

PHYS3701 Introduction to Quantum Mechanics I Spring 2021  
Homework Assignment #3

Due at 5pm to the Grader on Thursday 4 Feb 2021

(1) Find the resulting ket, as an expansion in the  $|\pm\mathbf{z}\rangle$  basis, that results from  $\hat{R}(\alpha\mathbf{j})|+\mathbf{z}\rangle$  where  $\hat{R}(\alpha\mathbf{j})$  is the operator which effects a counter-clockwise rotation through an angle  $\alpha$  about the  $y$ -axis. Check to see if your answer makes sense for  $\alpha = 0$ ,  $\alpha = \pi/2$ , and  $\alpha = \pi$ . Recall (2.42) and (2.43a) in the textbook.

*Hints.* Base your form of  $\hat{R}(\alpha\mathbf{j})|+\mathbf{z}\rangle$  on (2.32) in the textbook. You will need to evaluate  $\hat{J}_y|\pm\mathbf{z}\rangle$  to work this out, and that is most easily done by writing  $|+\mathbf{z}\rangle$  in terms of the  $|\pm\mathbf{y}\rangle$ .

(2) Prove the following properties of commutators:

$$(i) [\hat{A}, \hat{B} + \hat{C}] = [\hat{A}, \hat{B}] + [\hat{A}, \hat{C}]$$

$$(ii) [\hat{A}\hat{B}, \hat{C}] = \hat{A}[\hat{B}, \hat{C}] + [\hat{A}, \hat{C}]\hat{B}$$

$$(ii) [\hat{A}, \hat{B}\hat{C}] = \hat{B}[\hat{A}, \hat{C}] + [\hat{A}, \hat{B}]\hat{C}$$