Precision physics with atoms & nuclei

My group uses atoms and nuclei as precise probes of fundamental physics. Our research projects focus on testing the validity of fundamental physical laws using careful measurements.

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

2025 Summer Projects

Fundamental 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 a fundamental open problem. A clue to understanding this mystery may be found from precise measurements of the shape of nuclei. Measurements of nuclear shape fluctuations also provide information about the spectrum of dark matter candidate particles called axions.

You will join a team that operates a high–precision experiment to measure the properties of nuclei within a crystal. This project requires common sense, sound fundamentals in E&M and quantum mechanics, and the ability to pick up new skills rapidly.

*C*ryogenic single–ion 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 precise atomic clock measurements. We have built a new 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 testing and characterizing important pieces of the clock that may eventually become Canada's official time standard. This project requires a good grasp of basic physics, sound engineering fundamentals, and an ability to get things done despite constraints and challenges.

Requirements

I like introducing students to the joys of experimental physics: but genuine curiosity and enthusiasm for doing physics are essential. Prior experience with building/fixing hardware, analog electronics or mechanical fabrication will be helpful, though not essential.

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