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 to study gravity, and testing the validity of physical laws using careful measurements on atoms and molecules. Previous summer students have done experiments ranging from thermal engineering of ultrastable cavities, to building ion traps, to launching optical atomic clocks on a high-altitude balloon.

You can see some of our recent work at http://uoft.me/vutha

2021 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 noble-gas ice crystals, to make an ultra-precise measurement of the electron’s shape (www.edmcubed.com).

Optical atomic clocks to probe fundamental physics

An interesting experimental question that could shed light on the nature of dark energy is the following: *are the laws of physics truly constant in time?* Insight into questions like this one can be provided by sufficiently precise atomic clock measurements. We are developing a new optical atomic clock with significantly higher precision compared to the state of the art. You will be involved in building important subsystems of the clock, including the ultrastable laser and the detection system.

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 !*)