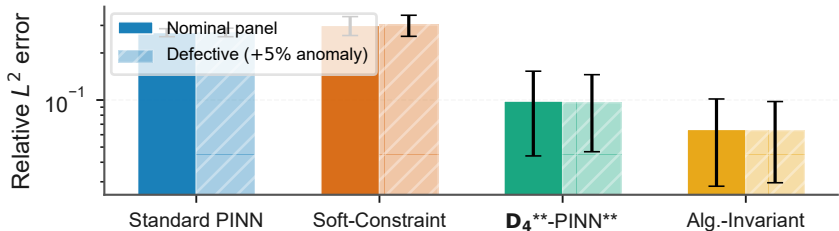
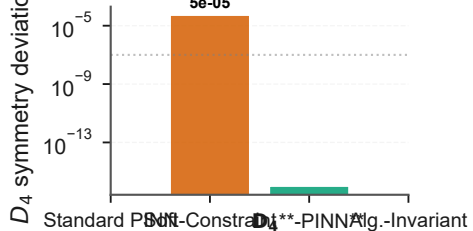
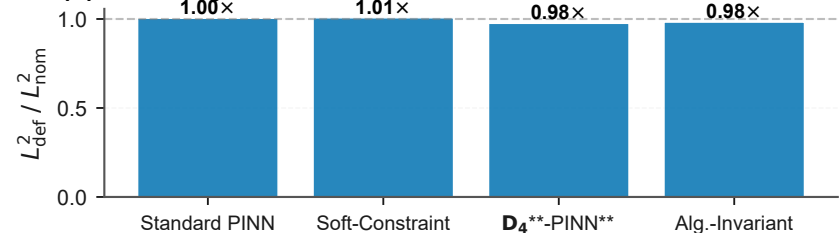


**(a) Forward: nominal vs. defective****(b) Symmetry deviation****(c) Anomaly detection ratio****Key insight :**

$D_4$ -PINN enforces symmetry at machine precision ( $\sim 10^{-17}$ ).

A defective panel breaks  $D_4$  symmetry  $\rightarrow$  the  $L^2$  error rises measurably.

$\rightarrow$  Built-in anomaly detector with no retraining.