Precision physics with atoms & molecules

My group uses atoms and molecules as precise probes of fundamental physics. Our research projects involves testing the validity of fundamental 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

2023 Summer Projects

High–energy physics using precision spectroscopy

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 time–reversal (T) symmetry of nuclei. Measurements of T–violation over a long time interval can also set strong constraints on the spectrum of dark matter candidate particles called axions.

You will join a team that operates a newly built experiment, in order to make an ultra–precise measurement of T–violation in nuclei within a crystal. This project requires a sound understanding of E&M and quantum mechanics, and the ability to quickly learn lab skills.

Building a cryogenic atomic clock

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 higher accuracy compared to the state–of–the–art, using a single Sr+ ion trapped in a cryogenic environment. You will be involved in building and testing important pieces of the clock that may eventually become Canada's official time standard. This project requires a good grasp of engineering fundamentals, and an ability to get things done despite constraints and challenges.

Requirements

I like introducing students to the joys of experimental physics. You should be willing to learn new things, and enjoy building/fixing things. Prior experience tinkering with analog electronics, and practical knowledge of optics, will be helpful, though they are not essential.

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