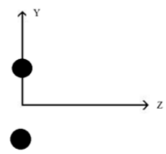
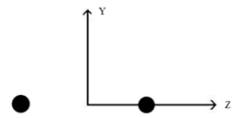
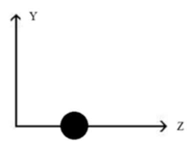
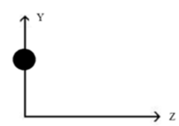
QM1 Concept test 7.1

A beam of neutral silver atoms in a spin state $|\chi\rangle = \frac{1}{\sqrt{2}}(|\uparrow\rangle_z + |\downarrow\rangle_z)$ propagates into the paper (x-direction). The beam is sent through an SGA with a horizontal magnetic field gradient in the <u>–*z*-direction</u>. What is the pattern you expect to observe on a distant screen in the y-z plane when the atoms hit the screen?

A. 

B. 

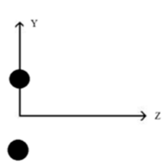
C. 

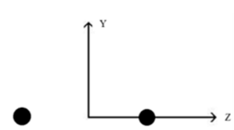
D. 

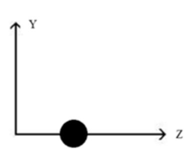
1

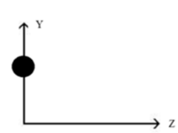
QM1 Concept Test 7.2

A beam of neutral silver atoms in a spin state $|\chi\rangle = \frac{1}{\sqrt{2}}(|\uparrow\rangle_z + |\downarrow\rangle_z)$ propagates into the paper (x-direction). The beam is sent through an SGA with a horizontal magnetic field gradient in the <u>–*y*-direction.</u> What is the pattern you expect to observe on a distant screen in the y-z plane when the atoms hit the screen?

A. 

B. 

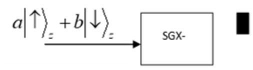
C. 

D. 

2

QM1 Concept test 7.3

A beam of neutral silver atoms in a spin state $|\chi(t=0)\rangle = a|\uparrow\rangle_z + b|\downarrow\rangle_z$ is sent through an SGX-. An "up" detector blocks some silver atoms, as shown in the picture below. What are the most appropriate basis vectors to find the fraction of the atoms exiting in the "down" output spin state?



A. $|\uparrow\rangle_x$ and $|\downarrow\rangle_x$

B. $|\uparrow\rangle_z$ and $|\downarrow\rangle_z$

C. either $\{|\uparrow\rangle_x, |\downarrow\rangle_x\}$ or $\{|\uparrow\rangle_z, |\downarrow\rangle_z\}$

D. $|\uparrow\rangle_z$, $|\downarrow\rangle_z$, and $|\downarrow\rangle_x$

E. None of the above

3

QM1 Concept Test 7.4

A beam of neutral silver atoms in a spin state $|\chi(t=0)\rangle = a|\uparrow\rangle_z + b|\downarrow\rangle_z$ is sent through an SGX-. An "up" detector blocks some silver atoms, as shown in the picture below. What fraction of the initial silver atoms will be blocked by the detector?

A. $|a|^2$

B. $|b|^2$

C. $\frac{|a+b|^2}{2}$

D. $\frac{|a-b|^2}{2}$

E. None of the above

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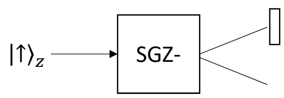
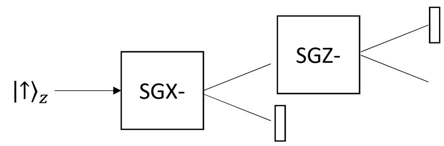
Concept Test 7.5

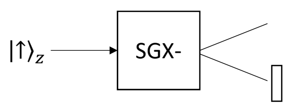
The initial state of a beam of neutral silver atoms is $|\uparrow\rangle_z$. Suppose you want to prepare a beam of neutral silver atoms in spin state $|\downarrow\rangle_z$. Which of the following shows an appropriate SGA to collect neutral silver atoms in spin state $|\downarrow\rangle_z$?



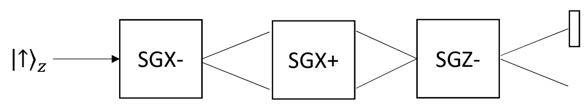
A



B



C

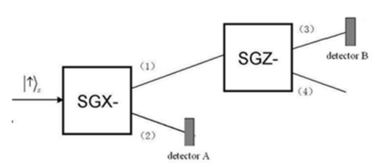


D

5

QM1 Concept Test 7.6

A beam of neutral silver atoms is in an initial spin state $|\uparrow\rangle_z$. It propagates through two SGAs as shown below. What is the probability that detector B will click for the atoms enter the first SGA?



A. ½

B. ¼

C. 1/8

D. 1

E. none of the above

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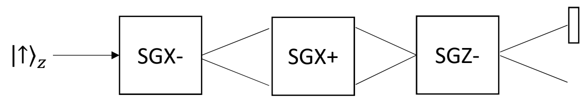
Concept Test 7.7

The initial state of a beam of neutral silver atoms is $|\uparrow\rangle_z$. It propagates through three SGAs as shown below. What is the probability that the detector will click for the atoms that enter the first SGA?



A. ½
B. ¼
C. 1/8
D. 1
E. None of the above

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QM1 Concept Test 7.8

Suppose neutral silver atoms are in an unknown state. The spin state of each atom is either a mixture with 70% of the atoms in the $|\uparrow\rangle_z$ state and 30% of the atoms in the $|\downarrow\rangle_z$ state or it is a superposition state $\sqrt{\frac{7}{10}}|\uparrow\rangle_z + \sqrt{\frac{3}{10}}|\downarrow\rangle_z$. Choose all of the following statements that are correct about the beam propagating through an SGZ or SGX apparatus.

(I) When the beam propagates through the SGZ, 70% of the atoms will register in one detector and 30% of the atoms will register in the other detector, regardless of the two possibilities for the state.

(II) When the beam propagates through the SGX, 50% of the atoms will register in one detector and 50% of the atoms will register in the other detector, regardless of the two possibilities for the state.

(III) We can use an SGZ to distinguish between the two possible spin states of the incoming silver atoms.

A. (I) only B. (II) only C. (III) only D. (II) and (III) only E. none of the above

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