



Module PMRF-ISSS007/III/2026

## Spherical Harmonics and Efficient Rotation Equivariant Neural Networks

### Name of the PMRF student

Pavan Subhaschandra Karjol

### Required background of the students taught

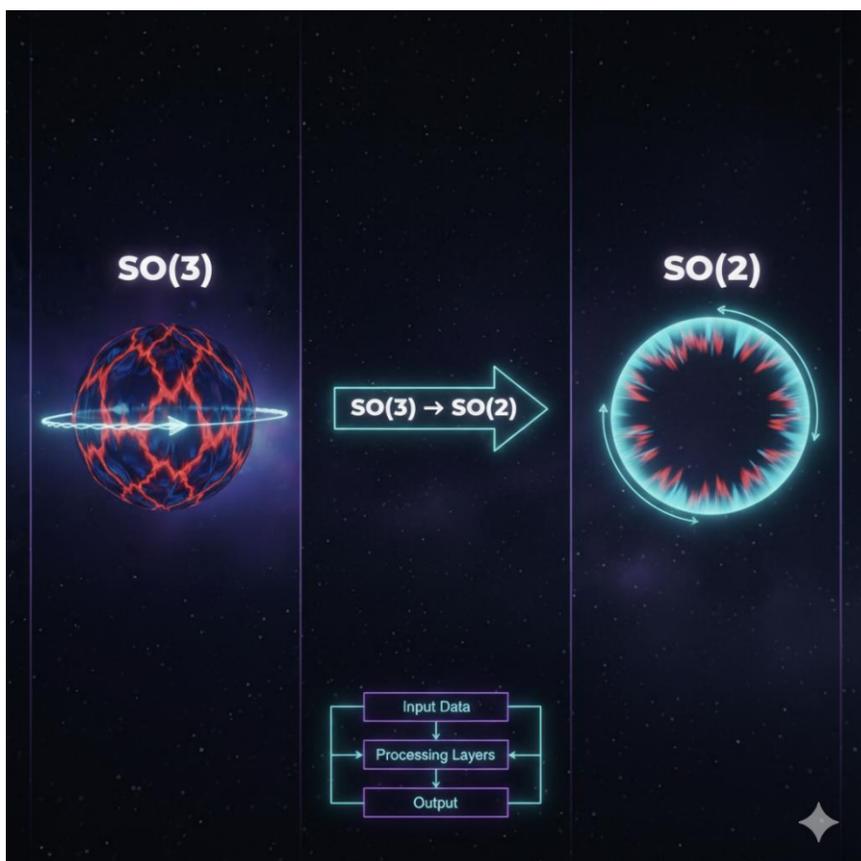
Basics of group theory

### Details of the content of the module

Module 1 – Spherical harmonics and  $SO(3)$  representations. Functions on the sphere, harmonic expansions, irreducible representations of  $SO(3)$ , Wigner-D matrices, and steerability as the mathematical foundation for rotation-equivariant features.

Module 2 – Steerable and equivariant neural networks. Equivariance vs invariance, equivariant convolutions, tensor products and Clebsch–Gordan coefficients, and why standard  $SO(3)$  tensor products become computationally expensive in practice.

Module 3 – Efficient  $SO(3)$  equivariance via  $SO(2)$  reduction and local frames. Canonicalization by aligning local axes, reduction of  $SO(3)$  operations to  $SO(2)$  operations, efficient architectures avoiding Clebsch–Gordan tensor products, and case studies from eSCN and QHNetV2 for molecular and quantum Hamiltonian prediction.



### Schedule of the module

Start Date: Feb 12, 2026

#### Details of the content of the module

Live lectures will be conducted (or recorded lectures uploaded) on Wednesdays and Fridays from 11:30 AM to 1:00 PM (3 to 4 Lectures)

End Date: Tentatively by Feb 25, 2026

Total lecture hours : 7 (approx.)

Meeting link : Will be shared later

[Link](#)

Contact email ID: pavankarjol@iisc.ac.in

Registration link:

<https://forms.gle/7cfz9drbt3N8Tkxj9>