Improving Detector Sensitivity through Computational Methods – Abstract

Treatment of ailments is dictated by the results of medical imaging; therefore, high quality and precise imaging is imperative to long term, positive health outcomes. One of these imaging techniques is Single Photon Emission Computed Tomography (SPECT). Some of the conditions imaged and studied using SPECT are: mental disorders, various types of cancers, blood clots in the lungs, and heart disease. SPECT imaging systems use gamma-ray detectors that take images of the patient at many different angles, which are then made into a three-dimensional image (a reconstructed image). In our first SPECT prototype we noticed that our reconstructed images contained artifacts which we attributed to a mis-positioning of events near the strip/electrode edges of our detector, decreasing efficiency and overall sensitivity. I will design a different positioning technique that will correct for this mis-positioning and implement it in our new SPECT system. The new SPECT system will use two germanium detectors. Germanium is a material with a higher performance than the traditionally used detectors for SPECT imaging, resulting in higher sensitivity (brighter images), and higher contrast (features like tumors or lesions are more identifiable than the noise in the image). When events are mis-positioned and/or uncounted, objects like tumors are difficult to identify because the images are blurry, noisy, and darker. The mis-positioned or uncounted events are likely due to a combination of electrode geometry and our current positioning estimation. Computational methods have been shown to correct for the effects due to the electrode geometry, but only in limited cases. The goal of my study is to investigate and implement different data analysis methods and verify which can improve the performance of our system. I will do this in three aims: Aim 1) Characterize in greater detail our current detector, Aim 2) Develop a new computationally based method for data analysis, and Aim 3) Implement the method in our SPECT system.

Interests:
Instrumentation for planetary exploration and/or gamma-ray imaging.
Also wanting to broaden my experience with other energy regimes, to eventually develop the ability to pair the right detector for a particular astronomy application.