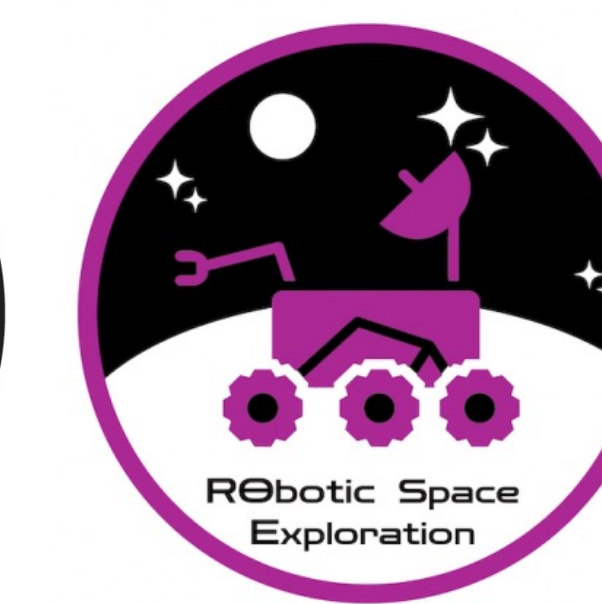


Testing and Characterizing Global Localization with Stars and Gravity

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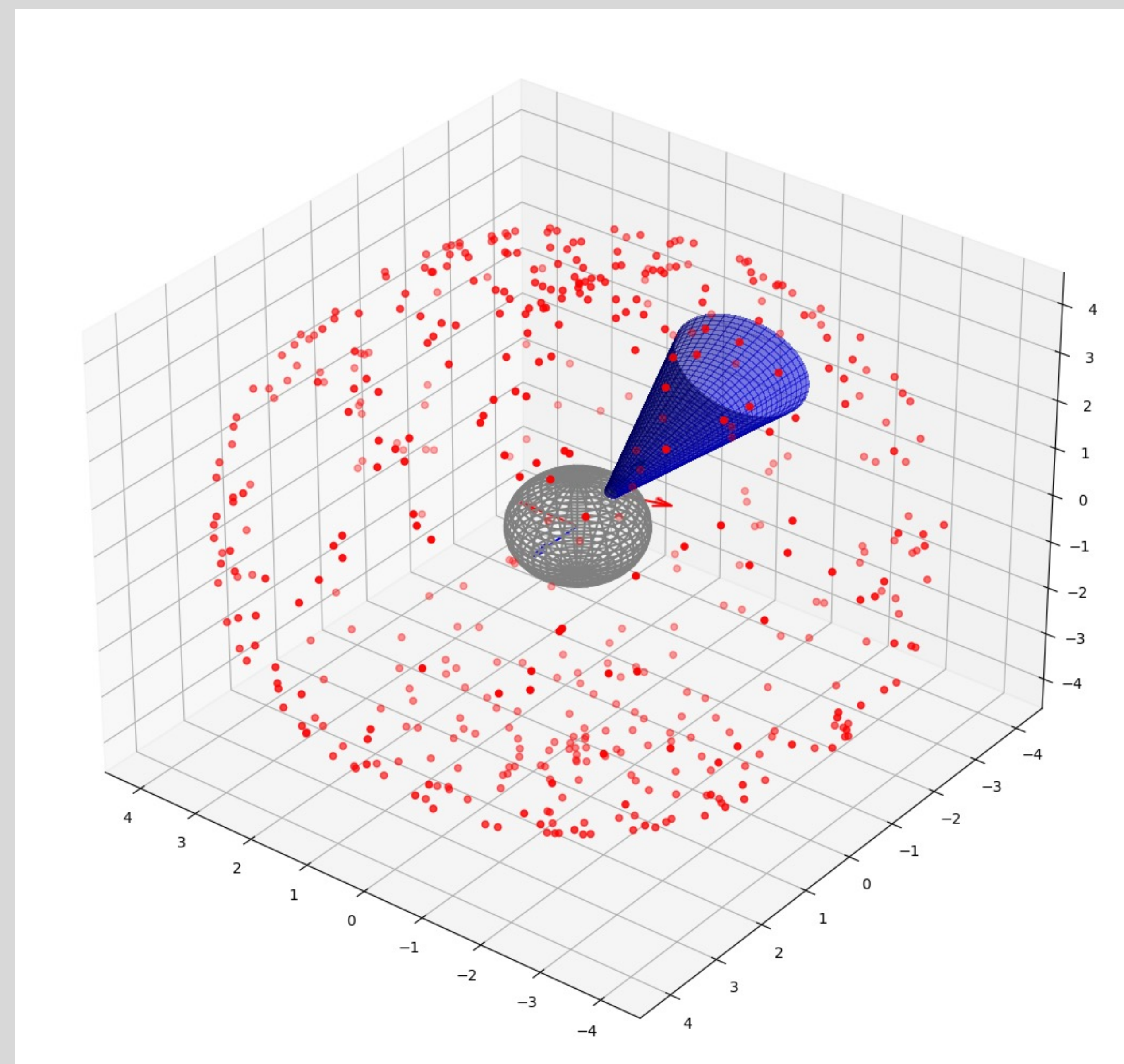
Introduction

The Problem

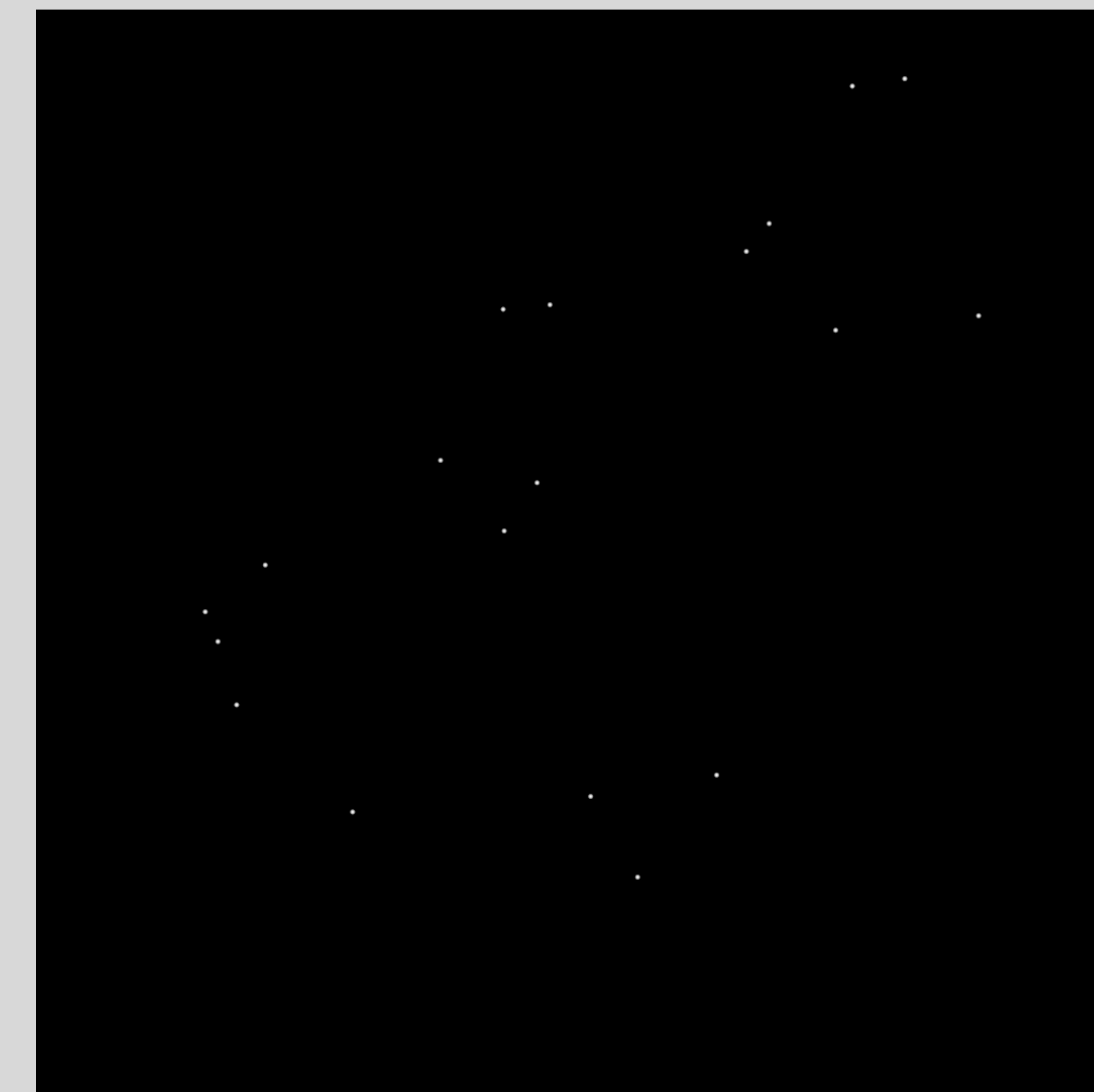
Rovers cannot use GPS positioning when exploring other planets due to the lack of satellites. Instead, rovers can use images of the stars to determine its location on the planet. In order to test this method, a simulation capable of generating accurate images of the stars from any location at any viewing angle must be created.

Technology Stack

PyVista, a 3D plotting library in Python, was used to create the simulation. PyVista provides a high-level API to the popular Visualization Toolkit (VTK) library in C++.



Stars in the simulation are plotted in 3D coordinates around a planet. Then, the camera is placed on the surface and aimed at a certain point in the sky



Simulated Image from Papakolea

Latitude: 21.32°
Longitude: -157.84°
Right Ascension: 324.02°
Declination: 0.81°

Solution

Agile Methodology

- Broad tasks were broken down into smaller, iterative cycles
- Scrum framework was used with weekly sprints and sprint planning sessions
- Past accomplishments were reviewed periodically to identify any retrospective changes necessary

Tasks Accomplished

- The simulation can successfully generate images of stars against a night sky
- The camera can be placed at any latitude and longitude and point anywhere in the sky
- Star-recognition software such as Astrometry and Open StarTracker successfully recognize the stars in the simulated images and can identify the location in the sky
- Coordinates identified by Astrometry are less than 1 arcminute (0.0167 degrees) off from the original data that the simulation was constructed from

Challenges and Learnings

- Initially, Matplotlib was chosen due to its popularity
- However, Matplotlib lacked flexible camera controls, making it very difficult to place the camera at a certain location or precisely aim the camera at a point
- Eventually, the switch to PyVista was made as it was a more robust 3D plotting library
- Learned about a lot of different data visualization tools and libraries within the Python ecosystem