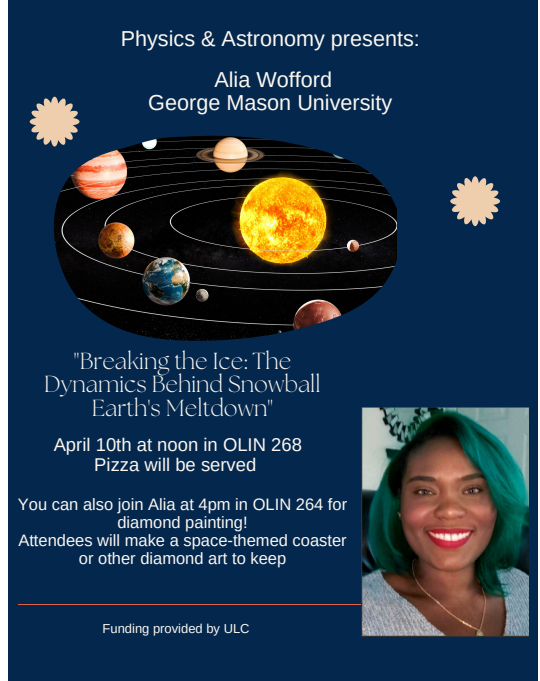
Announcements

- Third mid-term exam next Thursday, April 17 from 7:00–9:00 pm
- Optional review session Tuesday, April 15 at 8:00 pm in Olin 268
- You may bring a third note card for this unit. You do NOT need to put the spin states from Table 5.1 or Schrödinger's equation on your note card



Lecture 20 — Concept Test 1

Consider an electron-positron pair in the state

$$|\psi\rangle = \sqrt{\tfrac{2}{9}}\,|\uparrow\uparrow\rangle + \sqrt{\tfrac{1}{9}}\,|\uparrow\downarrow\rangle + \sqrt{\tfrac{1}{3}}\,|\downarrow\uparrow\rangle + \sqrt{\tfrac{1}{3}}\,|\downarrow\downarrow\rangle$$

What is the probability that a measurement of the z-component of the positron spin will find a value $S_z^{\text{pos}} = +\hbar/2$?

1. 1/9

2. 1/3

3. 4/9

4. 1/2

5. 5/9

6. 2/3

Lecture 20 — Concept Test 2

Given the electron-positron state

$$|\psi\rangle = c_+ |\uparrow\rangle \left(\tfrac{1}{c_+} \sqrt{\tfrac{2}{9}} |\uparrow\rangle + \tfrac{1}{c_+} \sqrt{\tfrac{1}{9}} |\downarrow\rangle \right) + c_- |\downarrow\rangle \left(\tfrac{1}{c_-} \sqrt{\tfrac{1}{3}} |\uparrow\rangle + \tfrac{1}{c_-} \sqrt{\tfrac{1}{3}} |\downarrow\rangle \right)$$

determine the value of c_-.

1. $\sqrt{1/9}$
2. $\sqrt{1/6}$
3. $\sqrt{1/3}$
4. $\sqrt{1/2}$
5. $\sqrt{8/9}$
6. $\sqrt{2/3}$

Lecture 20 — Concept Test 3

Consider the electron-positron state

$$|\psi\rangle = \sqrt{\tfrac{1}{3}}\,|\uparrow\rangle\,|\phi_1\rangle + \sqrt{\tfrac{2}{3}}\,|\downarrow\rangle\,|\phi_2\rangle$$

where

$$|\phi_1\rangle = \sqrt{\tfrac{2}{3}}\,|\uparrow\rangle + \sqrt{\tfrac{1}{3}}\,|\downarrow\rangle \qquad \text{and} \qquad |\phi_2\rangle = \sqrt{\tfrac{1}{2}}\,|\uparrow\rangle + \sqrt{\tfrac{1}{2}}\,|\downarrow\rangle$$

If we measure the z-component of spin for the electron and find a value $S_z^{\text{elec}} = +\hbar/2$, what is the new state of the electron-positron system?

1. $|\psi\rangle$ (no change)
2. 0
3. $|\uparrow\rangle\,|\phi_1\rangle$
4. $|\uparrow\rangle\,|\phi_2\rangle$
5. $|\downarrow\rangle\,|\phi_1\rangle$
6. $|\downarrow\rangle\,|\phi_2\rangle$

Lecture 20 — Concept Test 4

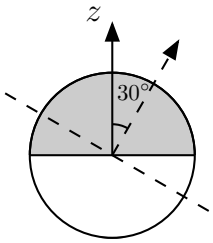
Given this new state $|\psi\rangle = |\uparrow\rangle\,|\phi_1\rangle$ with $|\phi_1\rangle = \sqrt{\frac{2}{3}}\,|\uparrow\rangle + \sqrt{\frac{1}{3}}\,|\downarrow\rangle$, what is the probability that a measurement of the z-component of the positron spin will find a value $S_z^{\text{pos}} = +\hbar/2$?

1. 1/9
2. 1/3
3. 4/9
4. 1/2
5. 5/9
6. 2/3

Lecture 20 — Concept Test 5

An electron-positron pair is created. A measurement is made that reveals $S_z^{\text{elec}} = -\hbar/2$.

According to our hidden variable theory, what is the probability that a subsequent measurement of the positron spin will find a value $S_{30^\circ}^{\text{pos}} = +\hbar/2$?



1. 1/6

2. 1/3

3. 1/2

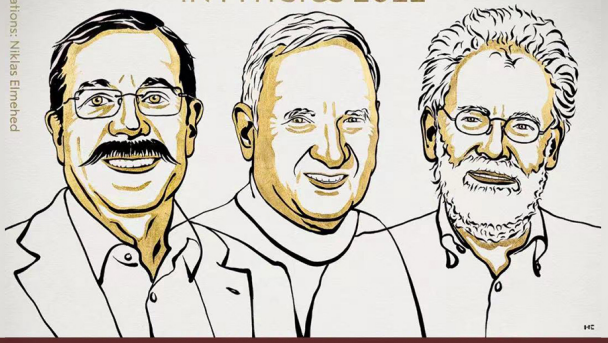
4. 2/3

5. 5/6

6. 1

THE NOBEL PRIZE IN PHYSICS 2022

Illustrations: Niklas Elmehed



Alain Aspect

John F. Clauser

Anton Zeilinger

"for experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science"

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