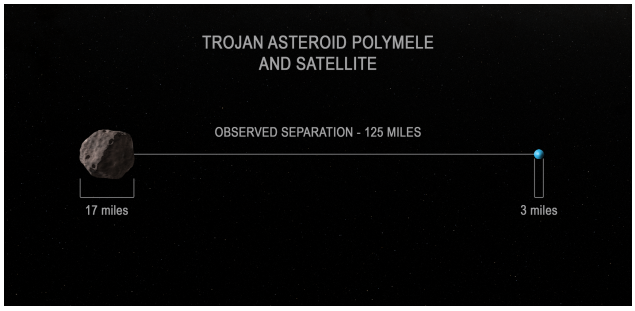
Over the week of January 30, 2023, I flew along with two other students from NAU to Longmont, Colorado, where we convened with ~200 other professional and amateur astronomers to execute the biggest centralized telescope deployment of this kind in history. The objective: to precisely measure the position of a small moon orbiting a distant asteroid.

1: Introductions at the day 1 all-hands meeting. Credit: Jessica Walsh

Polymele is the smallest of the targets for the NASA Lucy mission, a spacecraft currently traveling out to the orbit of Jupiter to explore a very unique and primitive population of asteroids known as the Trojans. Over the next two decades, the Lucy Spacecraft will encounter five such targets. Of these, three are known to have companions: Patroclus has a near-equal mass companion called Menoetius, Eurybates is known to have a small satellite named Queta, and Polymele was recently discovered to also host a small yet-unnamed moon.

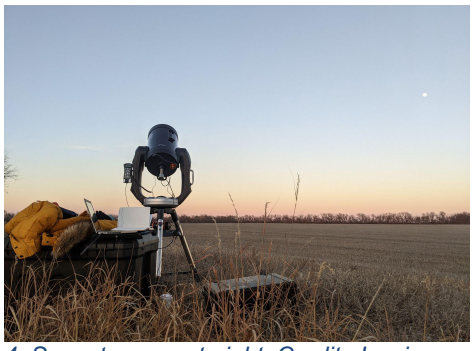


2: Artist's impression of Polymele and its small satellite. Credit: NASA Goddard Spaceflight Center

Polymele's moon was discovered during an event known as a stellar occultation, during which an asteroid or comet passes in front of a distant star, blocking out its light and casting a shadow on the surface of the Earth. This technique can be used to measure the precise shape and size of the asteroid, because the shadow cast produces an exact image of the object itself. During a previous occultation, a secondary dropout of star light was noticed, which clearly did not correspond to Polymele itself blocking the star. The reason for this secondary blink was a small moon, about ⅕ the size of Polymele, orbiting at a distance of about 200 kilometers.

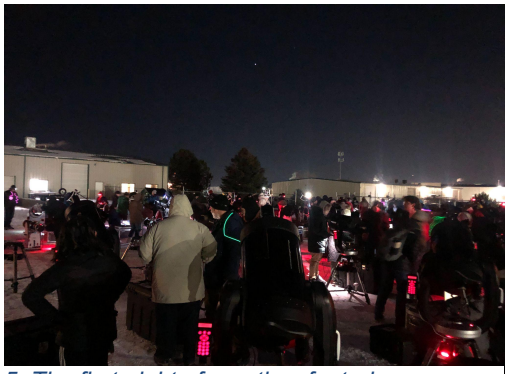
3: Excited for the big night! Credit: Ryder Strauss

Moons and other companion objects are a powerful tool for studying the physical properties of solar system objects. The motion of a moon as it orbits the main body can inform us about the mass, density, and composition of both objects, something which is very difficult to do without a ground-truth measurement. But the orbit of Polymele's moon is not well known: The discovery only comprises a single detection, with which it is difficult to precisely determine the orbital geometry of the system. This was the purpose of this recent occultation campaign based out of Longmont: to obtain a secondary measurement of the moon, to better constrain its orbit and facilitate future measurements of the system.



4: Sunset on event night. Credit: Jessica Walsh

Because of the uncertainty in the position of the moon, an unprecedented effort was required: 200 professional and citizen scientist observers were recruited from across the country to deploy 100 telescopes across rural Kansas, collecting more than 3 terabytes of data in a search for the moon. This was a triumph in citizen scientist engagement, as more than half of our observers were non-professionals, and many had no prior experience operating telescopes. This event was also a very powerful avenue for community engagement. While I was observing along the side of a deserted dirt road in the middle of Nowhere, KS, I was approached by a farmer and his daughter driving into town for the evening. His curiosity was infectious, as he sat with me during the data collection asking wonderful questions about the mission and the science we were doing. After collecting our data, I pointed the telescope at the Orion Nebula and snapped a photo for him to take home to his family as a souvenir.



5: The first night of practice, featuring underprepared astronomers braving failing technology due to unprecedented cold. Credit: Maria Chernyavskaya

I was not the only one to have such an experience. Jessica Walsh, a first-year in NAU's Astronomy department, states: "I don't think I've ever been a part of an undertaking this large. There was no shortage of interesting people from all over the country, and I made friends and connections that I hope will last a lifetime. I also learned a lot about operating a Celestron telescope and how to troubleshoot it. This project was kind of out of my wheelhouse, so it was an amazing opportunity to learn about occultations. Along my designated track I found the cutest farm with a lovely older couple. The couple was so welcoming and let me set up anywhere on their land. They offered to give me dinner, make me hot coffee, and they even made me cookies. It was such a great experience!"

6: An astronomer's rite of passage: taking a selfie in the primary mirror of a telescope as teammates work. Credit: Maria Chernyavskaya

Meanwhile, fellow first year Maria Chernyavskaya reports, "The highlight of the Polymele Occultation trip for me was getting involved in a large-scale astronomy project that engaged the community around it. Getting involved with the Lucy Mission allows the next generation of astronomers like myself to get hands-on experience in groundbreaking science. More than that, we get to share stories and experiences with later-career scientists across all disciplines and learn a breadth of knowledge that is otherwise inaccessible. It was a pleasure to problem-solve wacky telescope errors with such a wonderful group of people!"

While this effort was undoubtedly a scientific success, the degree of that success remains to be seen, pending a sizable data processing effort. But more powerful to me was the experiential, interpersonal, and social success of the campaign - all these experiences shared by the observers involved in the mission, and by the friendly locals who graciously lent us their land, their time, and their interest, will stick with us forever as cherished memories.