

Problem Set 3

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Recall that the angular momentum operator of a particle is given by

$$\hat{L} = \hat{r} \times \hat{p} = (\hat{r}_y \hat{p}_z - \hat{r}_z \hat{p}_y)u_x + (\hat{r}_z \hat{p}_x - \hat{r}_x \hat{p}_z)u_y + (\hat{r}_x \hat{p}_y - \hat{r}_y \hat{p}_x)u_z$$

then we have that

$$\begin{aligned} [\hat{L}_x, \hat{L}_y] &= [\hat{r}_y \hat{p}_z - \hat{r}_z \hat{p}_y, \hat{r}_z \hat{p}_x - \hat{r}_x \hat{p}_z] \\ &= [\hat{r}_y \hat{p}_z, \hat{r}_z \hat{p}_x] - [\hat{r}_y \hat{p}_z, \hat{r}_x \hat{p}_z] - [\hat{r}_z \hat{p}_y, \hat{r}_z \hat{p}_x] + [\hat{r}_z \hat{p}_y, \hat{r}_x \hat{p}_z] \\ &= [\hat{r}_y \hat{p}_z, \hat{r}_z] \hat{p}_x + \hat{r}_z [\hat{r}_y \hat{p}_z, \hat{p}_x] - [\hat{r}_y \hat{p}_z, \hat{r}_x] \hat{p}_z \\ &\quad - \hat{r}_x [\hat{r}_y \hat{p}_z, \hat{p}_z] - [\hat{r}_z \hat{p}_y, \hat{r}_z] \hat{p}_x + \hat{r}_z [\hat{r}_z \hat{p}_y, \hat{p}_x] + [\hat{r}_z \hat{p}_y, \hat{r}_x] \hat{p}_z - \hat{r}_x [\hat{r}_z \hat{p}_y, \hat{p}_z] \end{aligned}$$