

H.W. II

Josh Lucas

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1 SPINS LAB 1

This lab entailed preparing particles in a particular state, $|\pm\rangle_n$, and passing them through a second analyzer in the orthogonal directions noting the output on the table.

$ \langle out in\rangle ^2$	$ +\rangle$	$ -\rangle$	$ +\rangle_x$	$ -\rangle_x$	$ +\rangle_y$	$ -\rangle_y$
$\langle+ $	1	0	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
$\langle- $	0	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
$_x\langle+ $	$\frac{1}{2}$	$\frac{1}{2}$	1	0	$\frac{1}{2}$	$\frac{1}{2}$
$_x\langle- $	$\frac{1}{2}$	$\frac{1}{2}$	0	1	$\frac{1}{2}$	$\frac{1}{2}$
$_y\langle+ $	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	0
$_y\langle- $	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	0	1

We can see the symmetry in the results of the table, if the in's and out's were reversed the results would be the same.

2 CH.1 DEFINITIONS

Orbital Angular Momentum L • The electron, from a classical viewpoint has angular momentum around a radius. $L = mvr$ This momentum of a charged particle creates current loops which induce a magnetic moment.

Intrinsic Angular Momentum, S , Spin • Similar to a satellite in orbit rotating as it revolves an electron classically has a rotation called spin. The spin also produces current loops.

Gyroscopic Ratio • A dimensionless scalar constant that relates spin of a particle with the magnetic moment μ as in $\vec{\mu} = g \frac{q}{2m} \vec{S}$.

Quantization • The act of organizing information into discrete sets.

Spin $\frac{1}{2}$ system • The Stern-Gerlach observations showed that spins of the particles were oriented in either a up or down configuration, $\vec{S}_z = \pm \frac{\hbar}{2}$

Observable • The physical quantity that is measured.

Analyzer • A device which can distinguish the spin configuration of particles.

Ket • Symbolic representation of the quantum state.

Bra • Symbolic representation of the complex conjugate of quantum state.

State Preparation Device • When a device such as Stern-Gerlach device separates the up and down spins of particles they are said to be prepared in that state.

Local Hidden Variable Theory • The theory that there could be another yet undiscovered fact or trait about the system that would account for the observations.

Incompatible Observables • Observables that cannot be know simultaneously as in knowing orthogonal spin components of a particle.

Quantum State Vectors • The mathematical representation of the quantum state of a system containing both the real and complex information.

Hilbert Space • Vector space defined for a system that limits space to the necessary dimensions.

Dot Product, inner product, scalar product • The magnitude of two vectors multiplied by the cosine of the angle between them. It is the magnitude of the projection of one vector on to another.

S_z basis • The possible contents of the set.

Orthonormality • The combination of normalizing and making orthogonal a vector or state.

Basis Vectors :

Normalized • The spatial vector is normalized if it is a unit vector with magnitude of one.

$$\hat{i} \cdot \hat{i} = \hat{j} \cdot \hat{j} = \hat{k} \cdot \hat{k} = 1$$

Orthogonal • The spatial vectors are orthogonal if their directions are perpendicular to each other.

$$\hat{i} \cdot \hat{j} = \hat{i} \cdot \hat{k} = \hat{j} \cdot \hat{k} = 0$$

Completeness • The spatial vectors are complete if any vector to some point in the space can be written as linear superposition of the unit vectors, scaling them accordingly and summing directions.

$$\vec{A} = a_x \hat{i} = a_y \hat{j} = a_z \hat{k}$$

Normalization Constant • The complex constant C

Probability • Mathematical possibility of an event occurring, the chance that the quantum state of the ket is measured to be in the corresponding basis state.

Probability Amplitude • The inner product of input and output states.

Superposition State, Coherent Superposition • The combination of general spin 1/2 vector containing both up and down kets

Mixed State • A state created from a mixture of up and down spin atoms

Column-Row Vectors • Matrices for indexing information, framework for linear algebra or computational calculations.

Representation • Collection of coefficients that multiply the basis set

Kronecker Delta • Binary logical operator, True if equal, false if not.