Why this is important

Prior to this work, essentially all that was known about permafrost microbial communities in the Dry Valleys was that microorganisms are present. We greatly expanded what is known about the ecology of microorganisms that are found in Dry Valley permafrost at high elevations, by surveying the microorganisms using next generation sequencing techniques, by culturing the organisms, and more interestingly by doing activity assays both in situ and in the lab. Thus, greatly increasing our understanding of the microbial ecology in a rare spot on earth where the only potential living things are microorganisms.

This site is one of the best Mars analogue sites that we have on Earth, similar to the dry and ice-cemented permafrost found in the north polar region of Mars where Phoenix landed. Understanding what types of microorganisms could survive or be active in these types of soils, as well as detecting biosignatures (in the form of dormant or dead cells, and nucleic acids in our case), is important to understanding what we could be looking for in near surface water ice on Mars in the north polar regions.

Goordial, Jacqueline, Alfonso Davila, Denis Lacelle, **Lyle G Whyte**, et al. (2016b), *Nearing the cold-arid limits of microbial life in permafrost of an upper dry valley, Antarctica*, ISME J 10 (7), 1613–1624.

Hands-on Radio Interferometers

Dr. Sean Griffin *is a postdoctoral fellow in the McGill Cosmology Instrumentation Laboratory. He leads a project to design hardware for small, portable radio interferometers.*

Can you describe your project?

High-resolution radio astronomy is typically performed using arrays of many telescopes spread across a large area. The information from each telescope is combined in order to reconstruct the information about the part of the sky the telescopes are observing. In practice, this is called interferometry. Conceptually, this material is taught in undergraduate courses, but we wanted to produce a hands-on experiment that students could use to learn how interferometry is actually done in practice.

In addition to the teaching tool, this project can be adapted in order to build tools for identifying sites for future radio astronomy arrays (an "RF monitor"), or to use in conjunction with current telescopes (such as CHIME) to make ultra-high-resolution measurements of transient events (such as fast radio bursts) using very-long-baseline interferometry (VLBI).

Why did you find this project interesting?

I think that hands-on experience learning "real-life-astronomer" skills is an important part of a student's training; a tool like this one is something I would have appreciated having access to when I was an undergraduate.

What did you learn?

We've learned (unsurprisingly) that it is tricky to build a radio telescope in the middle of a big city like Montreal. There's so much radio frequency (RF) noise around us that it makes measuring any astrophysical source difficult because their signals are much dimmer than those coming from FM radio, TV, and cellphone transmitters.

However, this just means that we need to be more clever about how we go about building our experiment. What we are learning about characterizing the radio noise in the city is also directly applicable to our goals of building an RF monitor to identify radio quiet sites.

At first, we expected that we would only be able to look at the brightest objects in the radio sky due to how much RF noise there is in the city. After having worked on this project for some time, we now believe that it might be possible to expand out targets to include dimmer objects like pulsars. It is exciting to see that we are not necessarily as limited as we thought we once were.

What does doing your research look like?

My research consists mainly of working with electronics in a lab, but involves taking trips outdoors to make measurements of the sky with our experiment. I also write a lot of software to read and analyse data from the various instruments that I use, and to help me predict what the signals I observe will look like.

Once the full system is ready for deployment, we will be driving out into the field with our telescopes to make measurements of different sites in an attempt to identify 'radio-quiet' zones as possible future radio telescope sites. In the long term, we hope to build a small telescope array on the roof of the Rutherford Physics building to use as a teaching instrument and a platform for testing new radio astronomy hardware. This will require actually heading up to the roof and building it, which is very exciting.

What role did collaboration play in your research?

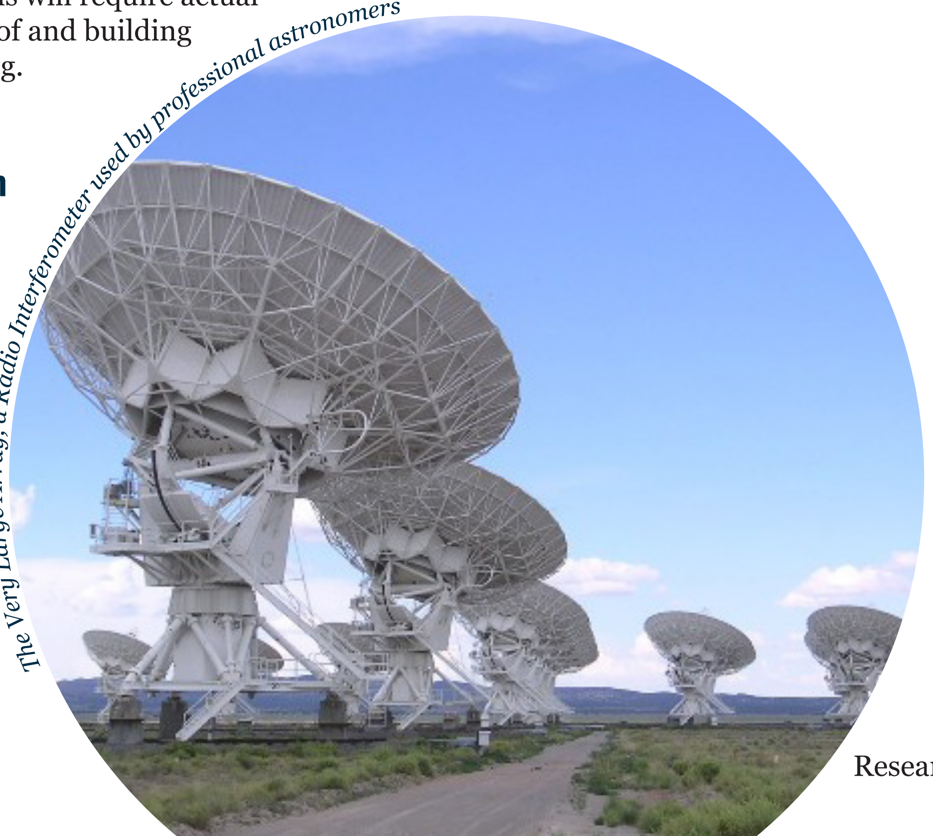
Different parts of our telescopes are being designed and tested by different people; there is too much work for any one person to do. Collaboration allows us to bring in specialists to work on the different components of the experiment, helping maximize our efficiency.

Why this is important

The first stage of this project is an instrument to give young astronomers hands-on experience with a real radio interferometer. This differs from traditional undergraduate lab experiments where students often repeat a historical measurement and do not represent modern experiments.

This instrument will allow undergraduates to work with state-of-the-art hardware and take make astronomical measurements in the same way that modern telescopes do. It is my hope that this will help motivate future experimentalists and get them excited about working in astronomy.

The second stage of this project is an instrument to help identify sites for future radio arrays. The hardware will allow us to characterise the environment in terms of both an absolute measurement of how noisy (or not) a given site is over a wide bandwidth with fine frequency resolution, and a measurement of the structure of that noise in time, which allows for the optimisation of data taking strategies in order to minimise the impact of any ambient RF interference.



The Very Large Array, a Radio Interferometer used by professional astronomers