

Infinitesimal transformations

$$R_3(\epsilon) = I + \epsilon \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \equiv I + \epsilon M_3$$

$$R_2(\epsilon) = I + \epsilon \begin{pmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix} \equiv I + \epsilon M_2$$

$$R_1(\epsilon) = I + \epsilon \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \equiv I + \epsilon M_1$$

$$M_1 M_2 - M_2 M_1 = \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} = M_3$$

same $[M_2, M_3] = M_1$
 $[M_3, M_1] = M_2$

Same commutation relation as the angular momentum operator

$$R_i(\theta) = \left(1 + \frac{\theta M_i}{n}\right)^n = e^{\theta M_i}$$

general rotation

$$R(\theta) = e^{\sum_{\alpha=1}^3 \theta_{\alpha} M_{\alpha}}$$

↑
generators

↑
parameters