

NON-SYMMETRIC GROUPS | SYMMETRIC GROUPS $[H, \hat{P}] = 0$

CONTINUOUS GROUPS

(GENERATORS = TENSOR OPERATORS)

HAMILTONIAN INVARIANT

$O(3)$

POINT GROUPS

SPACE GROUPS

Lie's GROUPS

R_3

FULL LINEAR GROUP

GL_{2L+1} IN $2L+1$ DIM.

UNITARY GROUP

U_{2L+1}

UNITMODULAR (SPECIAL UNITARY)

SU_{2L+1}

PROPER ORTHOGON. GROUP (ROTATION)

R_{2L+1}

SYMPLECTIC GROUP

SP_{2L+1}

ROTATION GROUP IN 3 DIM.

R_3

SYMMETRY OPERATIONS :

$$\frac{dF}{dt} = \frac{\partial F}{\partial t} + \frac{1}{i\hbar} [F, H]$$

INFINITESIMAL OPERATORS

GENERATORS

$$[\hat{H}, \hat{X}] = 0$$

① $\hat{X} = \hat{H}$ UNIFORMITY OF TIME (displacement in time)

ENERGY CONSERVATION LAW

② $\hat{X} = \hat{P}$ UNIFORMITY OF SPACE (translation)

CONSERVATION OF MOMENTUM

③ $\hat{X} = \hat{J}$ ISOTROPY OF SPACE (arbitrary rotations)

CONSERVATION OF ANGULAR MOM.

$$[H, \hat{J}] = 0 \Rightarrow \text{GOOD QUANTUM NUMBERS}$$

Transformation properties

PURELY QUANTUM MECH. PROPERTIES



ONLY CERTAIN ROTATIONS ARE SYMMETRY OPERATIONS

$$[\hat{H}, \hat{R}_\alpha] = 0$$

TRANSFORMATION PROPERTIES OF Ψ UNDER R_α

MOLECULES

„LATTICE TRANSLATIONS“

T_R

CRYSTALS

$$\text{IF } [\hat{H}, \hat{J}] \neq 0?$$

THEORY OF ANGULAR MOMENTUM
RACAH ALGEBRA (TENSOR OPERATORS)

ATOMS

④ SPATIAL INVERSION

PARITY

Ψ_+ even, Ψ_- odd

⑤ TIME REVERSAL

KRAMERS DOUBLETS

⑥ PERMUTATIONS

Ψ_A - ANTISYMMETRIC (FERMIONS)

Ψ_S - SYMMETRIC (BOSONS)

$\Rightarrow$ SECOND QUANTIZATION

SYMMETRY IN QUANTUM MECHANICS

BROKEN SPHERICAL SYMMETRY