

Constraining the Orbital Parameters of the Didymos-Dimorphos System: Lightcurve Observations in Preparation for AIDA/DART

Cristina Thomas, Northern Arizona University

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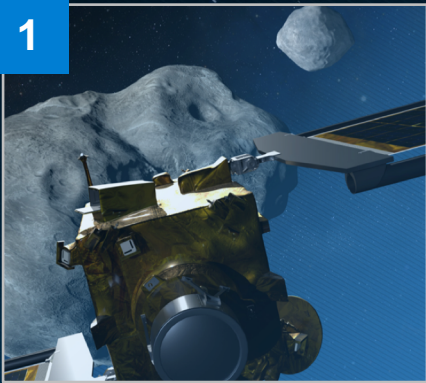
Andrew Rivkin, Nicholas Moskovitz, Petr Pravec, Petr Scheirich, Julia de Leon, Elena Mazzotta Epifani, Mirel Birlan, Benoit Carry, Steven Chesley, Elisabetta Dotto, Tony Farnham, Dora Fohring, Mikael Granvik, Ellen Howell, Simone Ieva, Matthew Knight, Monica Lazzarin, Fiorangela La Forgia, Erin May, Alessandra Migliorini, Shantanu Naidu, Marcel Popescu



DART's Level 1 Requirements

Defining the Mission's Planetary Defense Investigation

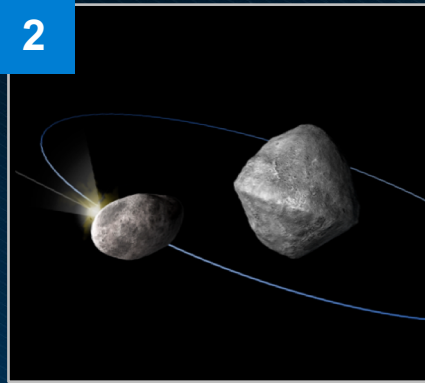
1



Impact Dimorphos

During its Sept/Oct 2022 close approach to Earth

2



Change the binary orbital period

Cause a ≥ 73 -second change in the orbital period of Dimorphos

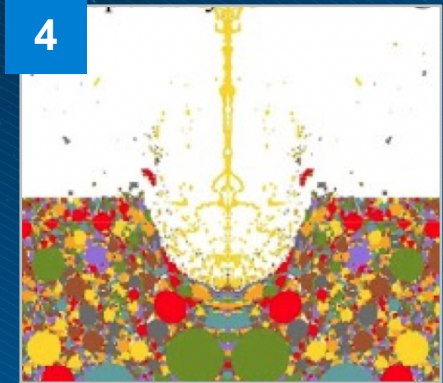
3



Measure the period change

To within 7.3 seconds, from ground-based observations before and after impact

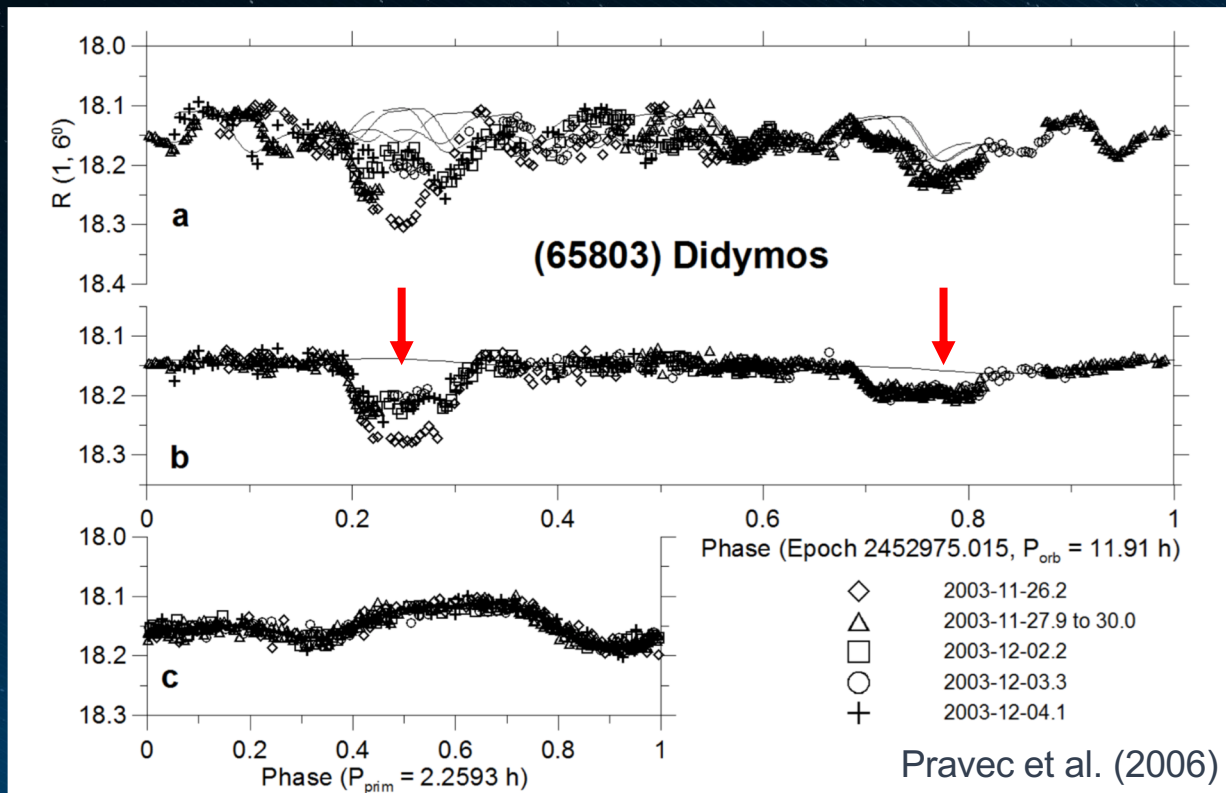
4



Measure "Beta" and characterize the impact site and dynamics

Beta = the momentum enhancement factor

The Didymos Lightcurve



Full lightcurve: Combination of rotational periods of primary and secondary and the orbital period of Dimorphos.

Mutual events as Dimorphos passes in front of or behind Didymos. Can also be from a shadow cast by one of the bodies.

Rotational Period of Didymos.

Lightcurves are folded to the rotational and orbital periods.



2020-2021 Observations

4 Lunations:

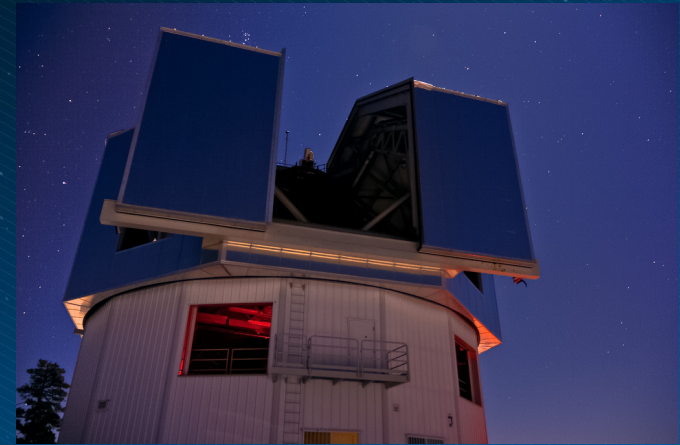
December 2020- March 2021, $V=18.9-20.2$

To meet our objectives, we require extremely precise photometry -- RMS < 0.01 mag (SNR ~100), $T_{\text{exp}} < 3$ mins.

Only medium and large ground-based facilities can be used.

Follow along:

<https://sites.google.com/view/didymosobs/>



**We need to understand the
Didymos-Dimorphos system
before we change it!**

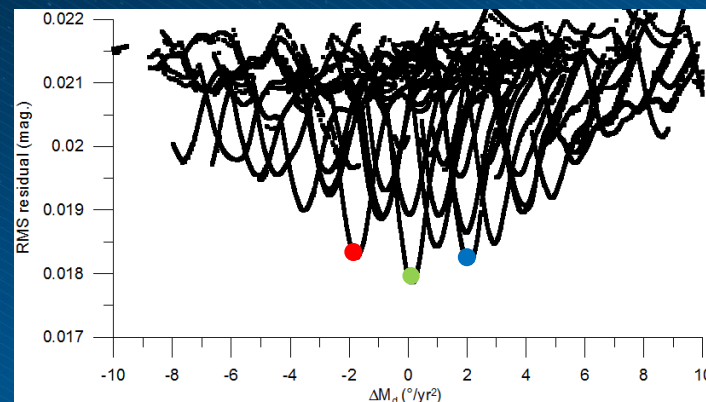


2020-2021 Primary Observing Goal: Dimorphos Orbital Position at Impact, Sept 30 2022

Modeling of 2003-2019 photometric observations found three possible Binary YORP solutions. Prior to our 2020-2021 observations these possible solutions resulted in a *3- σ uncertainty on the true anomaly at time of impact of $\pm 65^\circ$*

The Observations Working Group was required to provide the Dimorphos true anomaly at impact time to within $\pm 45^\circ$ in **mid-February 2021**.

ΔM_d ($^\circ/\text{yr}^2$)	P_{orb} (hours)
0.1 ± 0.2	11.92163 ± 0.00002
2.1 ± 0.2	11.92279 ± 0.00002
-1.8 ± 0.2	11.92046 ± 0.00002



ΔM_d - quadratic drift in the mean anomaly of the secondary. All uncertainties are 3- σ .

Preliminary Results from February 2021

We have a single BYORP solution!

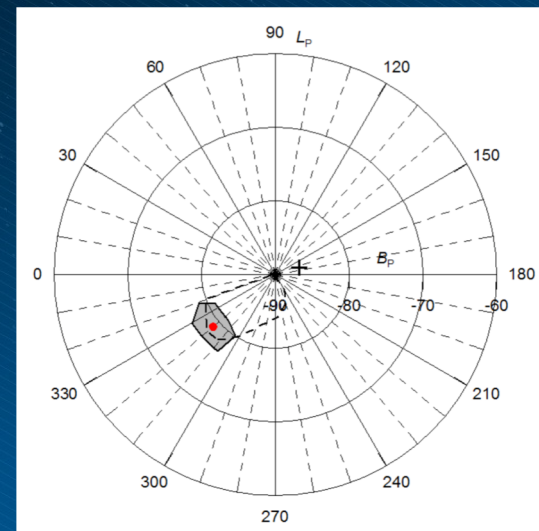
We refined the pole solution!

The Observations Working Group was required to provide the Dimorphos true anomaly at impact time to within $\pm 45^\circ$ in mid February 2021.

We delivered a position at impact to within $\pm 10^\circ$!!

Analysis of our complete dataset will be performed prior to publication. Plan to submit papers prior to launch.

ΔM_d ($^\circ/\text{yr}^2$)	P_{orb} (hours)
0.13 ± 0.14	11.921626 ± 0.000018



$$L_{\text{orb}}, B_{\text{orb}} = 320^\circ, -79^\circ \\ \pm (3.5^\circ \times 2^\circ, 3-\sigma)$$

Questions? cristina.thomas@nau.edu



DART

Double Asteroid Redirection Test

