

SOME STUDIES IN THE sdg INTERACTING BOSON MODEL OF
ATOMIC NUCLEI

BY

YELAMANCHILI DURGA DEVI

PHYSICAL RESEARCH LABORATORY

AHMEDABAD 380 009

INDIA

043



B14555

SUBMITTED TO THE GUJARAT UNIVERSITY
FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

JUNE 1991

CONTENTS

ABSTRACT

v

Chapter-I	INTRODUCTION	1
Chapter-II	DYNAMICAL SYMMETRIES IN INTERACTING BOSON MODEL	sdg
2.1	Introduction	17
2.2	$U(N)$ and $O(N)$ Groups and their Properties	21
2.3	$SU(3)$ Limit	24
2.4	$SU(5)$ Limit	26
2.5	$SU(6)$ Limit	30
2.6	$O(15)$ Limit	33
2.7	Weak-Coupling Limits	35
2.7a	$U_{sd}(6) \oplus U_g(9)$ Limit	36
2.7b	$U_{dg}(14)$ Limit	39
2.7c	$U_d(5) \oplus U_{sg}(10)$ Limit	39
2.8	Summary	40
Chapter-III	GEOMETRIC SHAPES	42
3.1	Introduction	42
3.2	$U(15)$ Coherent States	43
3.2a	Expectation Values	43
3.2b	Parametrization	45
3.3	Geometric Shapes and Dynamical Symmetries	47
3.3a	$SU(3)$ Limit	51
3.3b	$SU(5)$ Limit	53

3.3c	SU(6) Limit	58
3.3d	O(15) Limit	62
3.3e	Weak-Coupling Limits	67
3.3f	General Remarks	71
3.4	Relationship Between Shape Variables and Coherent State Parameters	73
3.5	Summary	74
Chapter-IV	ANALYTICAL RESULTS FOR TWO-NUCLEON TRANSFER STRENGTHS	76
4.1	Introduction	76
4.2	Two-Nucleon Transfer Operator in sdg Space	77
4.3	Analytical Formulas in the $SU_{sdg}(3)$ Limit	79
4.4	Average Fraction of $\ell = 0$ Strengths to all Excited States	85
4.5	Comments on the Analytical Results	88
4.6	Data Analysis	92
4.6a	$^{166}\text{Er}(t,p)^{168}\text{Er}$ Data	92
4.6b	R_{\pm} Data in Rare-Earth Region	93
4.7	Summary	98
Chapter-V	BAND STRUCTURES WITH A g-BOSON EXCITATION	100
5.1	Introduction	100
5.2	$U_d(5) \times 1g$ Limit	101
5.3	$SU_{sd}(3) \times 1g$ Limit	109
5.4	$O_{sd}(6) \times 1g$ Limit	117
5.5	Data Analysis and Discussion	124
5.6	Summary	130

Chapter-VI	SPECTROSCOPY IN sdg SPACE	131
6.1	Introduction	131
6.2	Matrix Elements in sdg Space	132
6.2a	Basis States	132
6.2b	Coefficients of Fractional Parentage (Identical Boson CFPs)	139
6.2c	Many particle Matrix Elements of gIBM Hamiltonian Operator	142
6.2d	Many particle Matrix Elements of Transition Operators	150
6.3	The Package SDGIBM1	156
6.4	Summary	167
Chapter-VII	SPECTROSCOPY OF ^{20}Ne, ^{24}Mg, ^{32}S AND ^{36}Ar NUCLEI	168
7.1	Introduction	168
7.2	Hamiltonian and E2, E4 - Transition Operators	169
7.3	Results and Discussion	171
7.3a	^{20}Ne	171
7.3b	^{24}Mg	173
7.3c	^{32}S	177
7.3d	^{36}Ar	179
7.4	Summary	181
Chapter-VIII	SPECTROSCOPY OF SAMARIUM ISOTOPES	182
8.1	Introduction	182
8.2	Spectroscopy of Low-Lying Levels in Sm Isotopes: Simple gIBM Calculations	184
8.2a	Energies	186

8.2b	E2 - Transitions and Quadrupole Moments	191
8.2c	Magnetic g-Factors	191
8.2d	E4 - Transitions	192
8.2e	Nuclear Radii: Isomer and Isotope Shifts	193
8.2f	Two-Nucleon Transfer Intensities	194
8.2g	Summary and Comments	195
8.3	Extended Calculations for $^{152,154}\text{Sm}$	196
8.4	Summary	207
Chapter-IX	SPECTROSCOPY OF $^{198,194}\text{Pt}$ AND ^{192}Os NUCLEI	208
9.1	Introduction	208
9.2	Hamiltonian and E2 and E4 Operators	209
9.3	Results and Discussion	210
9.3a	^{198}Pt	211
9.3b	^{194}Pt	214
9.3c	^{192}Os	221
9.4	Summary	225
Chapter-X	SCISSORS STATES IN ^{185}W	226
10.1	Introduction	226
10.2	Scissors States in sdIBM for ^{185}W	228
10.3	Scissors States in gIBM for ^{185}W	237
10.3a	Chain I: SU(3) \otimes U(2) Limit	240
10.3b	Chain II: U(15) \otimes U(2) Limit	249
10.4	Summary	254
Chapter-XI	Conclusions and Future Outlook	258

References	263
Appendix - A	276
Appendix - B	278
Appendix - C	280
Appendix - D	287
Appendix - E	290
Appendix - F	292
Appendix - G	296
Appendix - H	298
Appendix - I	299