Exploring the Quantum World: From Plants to Pulsars
September 24, 2014

**Introduction**
What do the interior of an atom, the bottom of a volcanic caldera, and the center of the sun have in common? Mike will begin with an introduction to quantum mechanics, which explores its relationship with our everyday world. Some aspects of the quantum world seem perfectly sensible but other concepts, like superposition, are deeply counterintuitive. Next, Joey will delve into an unexpected discovery in plant photosynthesis. Not only is chlorophyll capable of turning light energy into chemical energy, but it seems to do its job better than classical physics and chemistry would predict! Is it possible that quantum effects like superposition play a role in living organisms? Joey will show us the data and the tools scientists use to investigate this possibility. Finally, Tansu will turn our attention to the skies, and how quantum mechanics can explain the variety of sizes, colors and life stages of stars. While white dwarfs fade slowly, becoming smaller and cooler with time, others reach a critical state that leads to an explosive supernova.

**Speakers**

**Mike Goldman** is a fifth-year PhD student in physics at Harvard University. He grew up in upstate New York and studied physics at Amherst College. He works in Misha Lukin’s group to probe the quantum properties of atomic-scale defects in diamond. He is currently studying interactions between these defects and vibrations or magnetic impurities in the surrounding lattice. When he’s not in the lab, he enjoys cycling, reading, and taking full advantage of the Boston Symphony Orchestra’s student card.

**Joey Goodknight** came from the small town of Nevada City, California, but made his way to the big city for undergrad at UC Berkeley. Even more adventurous for graduate school, he left California for a PhD in Chemical Physics at Harvard. While he often wonders why he left California’s perfect weather, he very much enjoys working on developing new experiments to determine how molecules transfer energy, in the lab of Alan Aspuru-Guzik in the department of chemistry. In addition to science, Joey is involved in performing arts on campus and is a resident tutor in Pforzheimer House.

**Tansu Daylan** is a second year PhD student in the Harvard University Physics Department working with Professor Douglas Finkbeiner in the field of particle astrophysics. In particular his research is centered around the indirect identification of dark matter and involves several problems such as particle propagation in the galaxy, identification of diffuse gamma-ray emission components, and the radiative transfer of cosmic dust.
Glossary of Important Terms

Atom: An elementary unit of matter, which is comprised of protons, neutrons, and electrons.

Chlorophyll: An organelle in the cells of plants and some bacteria, which contains photosynthesis machinery.

Classical mechanics: A theoretical framework that describes the behavior of matter and energy at macroscopic scales, where quantum effects like superposition need not be considered.

Coherence: A feature of waves whose constituent parts are in phase with one another.

Degeneracy pressure: Pressure in a quantum gas, which is dependent on density but not temperature.

Electron: A negatively charged subatomic particle, which is one component of an atom.

Interference: The interaction of two waves as they meet, wherein the amplitudes of the two waves add together (constructive) or are cancelled by each other (destructive).

Pauli exclusion principle: A quantum mechanical principle that says that no two fermions (e.g., electrons) can be in the same state at the same time.

Photoexcitation: Energy transfer from a photon of light to another particle, such as an electron.

Pulsar: A rotating neutron star that emits electromagnetic radiation.

Photon: A single unit—or quantum—of light, which has both wave- and particle-like properties.

Quantum mechanics: A theoretical framework that describes the behavior of matter and energy at microscopic scales, where quantum effects like superposition are important.

Superposition: The principle that a particle exists in multiple states simultaneously.

Resources to learn more


Shedding light on supermassive black holes with pulsars, http://bit.ly/1mopC87, SITN article

Minute Physics, https://www.youtube.com/user/minutephysics, series of 1-minute videos on physics topics

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