum	21
4. Rayleigh-Schrödinger series	23
4a. Relation to Brillouin-Wigner series and convergence of the two series	23
4b. Scale transformation	25
5. Sum rule techniques	27
6. Counting-operator methods	31
6a. Feenberg's method	31
6b. Multiple scattering solutions	33
6c. Addition theorem for the energy of a composite system	37
6c (i). Connection with the optical model problem	40
6c (ii). The total energy of an N -body system	41
List of important symbols in chapter I	42

II. DIAGRAMMATIC METHODS: LINKED CLUSTER THEOREM AND GENERAL FORMULAE

1. Introduction	44
2. The Rayleigh-Schrödinger expansion and determinantal wave-functions	46
2a. Reduction in terms of two-particle matrix elements and clusters	46
2b. Representation by means of diagrams	50
2b (i). Goldstone diagrams	51

2b (ii). Hugenholtz diagrams	53
2b (iii). Brueckner diagrams	53
2c. Cancellation of unlinked cluster terms: Example of third order	54
3. Time dependent theory	61
3a. Second quantisation	61
3b. Time dependent perturbation theory.	66
3c. Linked cluster theorem	70
3c (i). Rules for Goldstone diagrams	73
4. Resolvent operator method: Time independent theory	73
4a. Matrix elements of the resolvent operator	78
4a (i). Notation and nomenclature	78
4a (ii). Example of calculation of the contribution of a diagram	80
4a (iii). $R(z)$ in terms of diagrams: The operator $G(z)$	83
4b. Energies and wave functions of stationary states	86
4c. Convolutions and decomposition of diagrams	87
4d. Volume dependence of various quantities	91
4e. Discussion of energy expressions	92
4e (i). Ground state energies: quantities D_0 and \bar{G}_0	92
4e (ii). Excited state energies	96
4f. Discussion of wave function expressions	99
4f (i). Ground state wave function	100
4f (ii). Excited state wave functions	103
4f (iii). Some special states	104
4g. A theorem on single particle energies	108
List of important symbols in chapter II	113

III. REARRANGEMENT METHODS: REACTION MATRIX

1. Introduction	118
2. Vertex modification: the t -matrix	119
2a. Graphical representation of the t -matrix equation	123
3. Propagator modification	124
4. Modified propagation in the t -matrix	128
4a. An approximation	133
5. The level shift after propagator modification	134
6. Choice of the single particle potential: self-consistency	136
List of important symbols in chapter III	140

IV. METHODS OF SOLVING t -MATRIX EQUATIONS AND APPLICATION TO NUCLEAR PROBLEMS

1. Introduction	142
1a. Some characteristics of the nuclear problem	142
1b. Standard forms: Bethe-Goldstone equation	144

1b (i). Two-particle wave-matrix	145
1b (ii). First Brueckner approximation to the t -matrix	146
1b (iii). Transformation to the coordinate space	147
2. Nuclear matter case: effective mass approximation	150
2a. Singularities of the t -matrix	152
3. Nuclear matter case: partial wave expansion	153
3a. Diagonal elements of the t -matrix	156
3b. Approximations in Green's function expressions	158
3b (i). Pauli principle	159
3b (ii). The energy denominators	159
3c. Treatment of the hard core potentials	160
3d. Qualitative effects of the hard core potentials	162
3e. Scheme for energy calculations	165
4. The t -matrix and effective single particle potentials in coordinate space	166
4a. The t -matrix	167
4a (i). Hard core contributions	170
4a (ii). The t -matrix for S-state interaction: an approximate form	170
4b. Single particle potential	171
4b (i). Spin-orbit part of single particle potential	174
5. Single particle energies	176
6. Application to nuclei	179
6a. Brueckner-Gammel-Weitzner method	181
6a (i). Reduction of the integro-differential equation to a differential equation	184
6a (ii). Approximate density dependence of the t -matrix	185
6b. Eden's method	186
6c. Centre of mass motion	190
6d. Accuracy of calculations	191
7. Further applications	192
7a. Some parameters for nuclear matter	192
7b. Shell model	193
List of important symbols in chapter IV	198

V. CONNECTION WITH SOME OTHER METHODS

1. Jastrow's variational method	201
2. Method of superposition of configurations	203
3. Brenig's two-particle approximation	207
4. Pseudo-potential method	211
5. Theory of superconductivity	215
List of important symbols in chapter V	221
REFERENCES	222
AUTHOR INDEX	229
SUBJECT INDEX	232