[Episode 4 - Lene Hau Transcript]

Dr. Lene Hau was born in Denmark on November 13, 1959. As a young girl she enjoyed school and especially excelled in math. She was a very bright student who skipped the 10th grade. Her father ran a heating business, and her mother was a shop clerk. They were encouraging of her scientific pursuits, and she continued her schooling at the University of Aarhus.

In 1984, she earned her bachelor's degree in mathematics from the university. She then continued her studies at the University of Aarhus to obtain a master's degree in physics, which she earned two years later in 1986. Hau did not stop here. She continued until 1991, when she obtained her doctorate in physics.

During her time in graduate school, she spent nine months at the European Organization for Nuclear Research, also known as CERN, where she worked on channeling high energy electrons and positrons in single crystals. In her studies of the Bose-Einstein condensate, Hau utilizes mathematical derivations to describe the physical meaning of her work. Such a condensate was predicted by Bose and Einstein in 1924, but it wasn't until 1994 that the technology was available to produce temperatures low enough to create a condensate in an experiment. Although the condensate contains millions of atoms, it behaves as if it were a single atom, but still exhibiting the usual particle-wave duality. The reason for the behavior of the Bose-Einstein condensate is essentially due to the Heisenberg uncertainty principle. For at such low temperatures, the momentum of the atoms is known accurately, so their positions cannot be accurately known. So the atoms and the condensate essentially spread out and become a single unit. Hau produced slow light by inducing quantum interference in the condensate. The Bose-Einstein condensate can be a condensate formed from fermions, that is, atoms which have non-integer spin states which are arranged such that the overall structure is a boson, or a structure that has an overall integer spin state. This condensate is made such that the wave functions are symmetric throughout the lattice so that if you were to rearrange the atoms, you would not change the overall spin state of the structure. Hau utilizes a sodium condensate with this physical property, because bosons can all be in the same quantum state. To explain this phenomenon with trapping light in an atom, Hau utilizes Schrödinger's wave equation. The wave equation is one which predicts the probability of an electron to be in a particular energy state. Solving the Schrödinger wave equation involves the use of the Hamiltonian operator. The Hamiltonian operator is one that operates on the individual wave functions, and the result is the individual probability amplitudes for a given quantum energy state. The probability amplitude squared tells the probability of finding an atom in a given energy state. In doing this, she can track the photon as it moves through the atoms in the sodium boson condensate. Trapping light could be the future for computers that use light instead of electrons to carry and process information. Also, potential future research could be creating black holes in the lab, because this process of trapping light is similar to what happens to light in a black hole.

I'm very excited to hear more about where her research takes us in the coming years. Learning about Lene Hau has been inspiring for me. She earned a bachelor in mathematics and did her PhD studies in quantum theory. This solid mathematical backing has guided her as a professor and researcher in the past 20 years. I hope to continue my math studies and use it as a guide in my own theoretical research in both chemistry and physics.