

First Fink Collaboration Meeting

Solar System



B. Carry

Lagrange, Observatoire de la Côte d'Azur

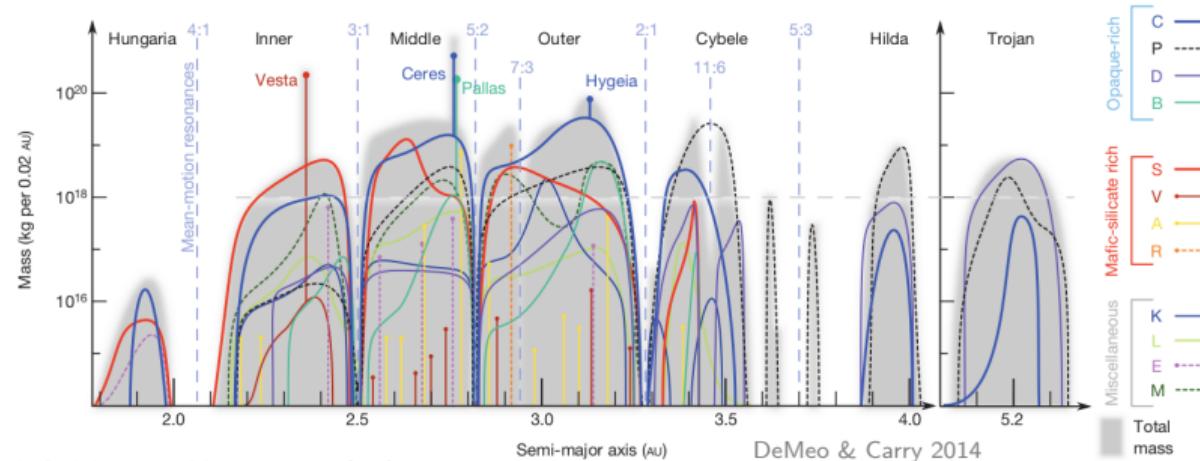
Small bodies and planetary formation

- **Leftovers of the early solar system**

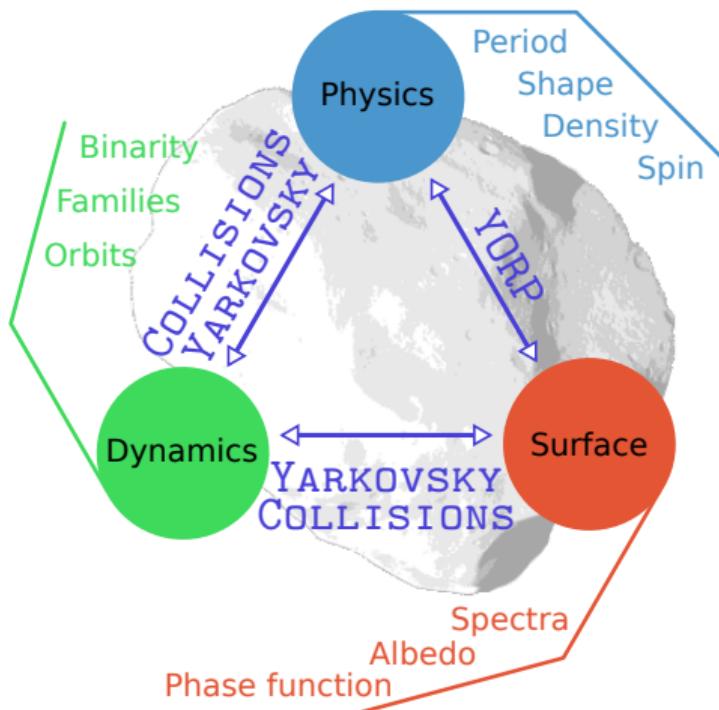
- Remnants of planet building blocks
- Limited dynamical evolution
- Little mineralogical evolution

- **Constraints on planetary formation & evolution**

- Orbital and size distributions
- Distribution of composition



What do we need to study?



• Discovery & Dynamics

- Dynamical structure
- Origins & evolution
- ▷ **Astrometry**

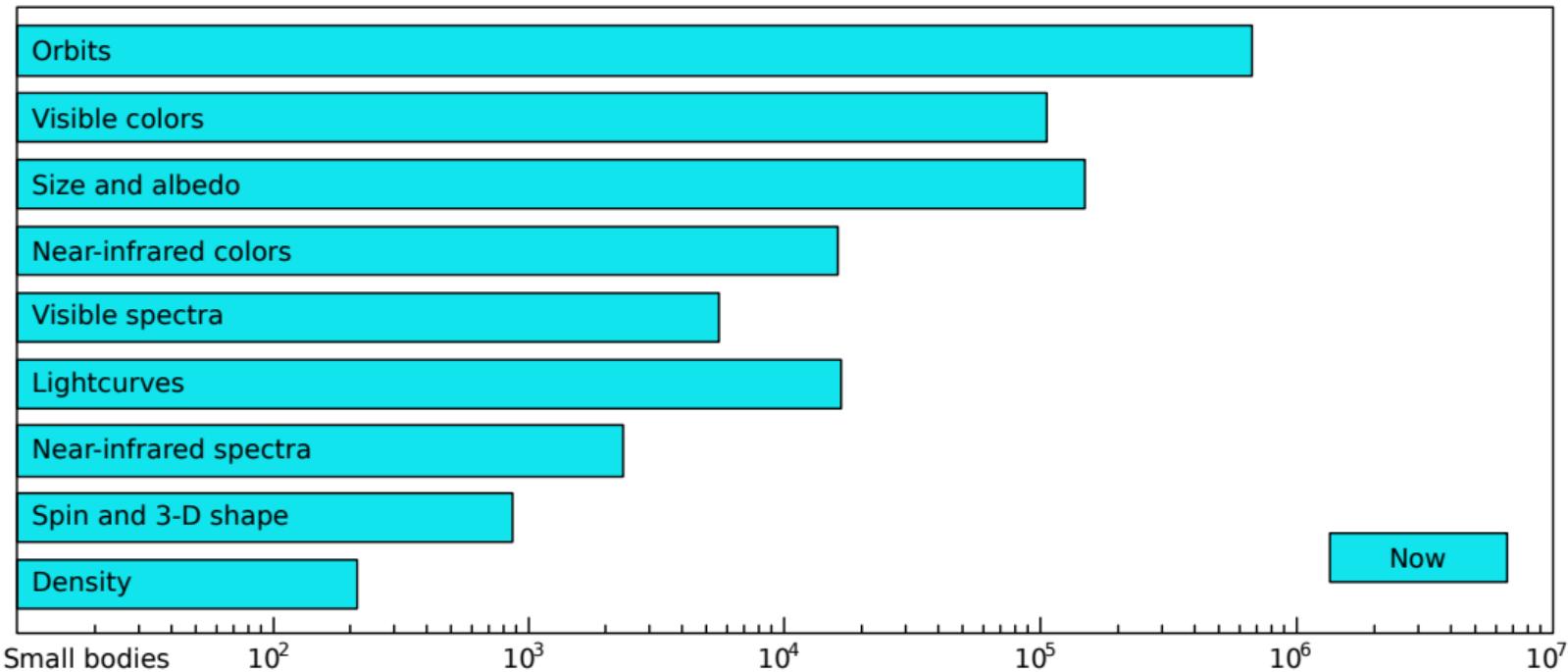
• Composition

- Location & timing of formation
- Compositional structure
- ▷ **Vis-NIR spectro-photometry**

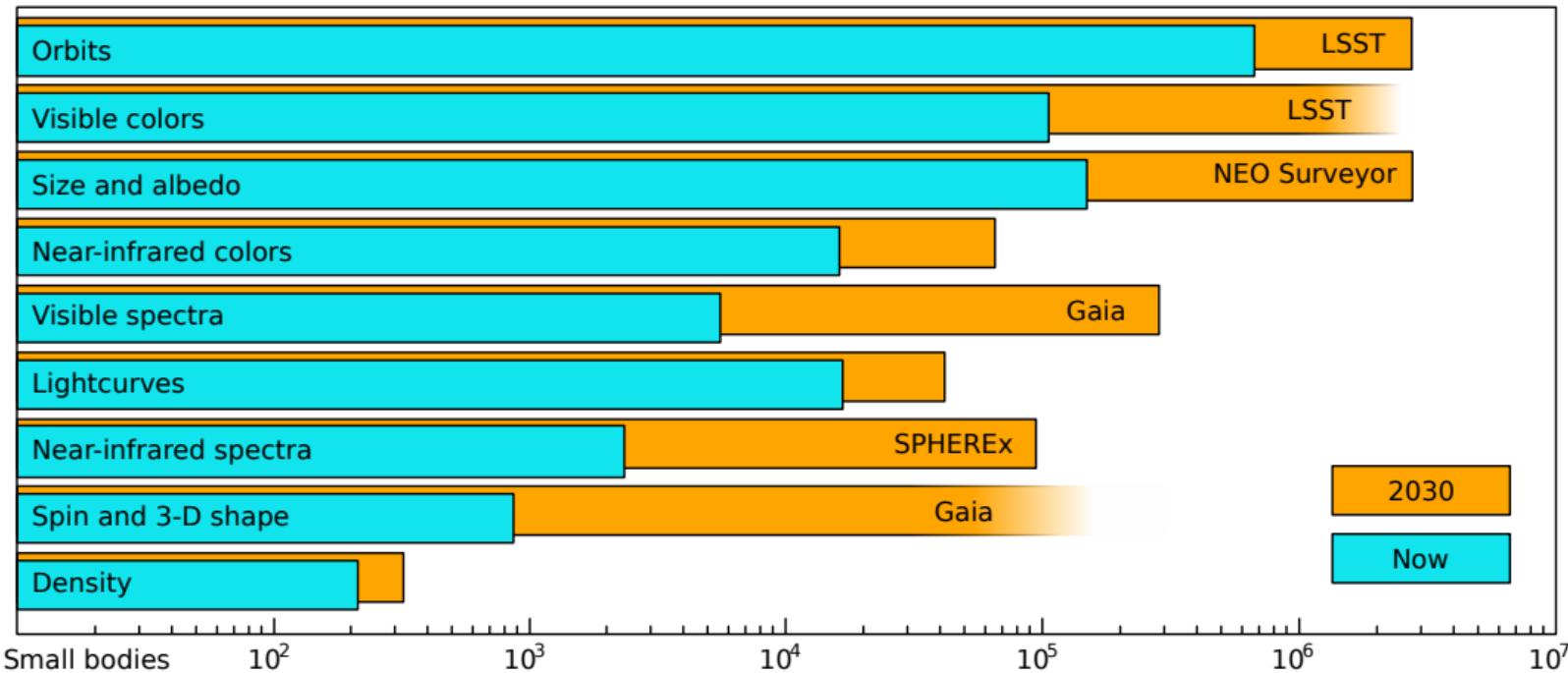
• Physical properties

- Diameter, Spin, ...
- Main evolutionary drivers
- ▷ **Light curves**

Legacy Survey of Space and Time



Legacy Survey of Space and Time

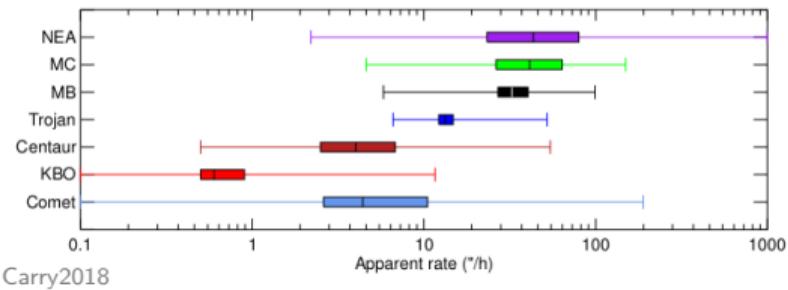
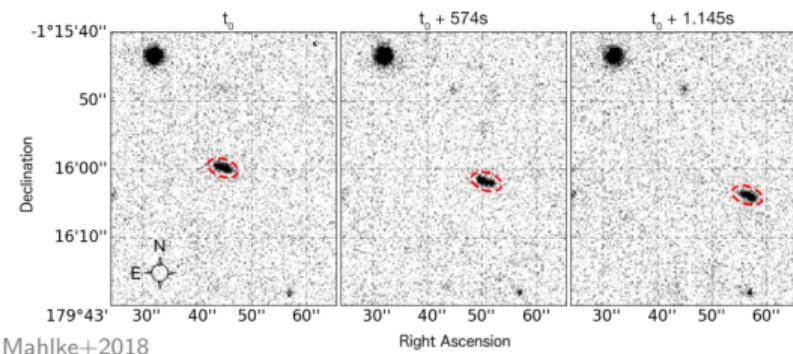


Challenges for Solar System Objects

Solar System Objects (SSOs) are **THE** transients!

- **Variable position**

- Asteroids: 10–100 ''/h
- 1–10 ''/h beyond Jupiter



Challenges for Solar System Objects

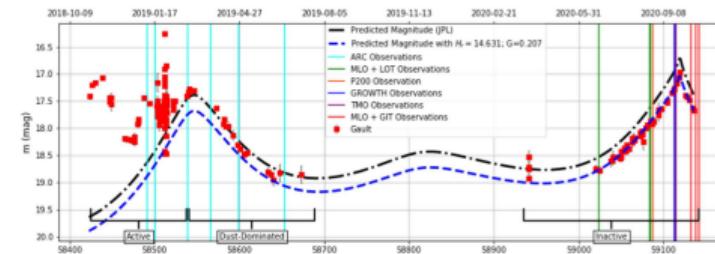
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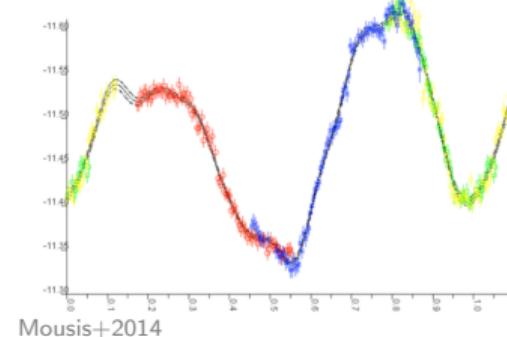
- Asteroids: 10–100 ''/h
- 1–10 ''/h beyond Jupiter

- **Variable magnitude**

- Sun-SSO-Observer
1–3 mag / months
- Irregular shape
 ≤ 0.15 mag / hours



Purdum+2021

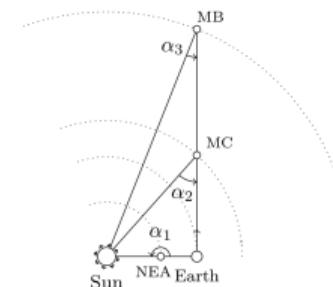


Challenges for Solar System Objects

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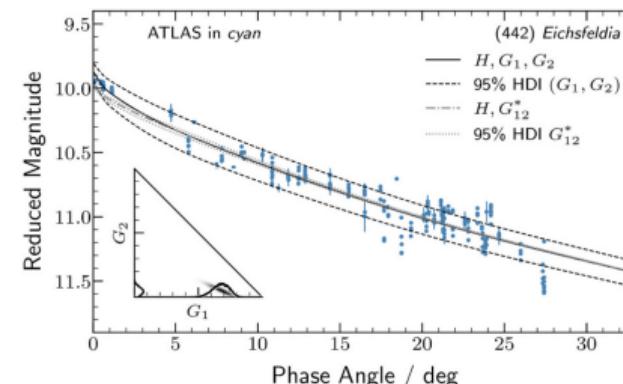


- **Variable magnitude**

- Sun-SSO-Observer
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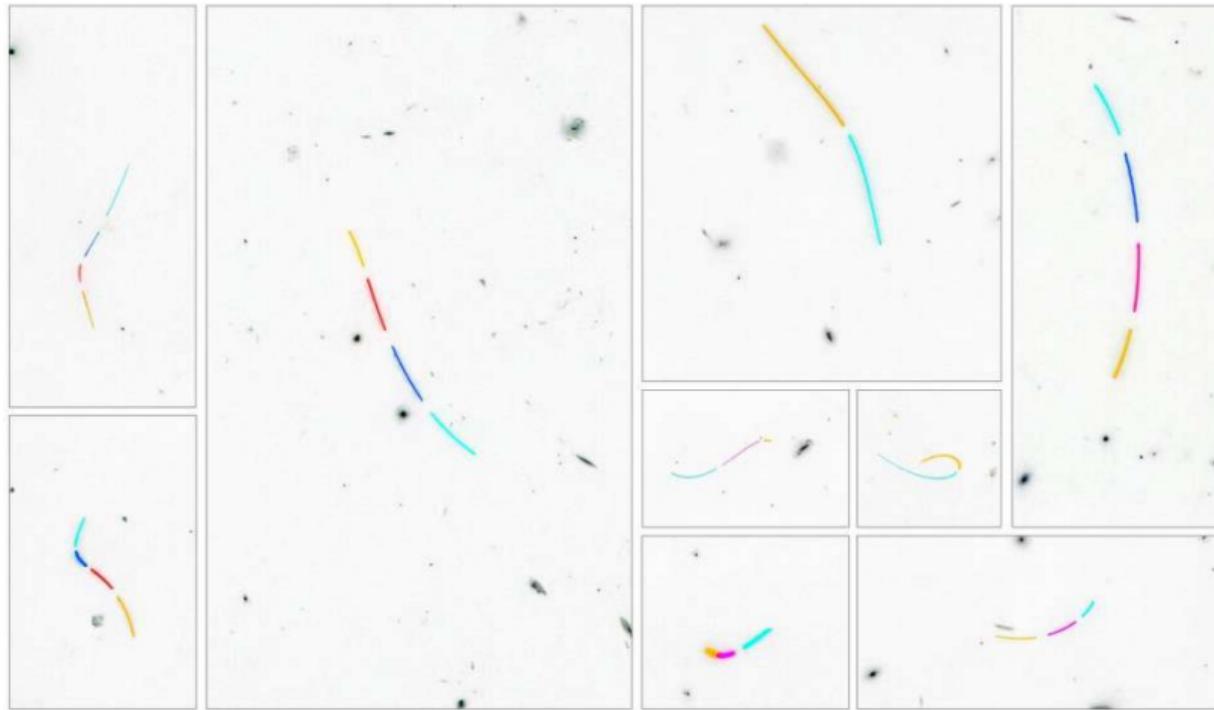
- **Variable colors**

- Function of phase
- Still poorly explored



Mahlke+2021

The vermins strike back



Kruk+2022, Image credit: Hubble Asteroid Hunter citizen science team, M. Zamani (ESA/Hubble)

SSOs in FINK Web portal

The screenshot shows a web browser window with the URL <https://fink-broker.org/post/>. The page title is "Posts". There are two news items listed:

- Solar System Science with Fink**
Jan 28, 2022
SSO
- Power failures at the University**
Jan 18, 2022
maintenance

SSOs in FINK Web portal

Fink Science portal 1.1 Search Statistics API Tutorials Info ▾



objectId

ConeSearch

Date Search

Class Search

SSO

Tracklet

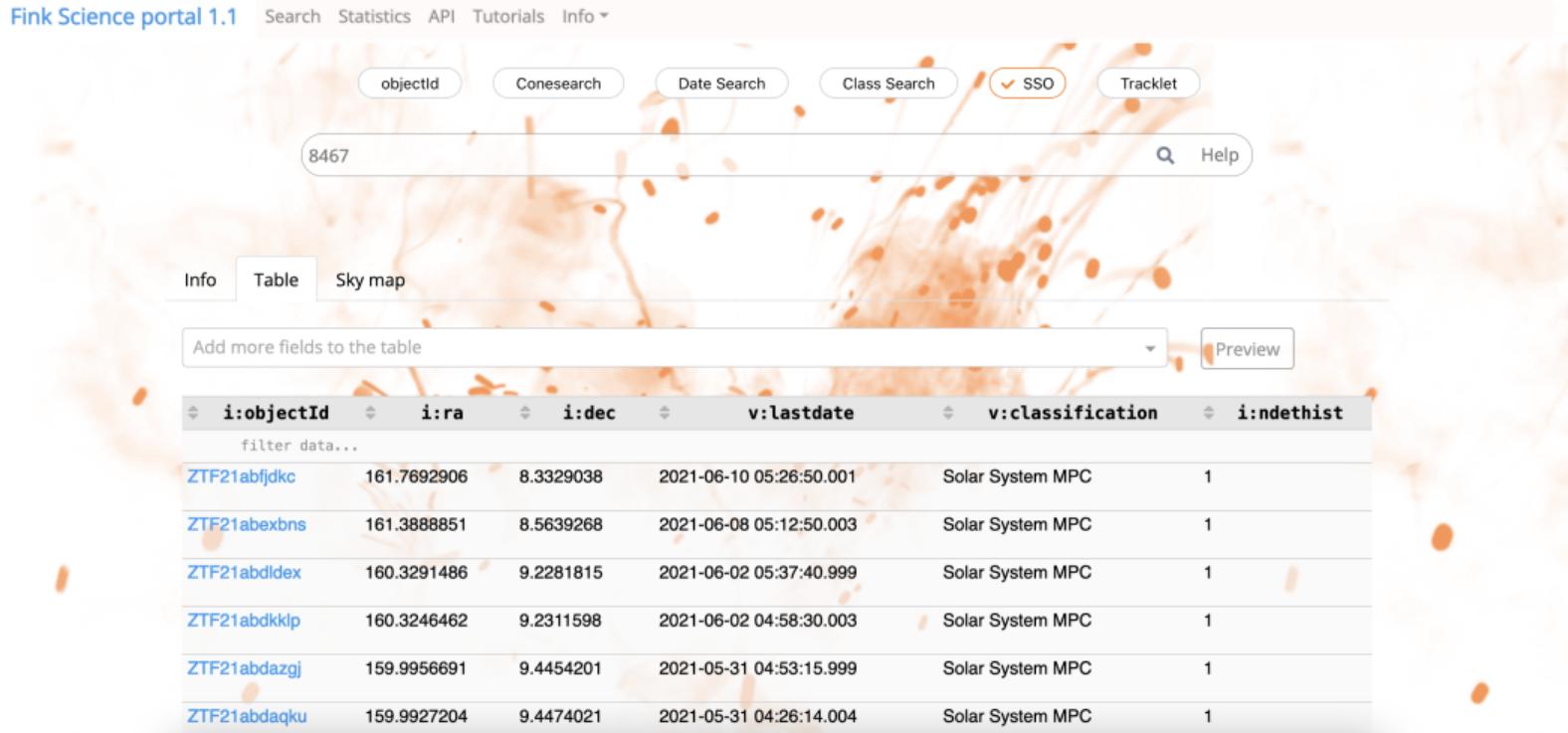
8467

Help

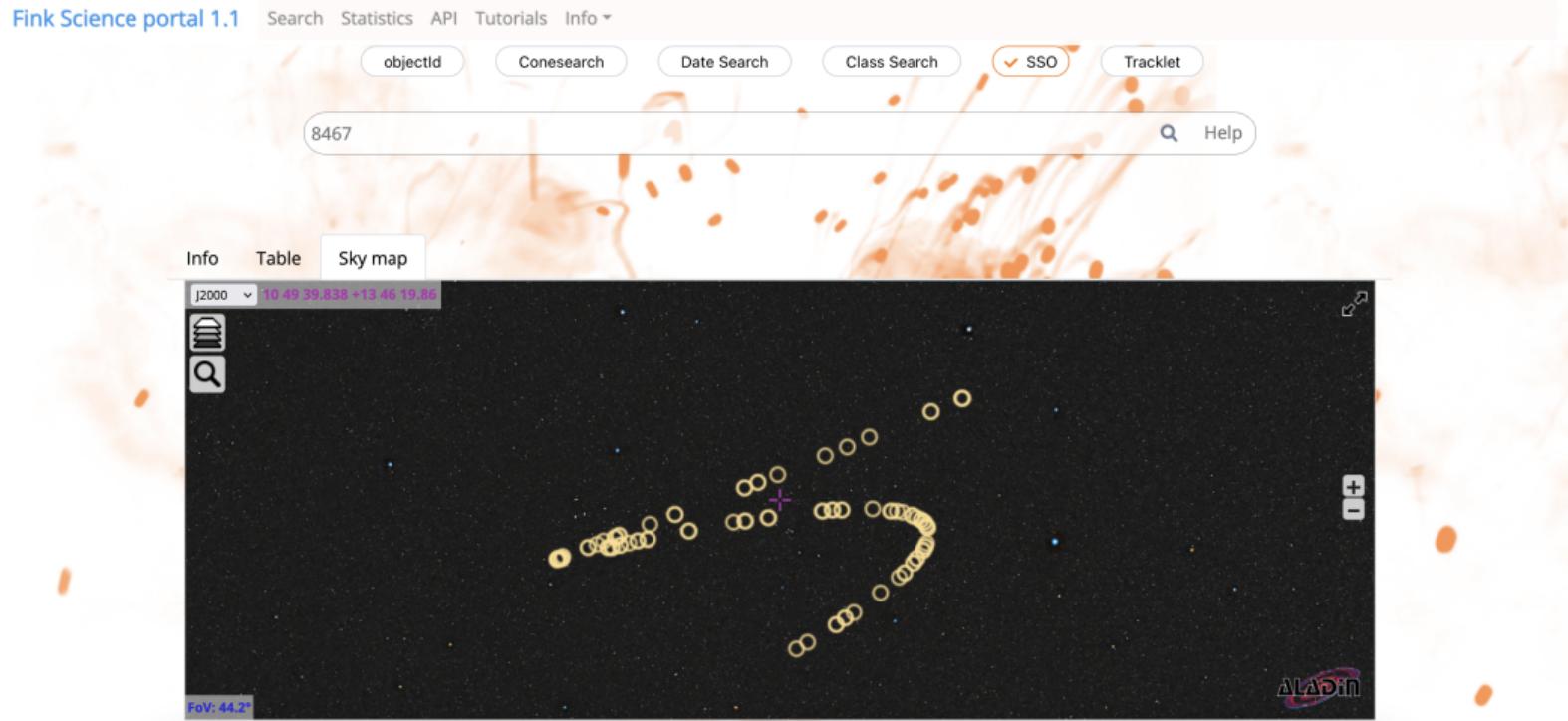
B

C

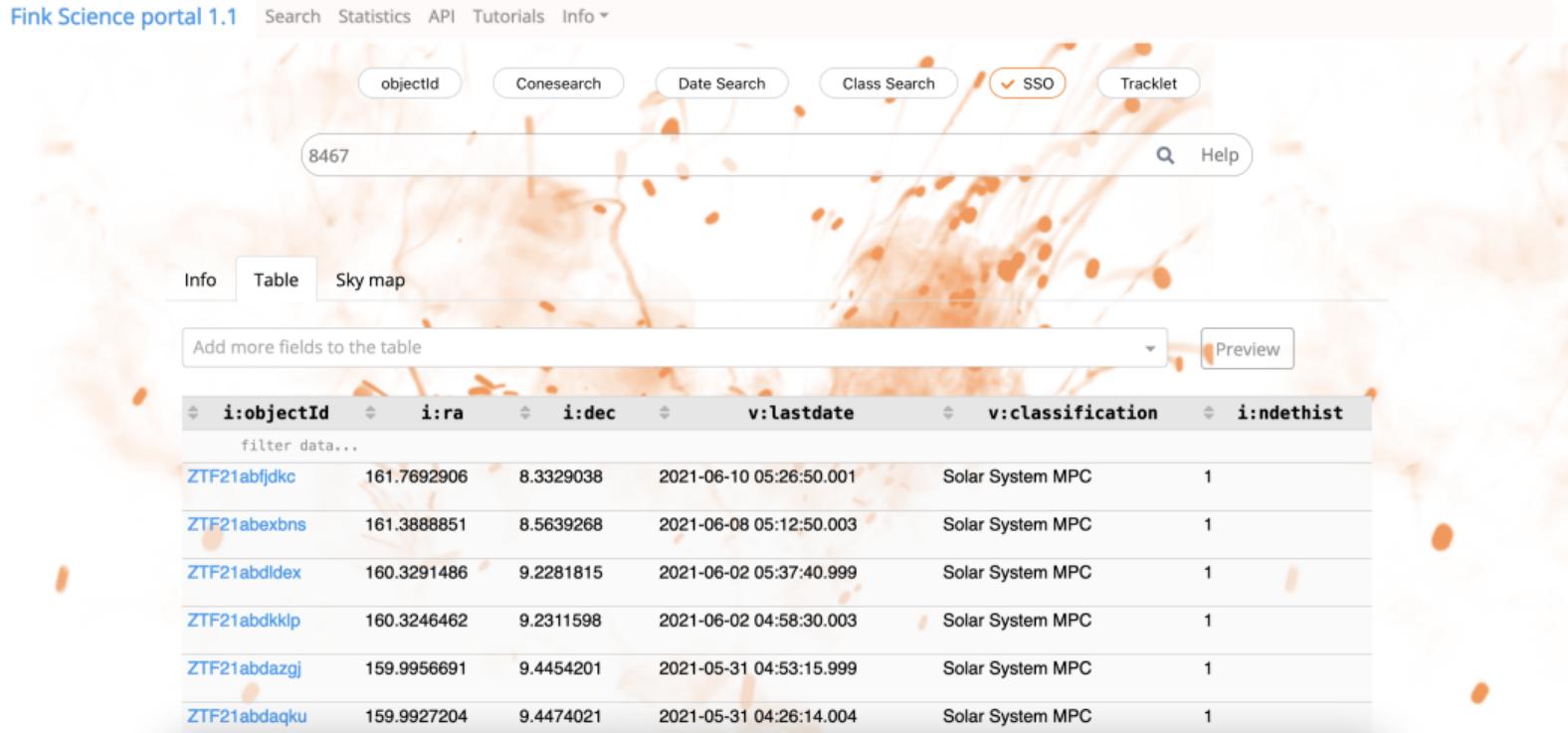
SSOs in FINK Web portal



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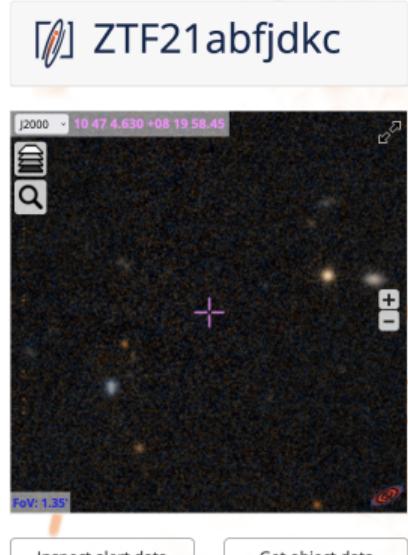
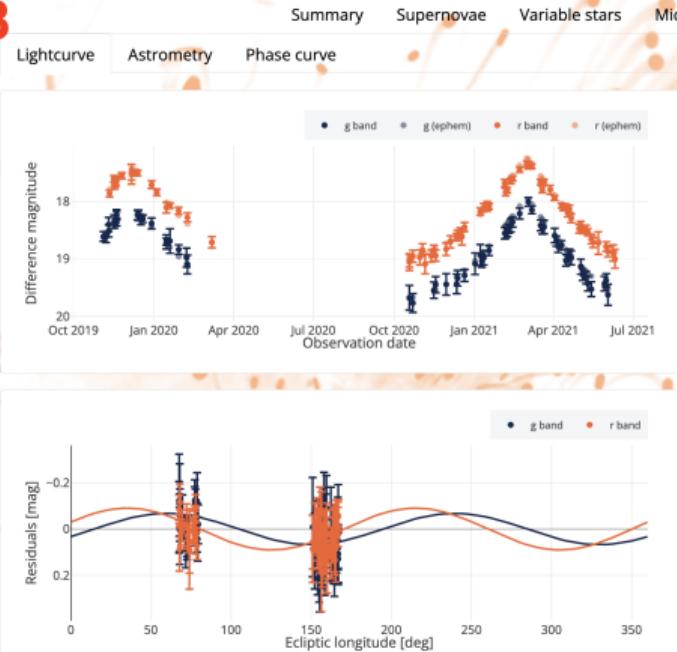


SSOs in FINK Web portal



SSOs in FINK Web portal

Fink Science portal 1.1 Search Statistics API Tutorials Info ▾

**B****A**

Download 8467 data

Name: Benoitcarry

Orbit type: Unclassified (mostly Main Belters)

```
# Properties from MPC
number: 8467
period (year): 5.75
a (AU): 3.2877322
q (AU): 3.0252589
e: 0.0568855
inc (deg): 10.49638
Omega (deg): 1.8208784
argPeri (deg): 113.49472
tPeri (MJD): 59038.95314999996
meanAnomaly (deg): 27.6286
epoch (MJD): 59200.0
H: 13.23
G: 0.15
neo: 0
```



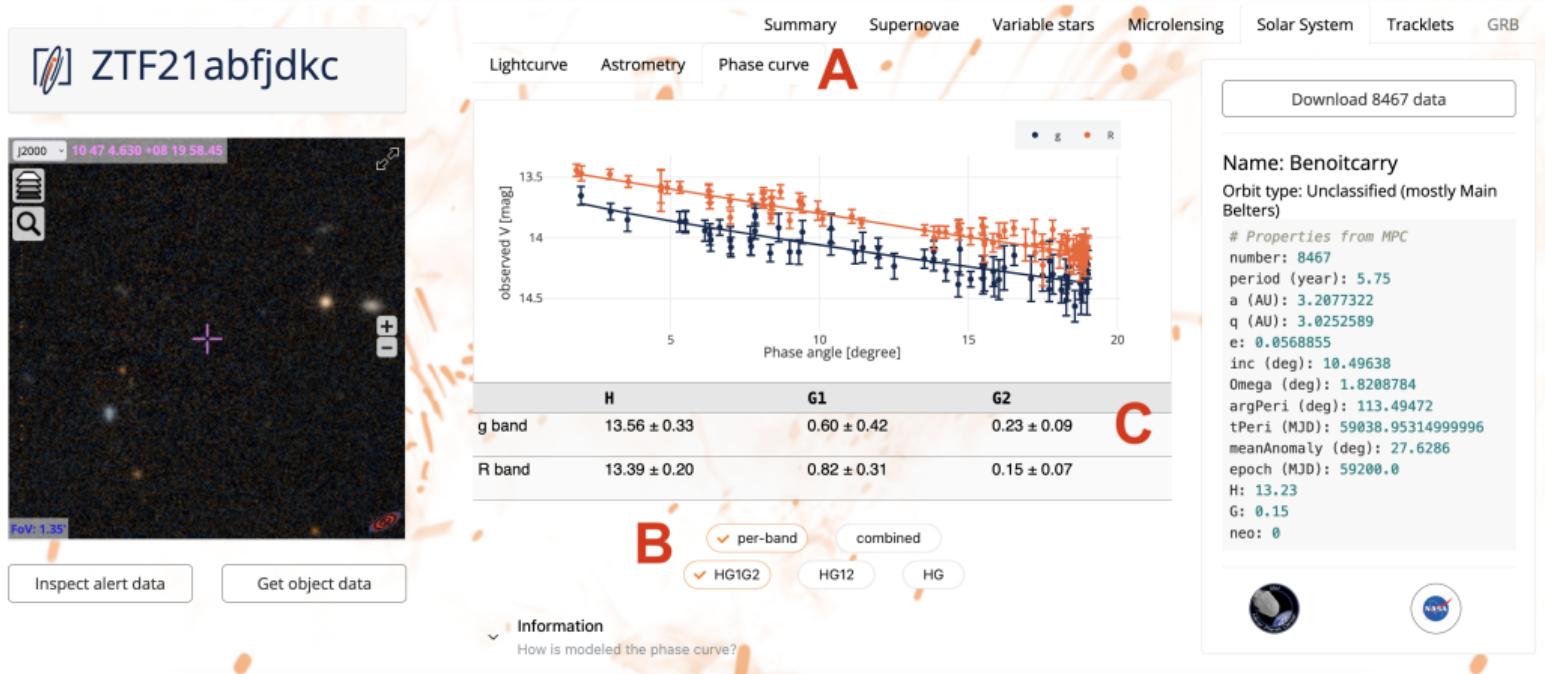
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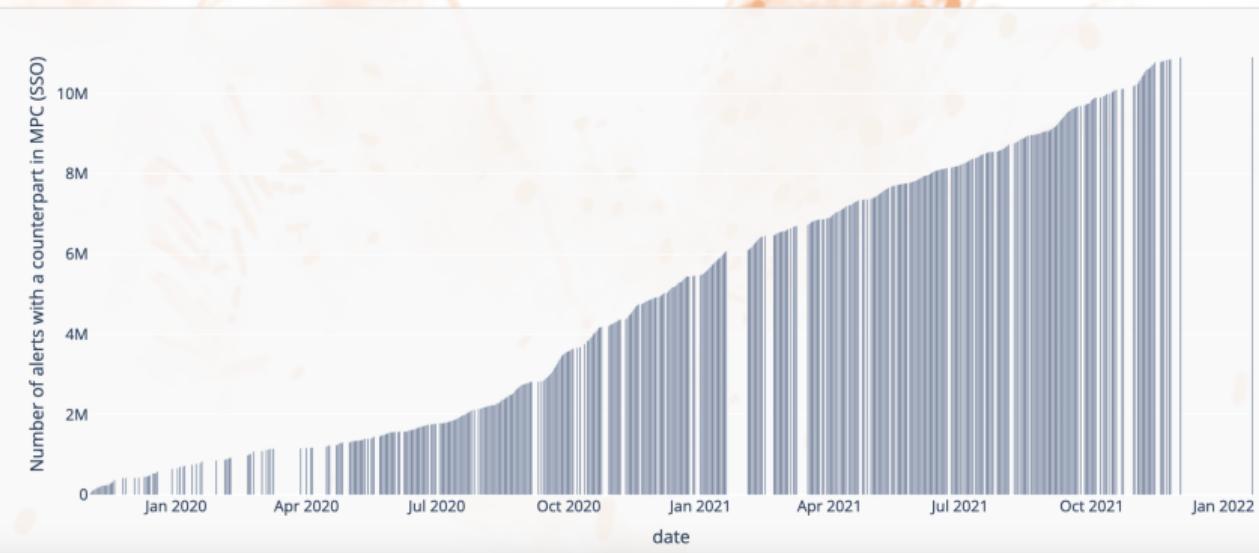
Fink Science portal 1.1 Search Statistics API Tutorials Info ▾



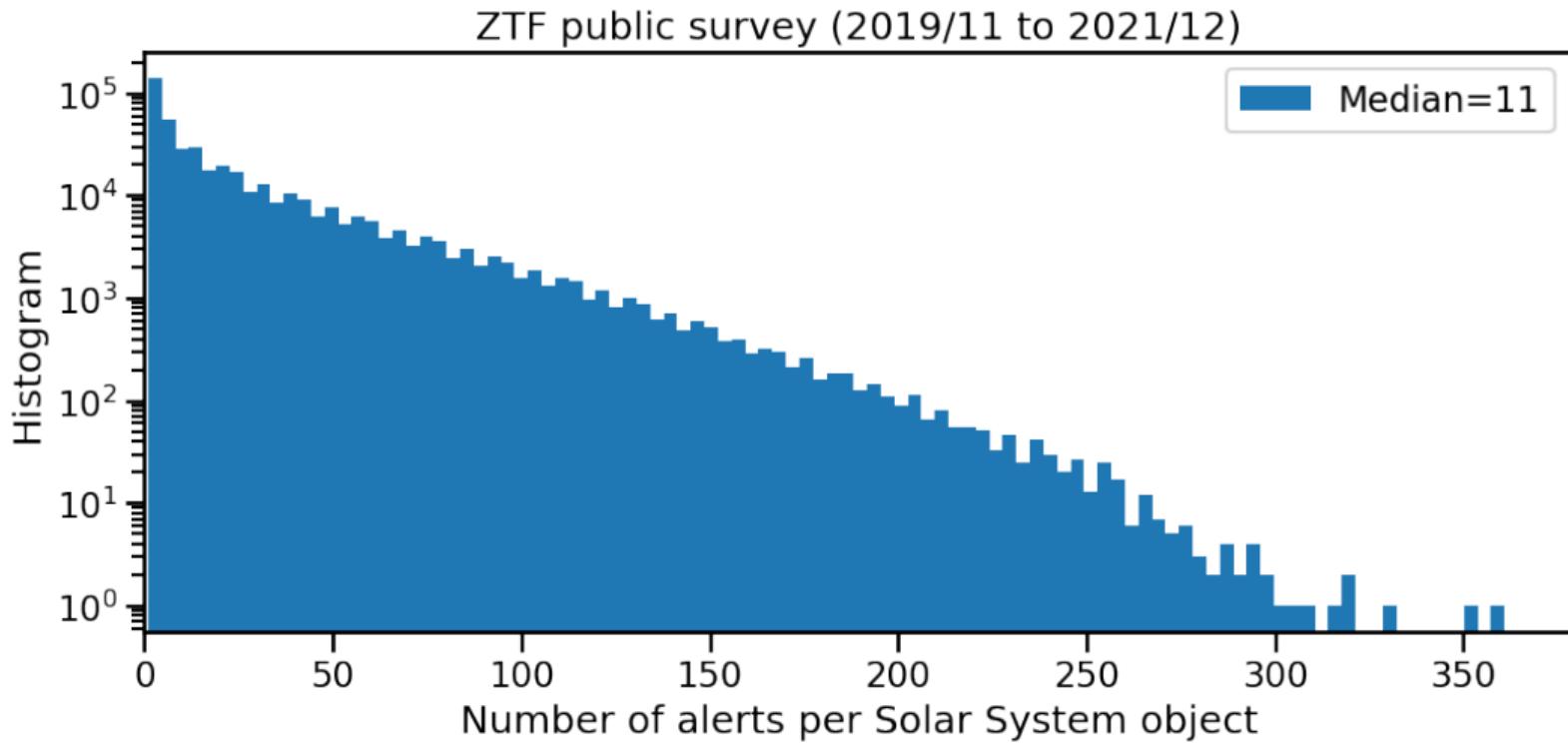
SSOs in FINK Web portal

[Heatmap](#)[Daily statistics](#)[Timelines](#)[TNS](#)[Help](#)

Number of alerts with a counterpart in MPC (SSO)

 Cumulative
 Percentage

SSOs in FINK Web portal



API: Retrieve observations of a single SSO

```
1 # Retrieve data for SSO 8467
2 r = requests.post(
3     'https://fink-portal.org/api/v1/sso',
4     json={
5         'n_or_d': '8467',
6         'output-format': 'csv'
7     }
8 )
9
10 # Format output in a DataFrame
11 data = pd.read_csv(io.BytesIO(r.content))
```

API: Retrieve observations of a single SSO

	d:cdsxmatch	d:mulens	d:rf_kn_vs_nonkn	d:rf_snia_vs_nonia	d:roid	d:snn_sn_vs_all	d:snn_snia_vs_nonia	i:candid	i:chipsf	i:classtar	...	i:ssdistnr	i:ssmagnr	i:ssnamenr	i:
0	Unknown	0.0	0.0	0.0	3	0.0	0.0	1621226961415015022	0.976525	0.966	...	0.0	19.1	8467	
1	Unknown	0.0	0.0	0.0	3	0.0	0.0	1619217241415015002	1.736162	0.974	...	0.0	19.1	8467	
2	Unknown	0.0	0.0	0.0	3	0.0	0.0	1613234500115015012	1.257103	0.975	...	0.0	19.1	8467	
3	Unknown	0.0	0.0	0.0	3	0.0	0.0	1613207290115015009	2.178776	0.984	...	0.0	19.1	8467	
4	Unknown	0.0	0.0	0.0	3	0.0	0.0	1611203650115015007	1.061751	0.978	...	0.0	19.0	8467	
...
129	Unknown	0.0	0.0	0.0	3	0.0	0.0	1044282835715015009	4.012848	0.983	...	0.0	18.0	8467	
130	Unknown	0.0	0.0	0.0	3	0.0	0.0	1043290915715015007	2.795130	0.984	...	0.0	18.0	8467	
131	Unknown	0.0	0.0	0.0	3	0.0	0.0	1043243805715015012	2.301576	0.989	...	0.0	18.0	8467	
132	Unknown	0.0	0.0	0.0	3	0.0	0.0	1040290065715015018	2.159039	0.983	...	0.0	18.1	8467	
133	Unknown	0.0	0.0	0.0	3	0.0	0.0	1037318175915015001	6.247330	0.983	...	0.0	18.1	8467	

134 rows × 47 columns

API: Retrieve more for a single SSO

```
1 # Retrieve data and ephemerides for SSO 8467
2 r = requests.post(
3     'https://fink-portal.org/api/v1/sso',
4     json={
5         'n_or_d': '8467',
6         'withEphem': True,
7         'output-format': 'csv'
8     }
9 )
10
11 # Format output in a DataFrame
12 data = pd.read_csv(io.BytesIO(r.content))
```

API: Retrieve more for a single SSO

:	index	Date	LAST	HA	Az	H	Dobs	Dhelio	VMag	SDSS:g	...	i:ssmagnr	i:ssnamenr	i:tooflag	i:xpos	i:ypos	d:tracklet	v:classif
0	0	2.459376e+06	14:54:33.54	4.124696	261.176112	27.990621	3.115887	3.118001	19.156665	19.599465	...	19.1	8467	0	1374.7506	1888.7060	NaN	Solar System
1	1	2.459374e+06	14:32:38.05	3.784646	258.147904	32.310257	3.087513	3.117019	19.138618	19.581418	...	19.1	8467	0	2707.3525	1057.7262	NaN	Solar System
2	2	2.459368e+06	14:33:53.82	3.876343	259.691209	31.553675	3.002582	3.114112	19.080910	19.523710	...	19.1	8467	0	655.7271	1824.2343	NaN	Solar System
3	3	2.459368e+06	13:54:36.44	3.221814	252.896743	39.520738	3.002190	3.114099	19.080628	19.523428	...	19.1	8467	0	683.2328	1819.2379	NaN	Solar System
4	4	2.459366e+06	13:41:28.40	3.024846	250.837483	41.993260	2.973654	3.113132	19.059950	19.502750	...	19.0	8467	0	1851.9312	1079.9875	NaN	Solar System
...	
129	129	2.458799e+06	02:20:21.20	21.257441	72.709530	56.385365	2.197868	3.075933	18.060828	18.503628	...	18.0	8467	0	2982.0828	1806.4133	NaN	Solar System
130	130	2.458798e+06	02:28:04.50	21.374772	73.098409	57.784841	2.204991	3.076325	18.079086	18.521886	...	18.0	8467	0	2508.8618	1984.5830	NaN	Solar System
131	131	2.458798e+06	01:20:03.40	20.240587	69.379109	44.320928	2.205341	3.076344	18.079964	18.522764	...	18.0	8467	0	2496.5618	1988.4333	NaN	Solar System
132	132	2.458795e+06	02:15:01.64	21.125359	72.699329	54.778187	2.227922	3.077518	18.134342	18.577142	...	18.1	8467	0	1158.0522	2582.2483	NaN	Solar System
133	133	2.458792e+06	02:43:46.65	21.576657	74.212058	60.178662	2.252597	3.078710	18.188883	18.631683	...	18.1	8467	0	3038.8313	133.6511	NaN	Solar System

134 rows × 69 columns

What's next?

- Improved connexion to SSO services
 - quaero for name resolving
 - SsODNet for ancillary informations
 - ESA Euclid for NIR colors
- Improved fitting of phase functions
 - Bayesian inference Mahlke+2021
 - Account for lightcurve if 3D shape available
 - Determine **taxonomy** from colors
- PSF analysis
 - Non-stellar PSF = {activity, binarity}
 - PSF flags from LSST
- Unknown SSOs?
 - ▷ Roman Le Montagner!