SPACEWATCH® Near-Earth Astrometric Follow-up

M. J. Brucker¹, C. Lejoly¹, J. A. Larsen², R. S. McMillan¹, T. H. Bressi¹, R. A. Mastaler¹, M. T. Read¹, J. V. Scotti¹, A. F. Tubbiolo¹

¹University of Arizona, ²U. S. Naval Academy

https://spacewatch.lpl.arizona.edu
mbrucker@arizona.edu

SPACEWATCH® was founded at the University of Arizona's Lunar and Planetary Laboratory (LPL) by Prof. Tom Gehrels and Dr. Robert S. McMillan in 1980. The original mission was to explore populations of minor planets in the solar system with the Steward Observatory 0.9-m telescope on Kitt Peak. This discovery survey included studies of Main Belt asteroids, Trojan asteroids, Centaurs, Trans-Neptunian objects, comets, and near-Earth asteroids (NEAs).

Today, Spacewatch is led by Dr. Melissa Brucker with the mission to observe NEAs and potential impactors (VIs) with its telescopes on Kitt Peak and its data center in Tucson, Arizona. The figures above are Spacewatch examples of a time series lightcurve of the Didymos system from December 1, 2022. Dimorphos is orbiting Didymos and passing in front of and behind it and the two bodies are each rotating.

In 2019, Spacewatch, the Catalina Sky Survey, and the University of Minnesota began a collaboration using the 90Prime camera on the Bok 2.3-m to discover faint asteroids, especially larger NEOs and Earth Trojan candidates. More than 450 NEOs have been discovered so far. According to the PDS Small Bodies Node, the Bok NEO Survey is the fourth site in discovery MPECs over the last 12 months, fifty over the past 5 years, and tenth since Sept. 19, 1993.

Because VIs are our highest priority targets, we have a program specifically to recover faint VIs with larger telescopes. We apply for time on Keck I, Gemini North, Gemini South, the MMT, and the Blanco 4-m telescope. We measure the VI astrometry to reduce the uncertainty in knowledge of the VIs' heliocentric orbital elements during their discovery apparitions (and beyond) to rule in or out possible impact(s).

Because many of the VIs have observations that span only a very short time, they could become lost or difficult to find after long intervals between visits near Earth.

SPACENET® operates the Steward Observatory 0.9-m telescope (691) and the LPL Spacewatch II 1.8-m telescope (291) at the Kitt Peak station of Steward Observatory. We use these telescopes 24 nights per luna for astrometric follow-up of near-Earth asteroids (NEAs). We also receive considerable time on the Steward Observatory Bok 2.3-m telescope for follow-up of fainter targets during bright time.

The astronomical community is honored to have the opportunity to conduct astronomical research on Iolkam Dzag (Kitt Peak) in Arizona. We recognize and acknowledge the very significant cultural role and reverence that this site has to the Tohono O'odham Nation.

University of Arizona Land Acknowledgement: We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the Tohono O’odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

Thomas et al. (2023 Nature 616, 448) determined that the impact reduced Dimorphos' orbital period by 33 minutes from 11 hours 55.29 minutes to 11 hours 32 minutes. Prof. Larsen and Prof. Matthew Knight (USNA) independently analyzed their 25 nights of the Didymos binary system's lightcurve data and submitted the results to the Dart Science Investigation Team.

The figures above are Spacewatch examples of a time series lightcurve of the Didymos system from December 1, 2022. Dimorphos is orbiting Didymos and passing in front of and behind it and the two bodies are each rotating.

In 2019, Spacewatch, the Catalina Sky Survey, and the University of Minnesota began a collaboration using the 90Prime camera on the Bok 2.3-m to discover faint asteroids, especially larger NEOs and Earth Trojan candidates. More than 450 NEOs have been discovered so far. According to the PDS Small Bodies Node, the Bok NEO Survey is the fourth site in discovery MPECs over the last 12 months, fifty over the past 5 years, and tenth since Sept. 19, 1993.

Because VIs are our highest priority targets, we have a program specifically to recover faint VIs with larger telescopes. We apply for time on Keck I, Gemini North, Gemini South, the MMT, and the Blanco 4-m telescope. We measure the VI astrometry to reduce the uncertainty in knowledge of the VIs' heliocentric orbital elements during their discovery apparitions (and beyond) to rule in or out possible impact(s).

Because many of the VIs have observations that span only a very short time, they could become lost or difficult to find after long intervals between visits near Earth.

The figures above are Spacewatch examples of a time series lightcurve of the Didymos system from December 1, 2022. Dimorphos is orbiting Didymos and passing in front of and behind it and the two bodies are each rotating.

The astronomical community is honored to have the opportunity to conduct astronomical research on Iolkam Dzag (Kitt Peak) in Arizona. We recognize and acknowledge the very significant cultural role and reverence that this site has to the Tohono O'odham Nation.

University of Arizona Land Acknowledgement: We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the Tohono O’odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

Spacewatch is supported by NASA/YORPO grant 80NSSC21K0657, the Lunar and Planetary Laboratory, Steward Observatory, Kitt Peak National Observatory, the Brinson Foundation of Chicago, IL, the estates of R. S. Vail and R. L. Walton, and other private donors. We rely on JPL and MPC for their web services.

The astronomical community is honored to have the opportunity to conduct astronomical research on Iolkam Dzag (Kitt Peak) in Arizona. We recognize and acknowledge the very significant cultural role and reverence that this site has to the Tohono O’odham Nation.

University of Arizona Land Acknowledgement: We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the Tohono O’odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

SPACENET® operates the Steward Observatory 0.9-m telescope (691) and the LPL Spacewatch II 1.8-m telescope (291) at the Kitt Peak station of Steward Observatory. We use these telescopes 24 nights per luna for astrometric follow-up of near-Earth asteroids (NEAs). We also receive considerable time on the Steward Observatory Bok 2.3-m telescope for follow-up of fainter targets during bright time.

The astronomical community is honored to have the opportunity to conduct astronomical research on Iolkam Dzag (Kitt Peak) in Arizona. We recognize and acknowledge the very significant cultural role and reverence that this site has to the Tohono O’odham Nation.

University of Arizona Land Acknowledgement: We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the Tohono O’odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.