Binary asteroid (65803) Didymos: Observations of and constraints on the binary system

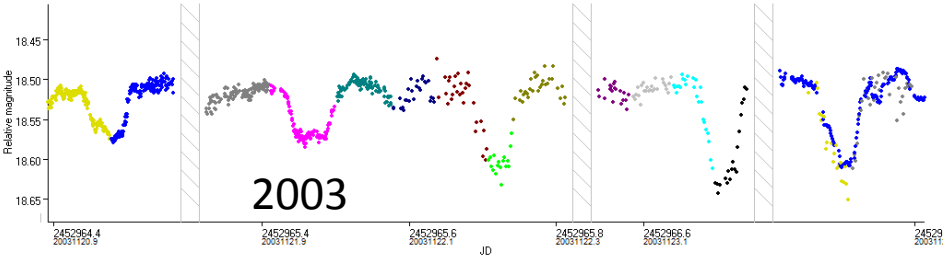
Petr Scheirich and Petr Pravec

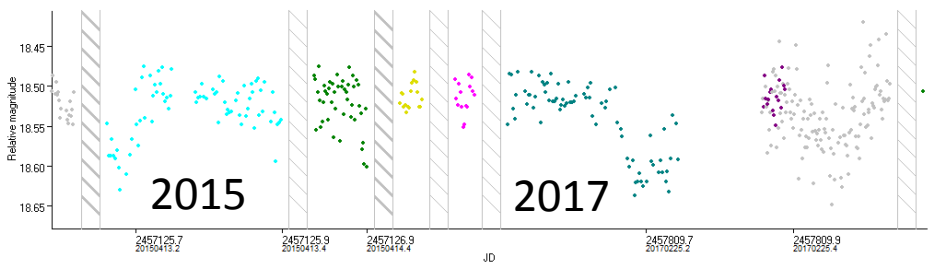
Astronomical Institute AS CR, Ondřejov, Czech Republic

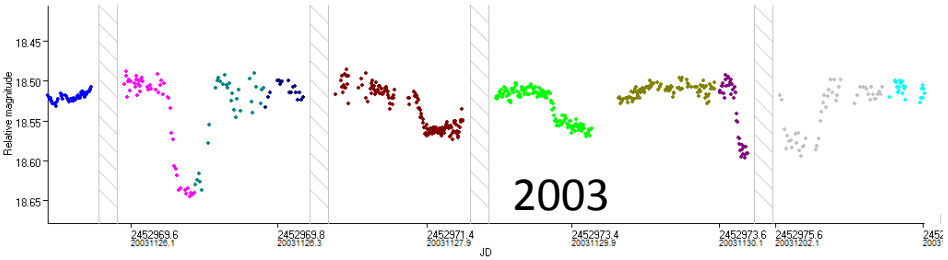
Hera Community Workshop

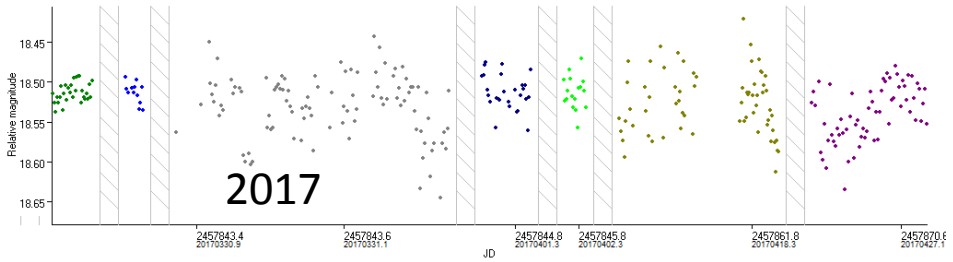
Berlin, 2018 November 15-16

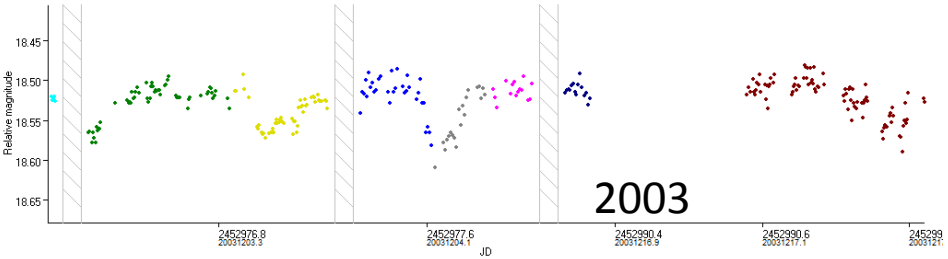
Long period component of the lightcurve

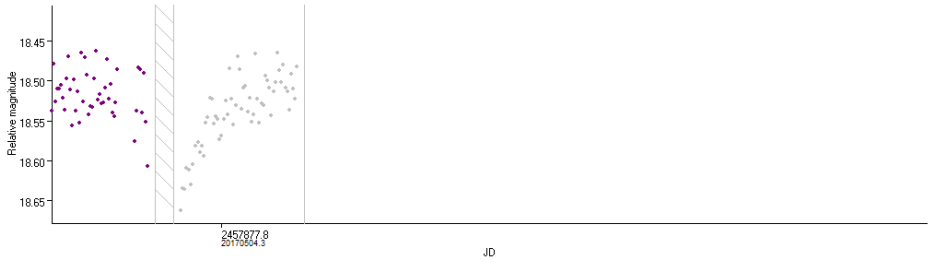


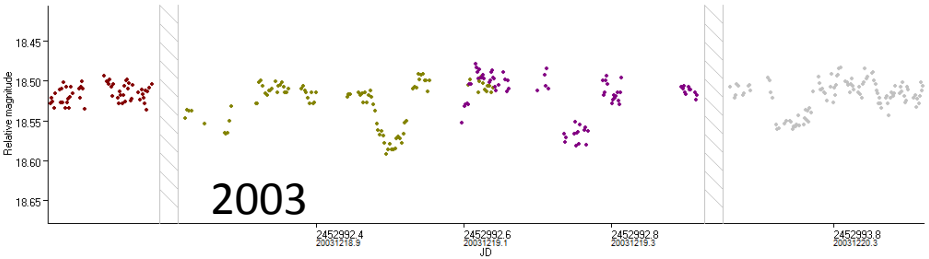










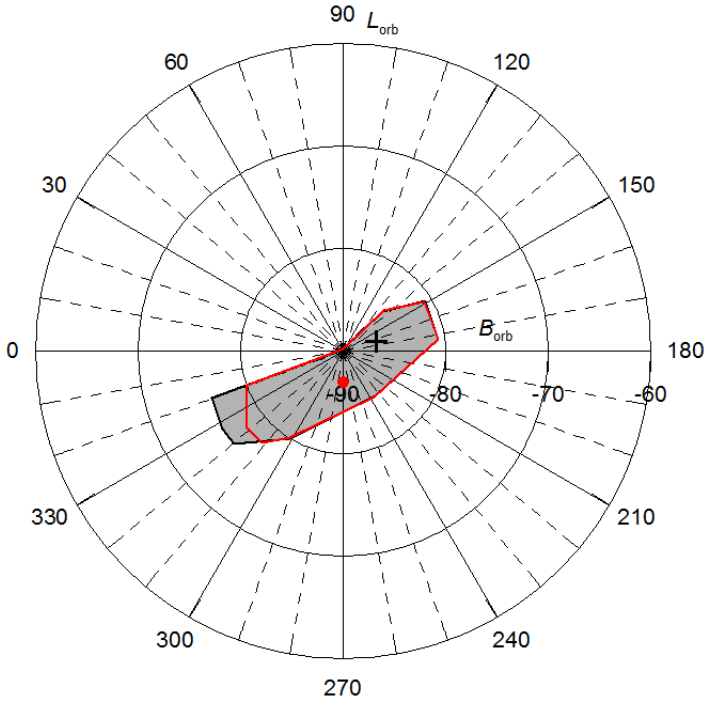


2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	▮												▮		▮							

Past apparitions

Didymos orbital model

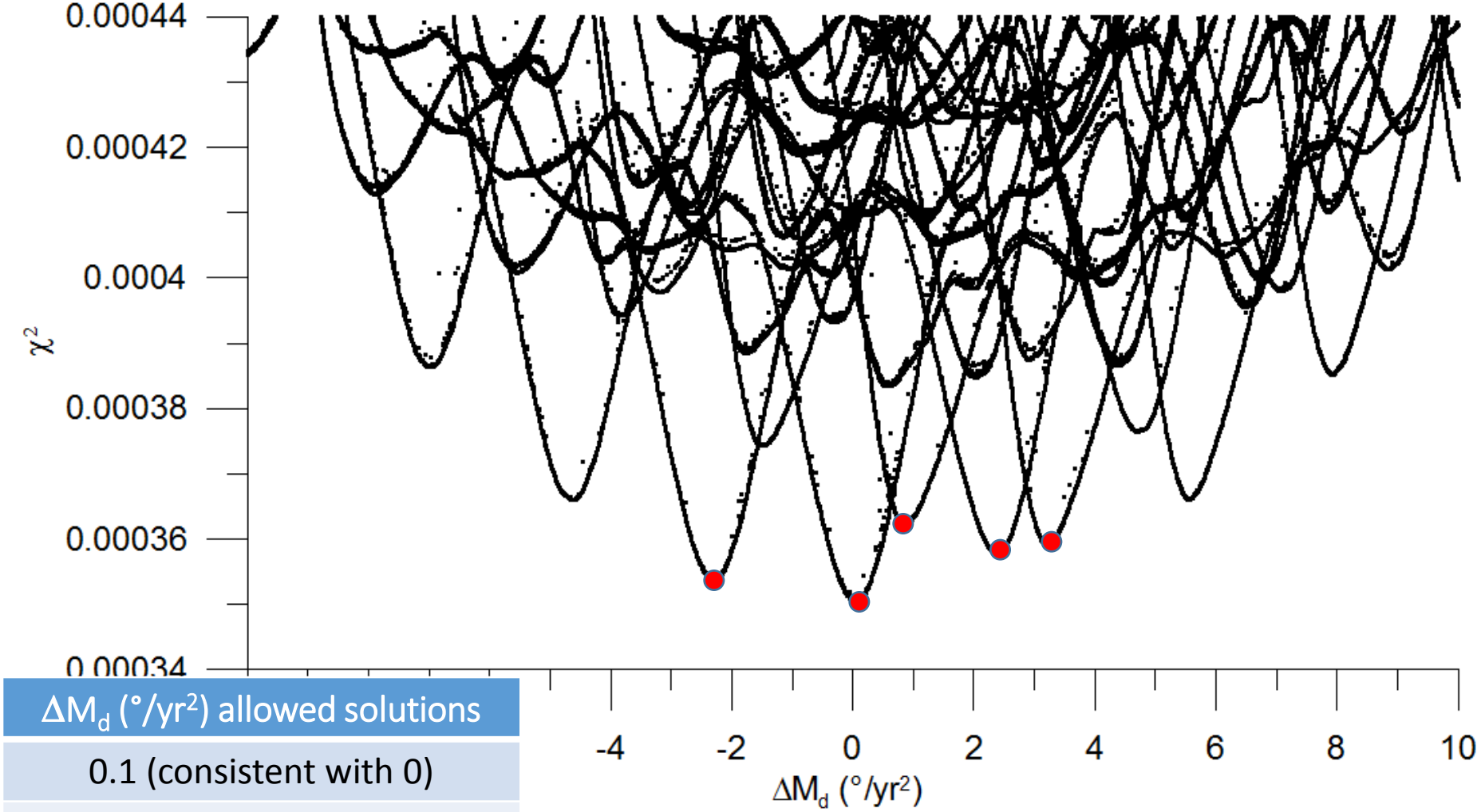
Main parameters		
Diameter ratio	D_S/D_P = 0.21 ± 0.01	*(Scheirich and Pravec 2009)*
Eccentricity	$e \leq 0.03$	*(Scheirich and Pravec 2009)*
Orbital pole	L_{orb}, B_{orb} = 270°, -87°	*(Scheirich and Pravec 2009, updated using 2015 & 2017 data)*
Orbital period	(P_{orb} = 11.92164 ±0.00003 h)	*Assuming zero BYORP!*
Primary rot. period	P_P = 2.2593 ± 0.0008 h	*Pravec et al. 2006*
Synchronous rotation of Didymoon: not sure.		



Allowed (conservative 3-σ uncertainty) area plotted.

Black outline: 2003+2015 data
Red outline: 2003+2015+2017 data

BYORP solutions from the 2003-2017 data

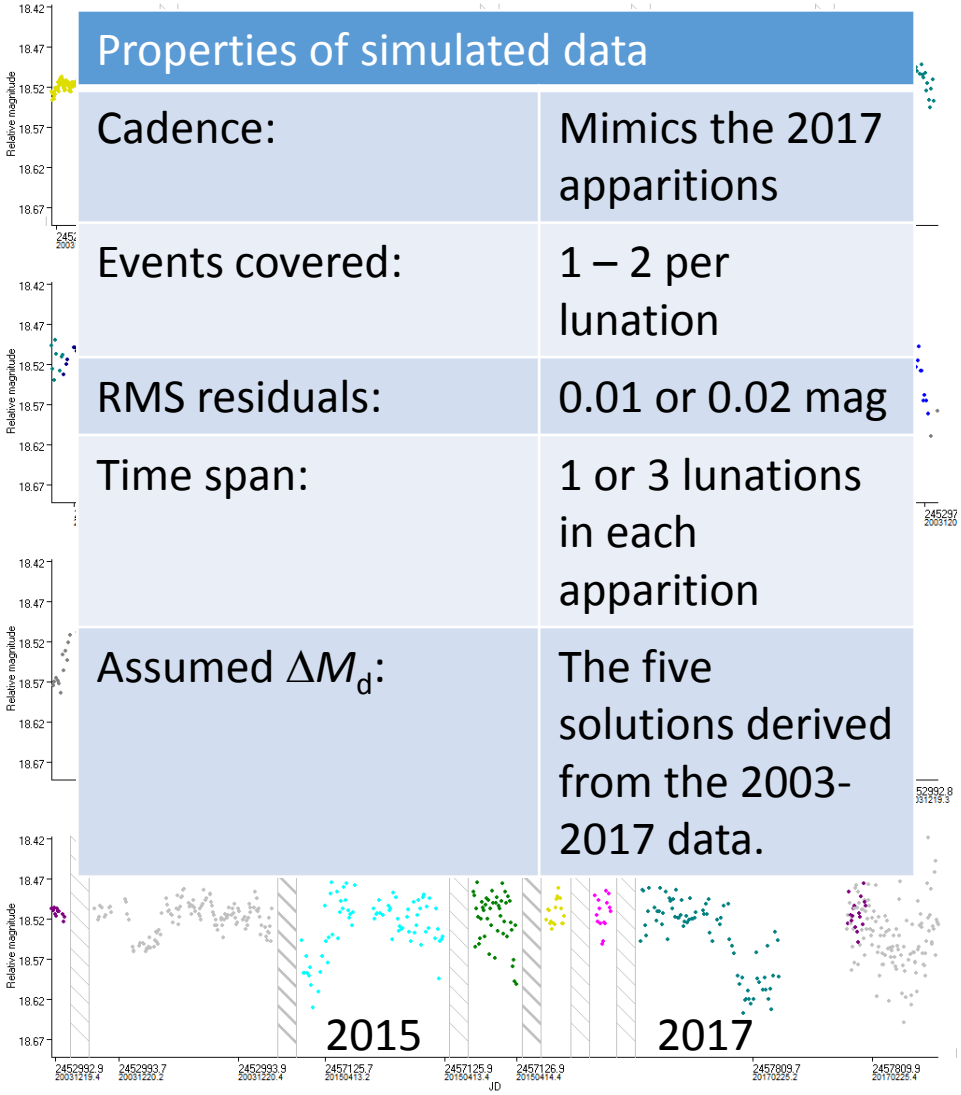


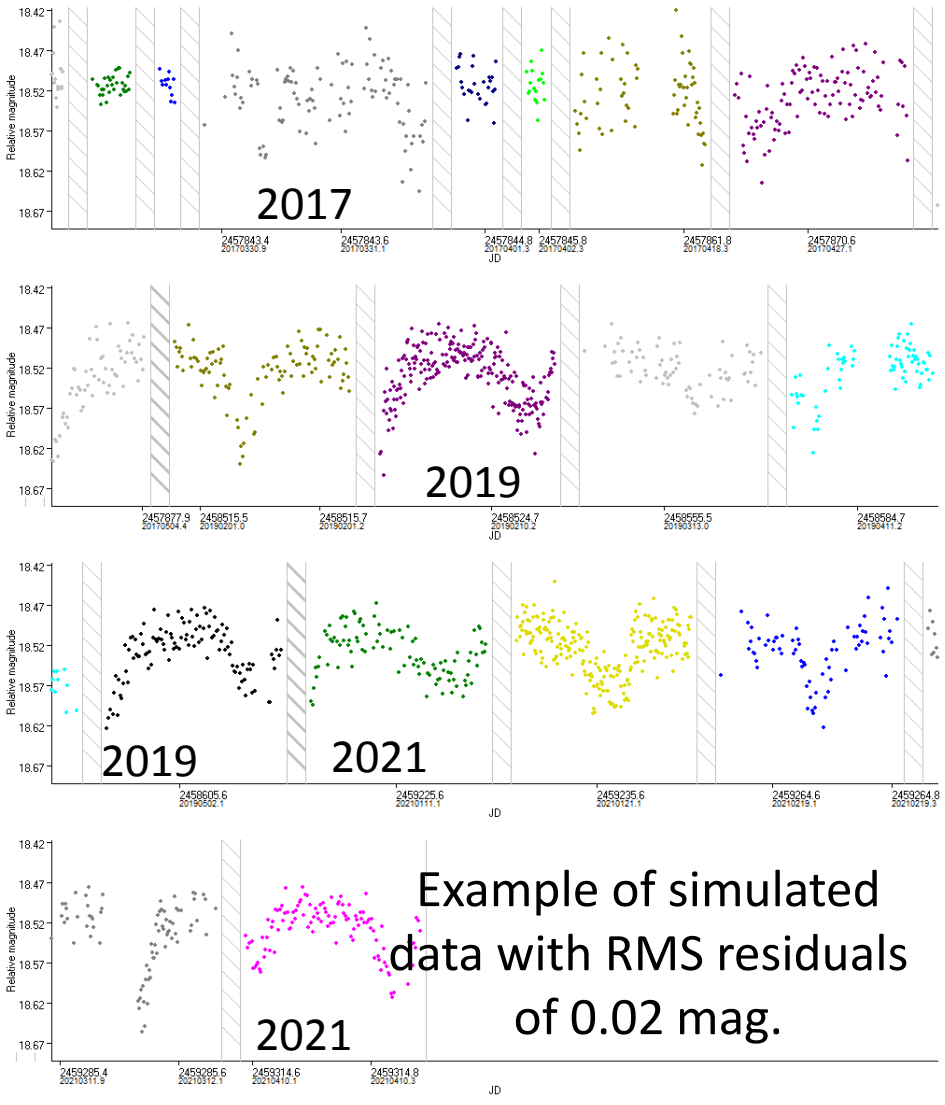
ΔM_d (°/yr²) allowed solutions
0.1 (consistent with 0)
-2.3
2.3
3.2
0.9

Prediction (scaled from the 1999 KW4 secondary): 2.8°/yr²
May be any value between -6 and +6°/yr² perhaps.

Simulated future apparitions

Properties of simulated data	
Cadence:	Mimics the 2017 apparitions
Events covered:	1 – 2 per lunation
RMS residuals:	0.01 or 0.02 mag
Time span:	1 or 3 lunations in each apparition
Assumed ΔM_d:	The five solutions derived from the 2003-2017 data.





Example of simulated data with RMS residuals of 0.02 mag.

Past and future apparitions

	2019	2021	BYORP resolved from 19&21	Oct 2022 M 3σ unc.	HST (RMS 0.02 mag) will help	HST (RMS 0.01 mag) will help
RMS 0.02	3 lunations	3 lunations	YES	+/-12°		
	3 lunations	---	NO		NO	YES
RMS 0.01	3 lunations	3 lunations	YES	+/-9°		
	3 lunations	---	NO		NO	YES
	1 lunation	3 lunations	YES	+/-9°		

Conclusions

- *Will we be able to determine or constrain the orbital drift by BYORP?*
  Yes.

- *What time distribution and quality of the data will be needed to predict the position of Didymoon with an uncertainty in mean anomaly < 20° at the time of the DART impact in October 2022?*
  We will need to observe at least 1 event in 1 lunation in 2019 and at least 1 event in each of the 3 lunations in 2021, with photometric rms errors 0.01 mag.

- *How could additional observations with the HST in Aug-Sep 2020 improve the orbit solution?*
  Not significantly (assuming the campaign in 2021 is successful).

Acknowledgements

- Access to computing and storage facilities owned by parties and projects contributing to the National Grid Infrastructure MetaCentrum provided under the programme "Projects of Large Research, Development, and Innovations Infrastructures" (CESNET LM2015042), is greatly appreciated.