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CITIZEN SCIENCE FOR DART MISSION: HOW I USED ROBOTIC TELESCOPES, OPEN-DATA, PYTHON AND MATHS TO STUDY THE DIDYMOS SYSTEM BEFORE AND AFTER THE IMPACT AND TEACH OTHERS

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ABSTRACT

Asteroid collision risks are real and unpredictable, and impacts could be catastrophic-making planetary defense an intergenerational challenge. On 26 September 2022, NASA's Double Asteroid Redirection Test (DART) Mission successfully tested its first planetary defense mission by impacting the Didymos binary asteroid system.

My citizen science project aimed to use open science to measure changes in the Didymos system before and after the DART impact. I submitted research proposals to the Faulkes Telescope Projects, the Burke Gaffney Observatory, the American Association of Variable Star Observers, and the Canadian Space Agency to obtain time on robotic telescopes to observe the Didymos system from ground and space.

I used Python and open datasets to create custom algorithms to perform differential photometry. The algorithm was able to query the GAIA EDR3 database for the selection of comparison stars, determine the correct aperture size to measure the brightness of comparison stars and the target asteroid, eliminate effects of phase angles, and carry out offsets to account for changes in distance between Earth and the asteroid. Mathematical tools, including standard deviation, curve fitting, and histograms, were used to generate light curves.

From the light curves, I determined the rotation period of Didymos before and after the impact. By querying the timings of the mutual events, I attempted to measure the orbital period of the binary system. In addition, I also measured the increase in the apparent brightness of the binary system and compared it to before and without impact scenarios. To get insights into the composition of the asteroid, I measured the length of the tail caused by the ejecta from Dimorphos for four weeks post-impact.

To encourage youths, especially girls, to take up maths, programming, and observational astronomy, I have made my entire citizen science project open source. I have posted my raw time series data of the Didymos system on the Asteroid Lightcurve Data Exchange Format (ALCDEF) database and published my Python algorithms and training modules as open-source code on GitHub.

I have given webinars and online training on this project in partnership with the Royal Astronomical Society of Canada, iTelescope.net, and the Global Innovation Field Trip to get youths around the world excited about solving 'hard' problems which benefit humanity.

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Comments:

Oral Presentation