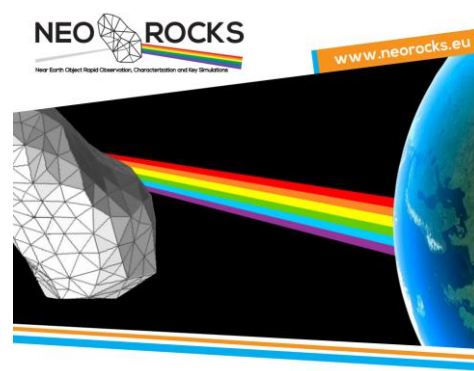


# Monitoring Near Earth Objects colors in the frame of NEORocks programme



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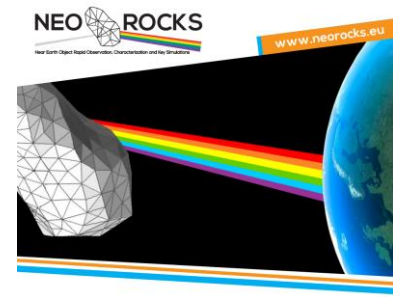
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# Rationale

This work was done in the framework of European Community programme called NEORocks. During 2020 several observational runs were performed at the Observatoire de Haute Provence and Observatoire de Pic du Midi, in France, for colors of Near Earth Objects (NEOs).

The goal of NEORocks programme is to improve the knowledge on the physical properties of the NEOs population, the implications for their origin and evolution, and the topics related to planetary defense. This goal is achieved by linking up the expertise in performing small body astronomical observations and the related modelling needed to derive their dynamical and physical properties to the pragmatic approach of planetary defense, which aims to provide operational loops and information systems to protect the citizens and the ground infrastructures from potential threats.

## FRENCH ASSETS INVOLVED IN NEORocks EC PROGRAM

- Observatoire de Haute Provence

Altitude: 650m

Coordinates:

Latitude: 43°55'51" N

Longitude: 5°42'48" E

MPC Code: 511



1.2m telescope

Programs granted by the Time Allocation Committee

FOV 13.1'x13.1', F/6

iKon-L 936 Andor camera 2kx2k E2V

Johnson UBV filters

Cousins RIJHK filters



## FRENCH ASSETS INVOLVED IN NEORocks EC PROGRAM

- Pic du Midi Observatory

Altitude: 2876m

Coordinates:

Latitude:  $42^{\circ}56'11''$  N

Longitude:  $0^{\circ}08'34''$  E

MPC Code: 586



T1M – 1.05m telescope

Devoted mainly to Solar System programs

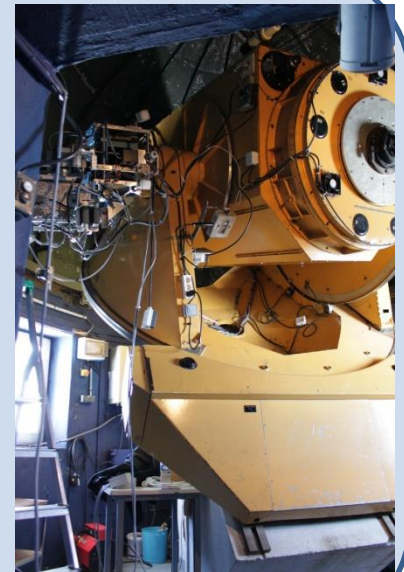
FOV  $8' \times 8'$

iKon-L Andor camera 2kx2k E2V (pixel scale  $0.22''/\text{pixel}$ )

SLOAN system of filters

Johnson UBV filters

Cousins RIJHK filters



# Campaigns in 2020 and 2021

Photometric observations were carried during four observational runs in 2020-2021:

- February-March 2020: Pic du Midi Observatory (3 nights – observations stopped for pandemic reasons)
- ~~April 2020 : Observatoire de Haute-Provence (cancelled due to pandemic reasons)~~
- June 2020: Observatoire de Haute-Provence (5 nights)
- November 2020: Observatoire de Haute-Provence (5 nights)
- January 2021: Observatoire de Haute-Provence (5 nights)

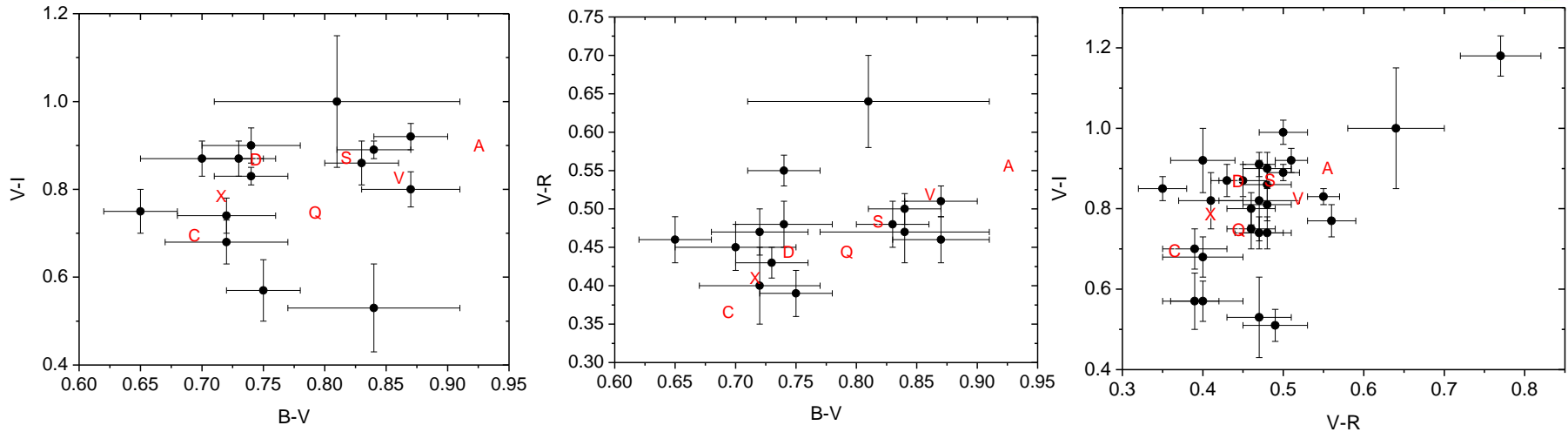
# Observations

When possible, colors, astrometry, and lightcurves were recorded for the newly discovered objects. Johnson B and V, Cousins R and Gunn I filters were used in determining colors of 31 NEOs.

A total of 51 NEOs (25 PHAs) were observed.

Aperture photometry of targets and field stars was used. The absolute calibration was computed using the Pan-Starrs catalogue. Sloan photometric system and the transformation equations from Kostov & Bonev (BAJ, vol 28, 2018) were used.

# Results



Color-color diagram for the PHAs observed during 2020-2021. Red letters are representing the mean values of colors for the major taxonomic classes from DeMeo et al 2009.

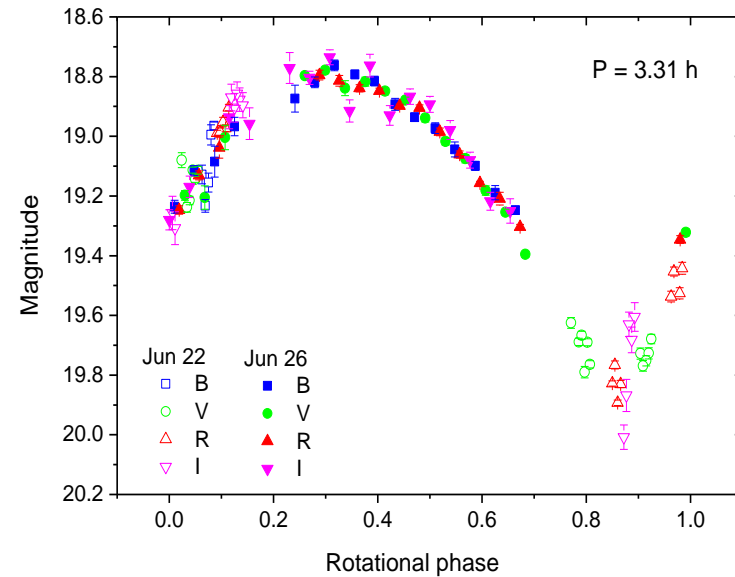
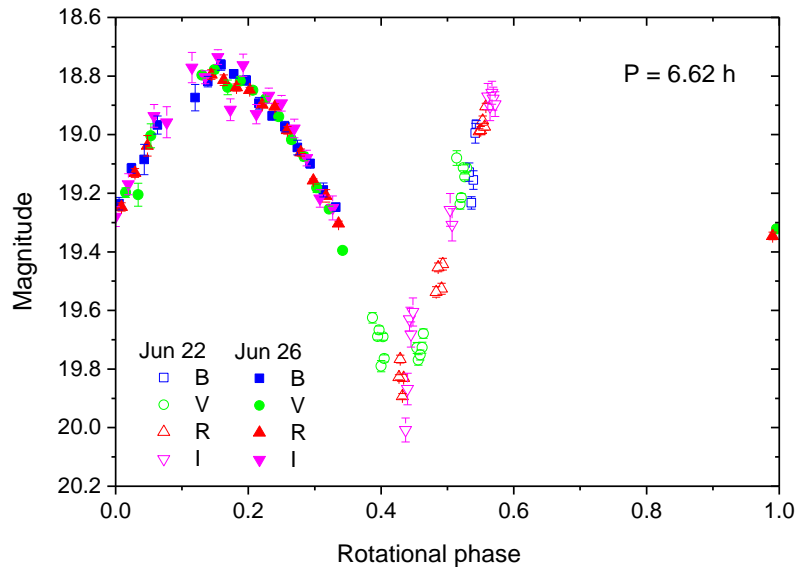
# List of observed PHAs

#	Object	H	e	a, au	i, deg
1	(65803) Didymos	18.0	0.38	1.645	3.408
2	(52768) 1998 OR2	15.8	0.57	2.384	1.012
3	(66391) 1999 KW4	16.6	0.69	0.642	38.886
4	(85989) 1999 JD6	17.1	0.63	0.883	17.061
5	(86039) 1999 NC43	15.9	0.58	1.760	7.131
6	(152978) 2000 GJ147	19.6	0.23	1.162	25.007
7	(154302) 2002 UQ3	17.6	0.56	1.719	28.817
8	(152978) 2000 GJ147	19.6	0.23	1.162	25.007
9	(154302) 2002 UQ3	17.6	0.56	1.719	28.817
10	(163014) 2001 UA5	17.5	0.44	1.787	9.937
11	(163348) 2002 NN4	20.1	0.44	0.876	5.418
12	(242216) 2003 RN10	15.6	0.54	2.230	39.648

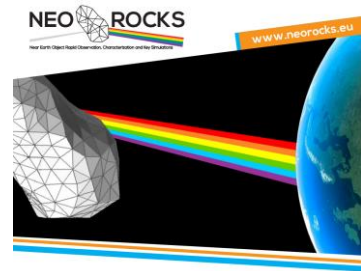
13	(333578) 2006 KM103	20.1	0.38	1.573	11.68
14	(332446) 2008 AF4	19.7	0.41	1.383	8.921
15	(415029) 2011 UL21	15.8	0.65	2.122	34.854
16	2002 GZ8	18.2	0.64	2.825	5.313
17	2003 AF23	20.9	0.42	0.875	23.226
18	2015 NU13	19.7	0.59	1.830	4.208
19	2016 CO247	20.5	0.51	1.420	18.348
20	2017 SE19	19.8	0.52	2.117	8.801
21	2020 DM4	21.7	0.45	1.888	4.120
22	2020 DT3	21.2	0.60	2.249	3.271
23	2020 ST1	22.0	0.57	2.454	7.961
24	2020 WP1	20.1	0.47	1.767	38.648
25	2020 YQ3	20.0	0.58	1.881	4.407



# Synodical Periods



- Composite lightcurve of (85989) 1999 JD6. Observations in different filters are shifted in order to achieve the best fit. The object has a period of 6.62 hours, however a half period could not be completely omitted.



# Conclusions

Color-color diagrams show PHAs of our sample in the context of major taxonomic classes (Red letters denotes the major taxons). As a first attempt:

- i) there is a small fraction of C-type asteroids;
- ii) the major part of our sample exhibits similarities with S and Q type taxons;
- iii) two objects are outliers of major taxons in the (V-I) – (V-R) diagram.