

Cosmology and Astroparticle Student and Postdoc Exchange Network (CASPEN)

Exit Report: Keith McBride

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CASPEN provided me with the rare opportunity as a 3rd year graduate student to do research at UCL and meet its faculty and staff. The work done at UCL with Dr. Linda Cremonesi involves our collaborative experiment, the ANTarctic Impulsive Transient Antenna (ANITA), to detect ultra high energy neutrinos. The main goal was to finalize simulation aspects for the most recent flight of ANITA. I also interacted with researchers on other experiments including Dr. Chamkaur Ghag who searches for dark matter. The interactions and the research done through CASPEN have been a big help in moving the ANITA simulation and analysis papers forward.

Visiting UCL allowed Dr. Linda Cremonesi and I to make a lot of progress on updating the simulation software "icemc" for the ANITA experiment's fourth flight. The simulation is a crucial part for analyzing data. Dr. Cremonesi and I worked on incorporating different triggering aspects into icemc. The Tunable Universal Filter Frontend (TUFF) was a newer component flown on ANITA but had not been added as an option into icemc (1). Most of my time at UCL was spent discussing with Dr. Cremonesi some tests of the software and what next steps are necessary for completion to show the TUFFs are correctly simulated. The direct results of these discussions are plots and processes that will be outlined in a paper on the simulation. This visit to UCL will be acknowledged on that publication and was helpful in this way.

In addition to working with me on simulations, Dr. Cremonesi introduced me to multiple experimentalists working with neutrinos. I met with Prof. Ryan Nichol who works on ANITA and discussed the different types of parameters that could be optimized for in an ANITA-IV analysis and how these can change in a possible ANITA-V experiment. Prof. Nichol and Dr. Cremonesi showed me their lab which houses a mini-ANITA model that was used as a museum exhibit prop. Also in the lab was the experiment CREAM TEA for Prof. Nichol's research on using muons to probe objects. I then got the opportunity to interact with LARA, the liquid Argon chamber housed in Prof. Nichol's lab which is being used for testing for the neutrino beamline experiment DUNE. A new mass spectrometer was being hooked up to LARA by Dr. Laura Manenti and I got the extraordinary chance of helping with that setup. Also working on the DUNE experiment was Dr. Chris Backhouse and Sebastian Jones who shared some simulation ideas for the detectors with me. Lastly, Lauren Dawson shared her experience working on the electronics for SuperNEMO which looks for neutrinoless double beta decay. Some of her research was conducted at Mullard Space Science Laboratory (MSSL), a unique science facility in London. CASPEN has allowed me to learn more about neutrino experiments in this way.

I contacted researchers regarding dark matter particle searches at UCL and was able to meet with a few of them as well. Prof. Mark Cropper of MSSL and I had an online discussion of the types of projects at MSSL such as GAIA and Euclid. I learned about the history of MSSL and some of the components that go into these experiments as well as the science they research. Finally, Dr. Chamkaur Ghag and Dr. Chris Gutschow agreed to speak with me regarding dark matter particle physics searches. I learned from Dr. Ghag the projected sensitivity levels for LZ and the role he plays in the radioactivity background from the experiment's materials. Dr. Gutschow introduced me to his research on missing transverse energy in

ATLAS runs. I have a better understanding of dark matter experiments and their challenges as a result of the interactions.

Working at UCL has helped my research with icemc and ANITA analysis. New ideas and tests for the simulation have been discussed in my interactions with Dr. Cremonesi. Conversing with Prof. Nichol and others on neutrino experiments have given me a lot of background into research questions after this project is finished. Learning about other collaborations like LZ and ATLAS that search for dark matter has helped me as a physicist. Overall, CASPEN has had a huge impact on both my current projects and future research.

- (1) P Allison, O Banerjee, JJ Beatty, A Connolly, C Deaconu, J Gordon, PW Gorham, M Kovacevich, C Miki, E Oberla, et al. *Dynamic tunable notch filters for the antarctic impulsive transient antenna (anita)*. [arXiv:1709.04536](https://arxiv.org/abs/1709.04536), 2017