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EE25BTECH11004 - Aditya Appana

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Question

The S_2 operation on a molecule with the axis of rotation as the Z-axis, moves a nucleus at (x, y, z) to

   A) $(-x, -y, z)$ B) $(x, -y, -z)$ C) $(-x, y, -z)$ D) $(-x, -y, -z)$

Solution

The rotation matrix for a rotation by an angle θ about the z-axis is:

$$R_z(\theta) = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{1}$$

Let the point be $\mathbf{x} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$. Therefore the rotated vector will be:

$$R_z(\theta)\mathbf{x} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} \tag{2}$$

$$\begin{pmatrix} x\cos\theta - y\sin\theta \\ x\sin\theta + y\cos\theta \\ z \end{pmatrix} \tag{3}$$

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It can be seen that a rotation about the Z-axis does not change the z-coordinate.
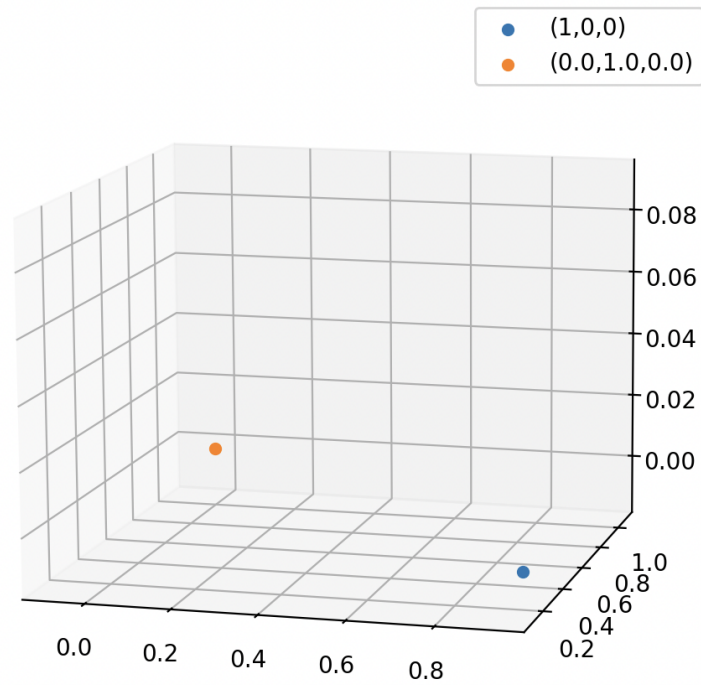Hence option(**A**) is correct.

Figure 1: Plot