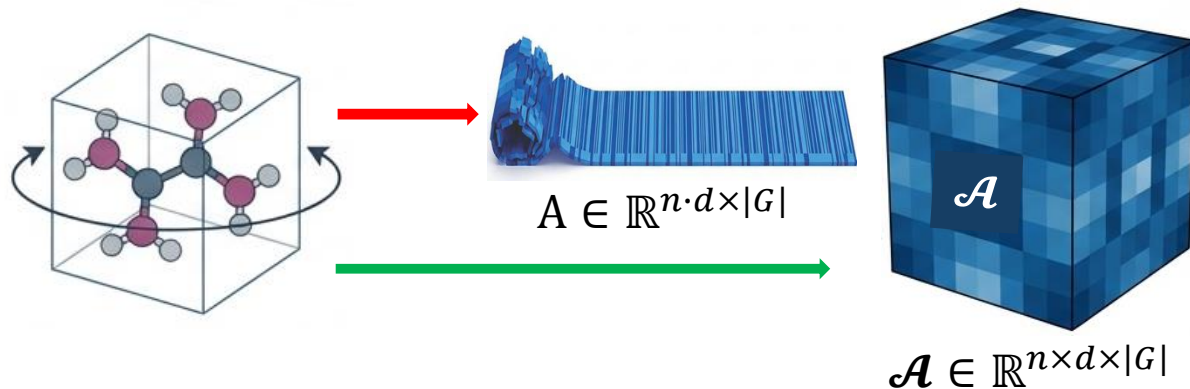


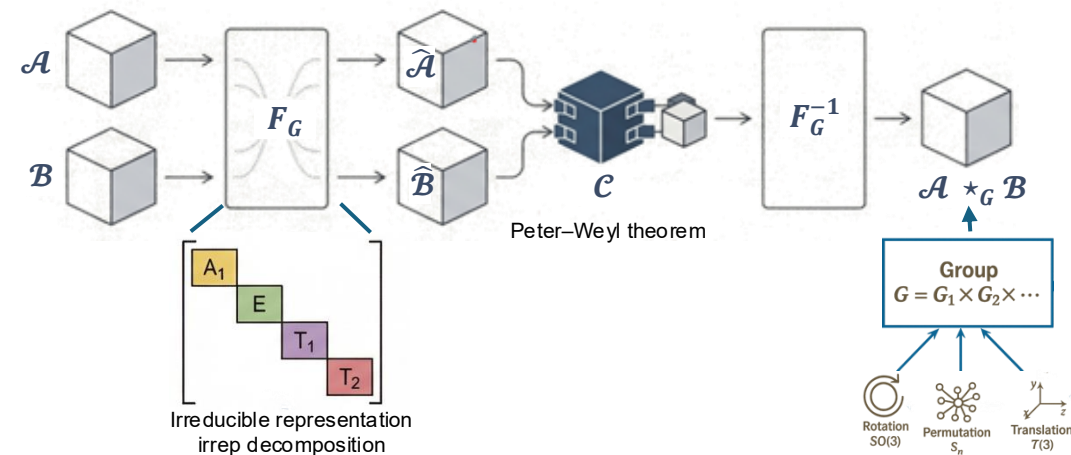
# The $\star_G$ tensor algebra: from optimal decomposition to symmetry discovery

## From molecules to (tensor) algebra



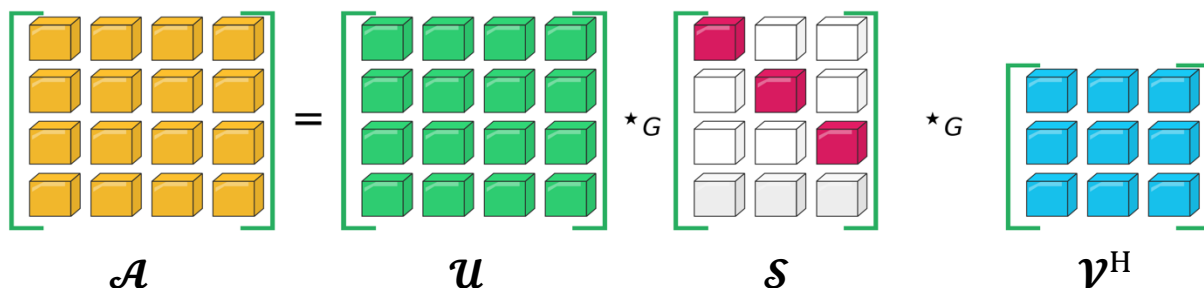
Data vectorization leads to loss of structural information

## The $\star_G$ product



Symmetry is in the algebra, not the architecture

## The $\star_G$ -SVD and irreducible representation decomposition

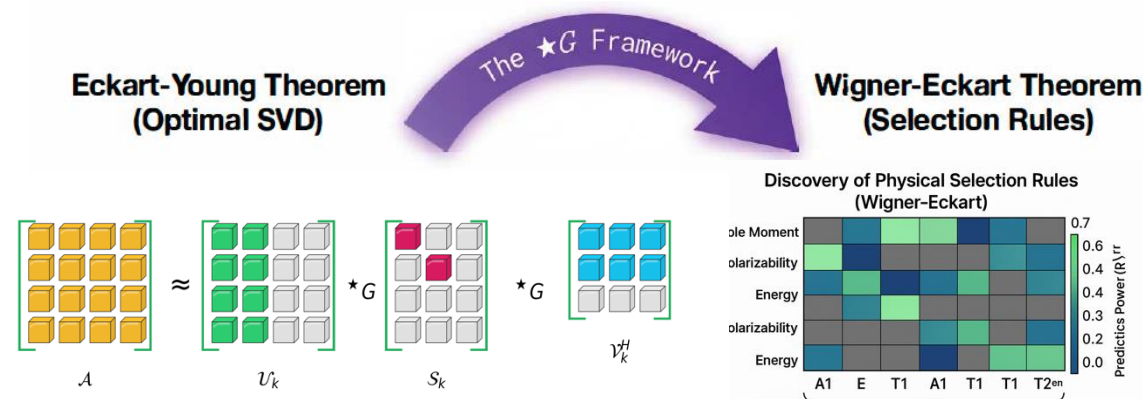


$$\|\mathcal{A} - \mathcal{A}_k\|_F \leq \|\mathcal{A} - \mathcal{B}\|_F$$

for any rank- $k$  equivariant tensor  $\mathcal{B}$

Provably Optimal low rank compression

## From Eckart–Young to Wigner–Eckart



Finding mathematically optimal decomposition (Eckart-Young) led to inadvertently recovering the physical selection rules (Wigner-Eckart)

Spectroscopy for physical symmetry:  
Recover selection Rules from Data