Precision physics with atoms & molecules

My group uses atoms and molecules as precise probes of fundamental physics. Our research projects involve building portable atomic clocks for gravitational physics, testing the validity of discrete symmetries of spacetime using the resonances of atoms and molecules. Previous summer students have done experiments ranging from thermal engineering of ultrastable cavities, to building ion traps, to launching optical clocks on a high-altitude balloon.

You can see some of our recent results at the group website: http://uoft.me/vutha

2020 Summer Projects

High-energy physics with low-energy molecules

One of the biggest mysteries about the universe is why everything is made up of matter, but there is no natural antimatter anywhere. This surprising imbalance, between two entities that should behave identically under the known laws of physics, is one of the biggest open problems in physics. A clue to understanding this mystery may be obtained from precise measurements of the shape of the electron (specifically, the "electric dipole moment of the electron"), which reveals unknown physics at hundreds of times higher energy than the LHC.

You will be participate in building a new experiment that traps molecules in inert gas ice, to make an ultra-precise measurement of the electron's shape (www.edmcubed.com).

Robust optical atomic clocks

An interesting question that could shed light on the nature of dark energy is the following: *are the laws of physics truly Lorentz invariant?* We are developing an experimental test of Lorentz invariance in different gravitational fields by comparing a pair of stable optical clocks against each other. Last year, two undergraduates participated in an experiment that operated the world's first optical clocks on a high-altitude balloon, as a prelude to eventual experiments in space.

You will build a precise yet physically robust clock laser, including all of its subsystems, and be involved with testing it in field applications.

Requirements

I like introducing students to the joys of experimental physics. You should be willing to learn new things, and enjoy working with your hands. Prior experience tinkering with analog/digital electronics, and practical knowledge of optics, will be helpful but is not essential.

Please contact Amar Vutha (amar.vutha@utoronto.ca) if you are interested. (*Be bold !*)