Re: Do free particles have spin?

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From: Gregory L. Hansen (*glhansen_at_steel.ucs.indiana.edu*)
Date: 09/27/04

Date: Mon, 27 Sep 2004 14:31:42 +0000 (UTC)

In article <F5ydnU97IMiHDsrcRVn−iw@softcom.net>,
David Rutherford <drutherford@softcom.net> wrote:
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>
>Gregory L. Hansen wrote:
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>> In article <Q8adndR7WaVc6MvcRVn−pA@softcom.net>,
>> David Rutherford <drutherford@softcom.net> wrote:
>>
>>>But if what I've read is correct, a photon's spin orientation is in the
>>>direction of its motion (longitudinal). So the polarization and spin
>>>orientation of a photon are orthogonal to each other, since the
>>>polarization is orthogonal to the direction of motion. From your
>>>comments above, however, you seem to be saying that spin orientation and
>>>polarization are one and the same thing. Obviously, that can't be true
>>>for a photon, since its spin orientation and polarization are in
>>>different directions.
>>
>> Horizontal and vertical are one basis for photon polarization. Another
>> basis is left and right circular. They're related.
>>
>> |left,right> = (|vertical> +,− |horizontal>)/sqrt(2)
>>
>> or something like that. Recall that a rotation is described by finding
>> the axis of rotation and applying a convention (the right−hand rule) to
>> define the direction it points. So the motion of the hands of a clock are
>> "pointing" into the wall, even though the hands move about the face. One
>> way to change from a transverse to a circular polarization is to pass a
>> transversely polarized beam through a birefringent plate, one that has
>> different indices of refraction for different polarization directions, at
>> 45 degrees, with a thickness so that one projection advances 1/4
>> wavelength ahead of the other.
>
>I don't know enough about the Dirac notation to know if you are saying
>that spin orientation and polarization are one and the same thing. Could
>you please answer yes or no to that question and explain why? And if
>they aren't the same thing, how does the measurement of the polarization
>of a free particle confirm the existence of its spin?

They're the same thing. The |kets> label states, they're like basis vectors.

I'll go classical. When a light wave is vertically polarized, the electric field at a particular point in space will look something like, with the first component an x value and the second a y value, third is z,

E_v = E0 (sin(wt), 0, 0)

If horizontally polarized,

E_h = E0 (0, cos(wt), 0)

E_h doesn't need a cosine, it could have been a sine, but you'll see the reason I chose that phase.

Circular motion, in Cartesian coordinates, is given by

(sin(wt), cos(wt), 0)

It's a vector sum of horizontal and vertical motion. The "direction" is given by the axis of rotation, which is mutually perpendicular to the two components.

That's what I tried to express above. Circular polarization can be expressed as a combination of two transverse polarization modes. The field of a circularly polarized light wave doesn't point in the direction of propagation, but a vector that describes how the field rotates (clockwise or counterclockwise) points along the direction of propagation.

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"We don't grow up hearing stories around the camp fire anymore about cultural figures. Instead we get them from books, TV or movies, so the characters that today provide us a common language are corporate creatures" -- Rebecca Tushnet