Group Theory methods in Physics

SWAYAM Prabha Course Code : NPTEL - S6

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DEPARTMENT	Physics
INSTITUTE	Indian Institute of Technology, Bombay
COURSE OUTLINE	This course is a first course pitched at UG level so that the students can appreciate the wide applications of the group theory tools in other areas of physics

COURSE DETAILS

S. No	Module ID/ Lecture ID	Lecture Title/Topic
1	L1	Introduction I
2	L2	Introduction II
3	L3	Subgroups and Generators
4	L4	Normal subgroup, Coset, Conjugate group
5	**L5**	Factor group, Homomorphism, Isomorphism
6	**L6**	Conjugacy Classess
7	**L7**	Permutation Group
8	L8	Cycle Structures
9	L9	Cycle Structures continued
10	L10	Young diagram and molecular symmetry
11	L11	Point groups
12	L12	Symmetries of Molecule, Schoenflies Notation
13	L13	Symmetries of Molecules, Stereographic Projection

14	L14	Examples of Molecular Symmetries, Proof of Cayley Theorem
15	L15	Matrix Representation of Groups-I
16	L16	Matrix Representation of Groups-II
17	L17	Reducible and Irreducible Representation-I
18	L18	Reducible and Irreducible Representation-II
19	L19	Great Orthogonality Theorem and Character Table-I
20	L20	Great Orthogonality Theorem and Character Table-I
21	L21	Mulliken Notation, Character Table and Basis
22	L22	Tensor Product of Representation
23	L23	Tensor Product and Projection Operator - I
24	L24	Tensor Product and Projection Operator - II
25	L25	Tensor Product and Projection Operator with the Example
26	L26	Binary Basis and Observables
27	L27	Selection Rules
28	L28	Selection Rules and Molecular Vibrations
29	L29	Molecular vibration normal modes: Classical Mechanics approach
30	L30	Molecular vibration normal modes: Group Theory approach
31	L31	Molecular vibration modes using projection operator
32	L32	Vibrational representation of character
33	L33	Infrared Spectra and Raman Spectra
34	L34	Introduction to continuous group
35	L35	Generators of translational and rotational transformation
36	L36	Generators of Lorentz transformation

37	L37	Introduction to O(3) and SO(3) group
38	L38	SO(n) and Lorentz group
39	L39	Generalised orthogonal group and Lie algebra
40	L40	Subalgebra of Lie algebra
41	L41	gl(2,C) and sl(2,C) group
42	L42	U(n) and SU(n) group
43	L43	Symplectic group
44	L44	SU(2) and SU(3) groups
45	L45	Rank, weight and weight vector
46	L46	Weight vector, root vector, comparison between SU(2) and SU(3) algebra.
47	L47	Root diagram, simple roots, adjoint representation
48	L48	SU(2) sub-algebra, Dynkin diagrams
49	L49	Fundamental weights, Young diagrams, dimension of irreducible representation.
50	L50	Young diagrams and tensor products
51	L51	Tensor product, Wigner â€“ Eckart theorem
52	L52	Tensor product of irreducible representation 1: Composite objects from fundamental particles
53	L53	Tensor product of irreducible representation 2: Decimet and octet diagrams in the Quark Model
54	L54	Clebsch â€“ Gordan coefficients
55	L55	Quadrupole moment tensor (Wigner-Eckart theorem) 2) Decimet Baryon wavefunction
56	L56	Higher dimensional multiplets in the quark model
57	L57	Symmetry breaking in continuous groups
58	L58	Dynamical symmetry in hydrogen atom: SO(4) algebra
59	L59	Hydrogen atom energy spectrum and degeneracy using Runge-Lenz vector

References if Any: