Re: Quantum mechanics and operators

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"cfgauss" <cfgauss@u.washington.edu> wrote in message
news:9e2e7039.0411142331.6c0a8309@posting.google.com...
> I'm trying to find out more about where the operators in quantum
> mechanics
> come from. From what I see, the justification for using them is that
> using
> them with the wave function, which is already known, gives you the
> expectation value for that operator, i.e., <E> = Integral[phi* (−i
> hbar d/dt)
> phi*]. But then I see the justification for the wave function as that
> if
> you put the operators in the equation E = p^2/2m, you get the
> Schrodinger
> equation. Well, that's great, but that argument just goes in a big
> circle.
> If you didn't know the wave equation, the solution to the wave
> equation, or
> the operators, how would you be able to come up with them? And what
> is the
> justification for what the operators are, other than "because it
> works." Do
> they "come" from anywhere?
>
> Also, if we look at the relativistic correct wave equation, my quantum
> mechanics books tell me that it comes from putting the operators into
> the
> relativistic energy equation. How can you justify doing this? How do
> you
> know the operators are relativisticly correct? How do we know that we
> don't
> have anything like an operator for mass that we have to put into the
> equations?
>
> I'm also interested in the use of complex numbers to write the
> equation. My
> quantum mechanics book mentions that they are used to simplify the
> equations, and that it doesn't physically mean anything. It mentions

> that
> you can write, for example, the equations describing electricity and
> magnetism in a form like that by saying F = E + icB, then you can
> write
> Maxwell's equations in terms of this F instead of separate equations
> for E
> and for B. So, you could also write the wave equation as the sum of
> two
> other "things," phi = phi_1 + i phi_2. Is there any kind of
> representation
> for these "fields" phi_1 and phi_2? Are they physically meaningful?
> Also,
> is there a physically meaningful representation of the field F = E +
> icB?
>
> I've tried to look through several quantum mechanics books for answers
> to
> these questions, but I haven't seen any argument that doesn't seem
> circular
> to me.
>
> Thanks very much!
> − Jeremy

Here's a provocative statement, to your quest, in L.E. Ballentine's Quantum Mechanics: A Modern Development, p. 77: "The dynamics of a free particle are invariant under the full Galilei group of space−time transformations, and this turns out to be sufficient to completely identify the operators for its dynamical variables. The method is based on a paper by T.F. Jordan (1975)."

I suspect you'll find quite a bit of what you're looking for in Ballentine's very excellent book.

John Lowry
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