- Quantum mechanics is a framework to do physics that replaced classical physics
- It was developed by Planck, Einstein, Schrodinger and Heisenberg beginning in late 19th century and solidified in 1925
- Quantum mechanics is applied to different physical phenomena, such as quantum electrodynamics
- This semester is a time to learn the basics of quantum mechanics, such as the general features, surprising elements and ideas that will be used later
- Quantum Chromodynamics: applying quantum mechanics to Australian direction
- Quantum Optics: applying quantum mechanics to photons
- Quantum Gravity: applying quantum mechanics to gravitation
- String Theory: quantum theory of gravity and all interactions
- Linearity of Quantum Mechanics: using equations of motion and dynamical variables to compare values with results of experiments
- Necessity of Complex Numbers: loss of determinism
- Unusual Features of Superposition: infinitely what is entanglement
- If you have a theory, you have some equations that you have solved for those dynamical variables
- Maxwell's theory of electromagnetism is a linear theory, meaning that if you have two waves propagating without affecting each other, you can form a third solution by simply putting them together
- Mathematically, there is an electric field, magnetic field, charge density, and current density that correspond to a solution if they satisfy Maxwell's equations
- Linearity states that if you multiply this solution by alpha, then it also becomes a valid solution for Maxwell's equations.
- Linearity implies that if two solutions (e1, b1, rho1, j1, and e2, b2, rho2, j2) are present, then the sum of those solutions (e1 + e2, b1 + b2, rho1 + rho2, and j1 + j2) is also a solution.
- Schematically, linear equations take the form L on U = 0, with U as the unknown.
- This equation can be expanded beyond one unknown (U) to multiple unknowns (U,V,W).
- The equation can also be expanded beyond one linear operator (L) to multiple operators (L1, L2) and multiple equations.
- So, what is a linear equation?
- A linear equation is something in which this L, then none can be anything, but L must have important properties, as being a linear operator will mean that L on A times U, for A is a number.
- Should be equal to A, L, U, and L on U1 plus U2, two unknowns, is equal to L U1 plus L U2.
- If an operator is linear, you also have L on alpha U1 plus beta U2.
- If U1 and U2 are solutions, which means L U1 equal L U2 equals 0, alpha U1 plus beta U2 is a solution.
- If L U1 is 0 and L U2 is 0, L of alpha U1 plus beta U2 is 0, and it is a solution.
- An example is a differential equation, D U, D, T, plus 1 over tau U equals 0.
- L U equals 0 can be written by taking L on U to be defined to be D U, D T, plus 1 over tau U.
- L alone can be written as D D T without anything here, plus 1 over tau.
- Check that L is a linear operator.