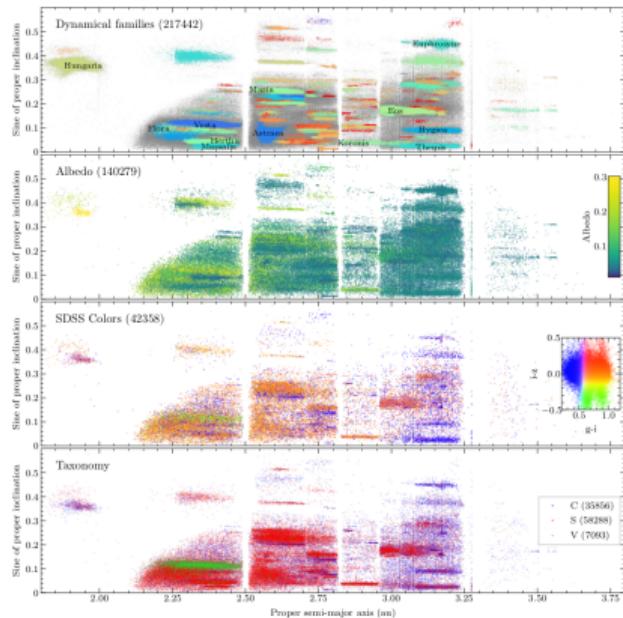


SsODNET

SOLAR SYSTEM OPEN DATABASE NETWORK



B. Carry¹, J. Berthier², M. Mahlke¹ & J. Normand²

¹Lagrange, OCA, Nice

²IMCCE, Paris Observatory

- ▷ Web form: <https://ssp.imcce.fr>
- ▷ python client: <https://rocks.readthedocs.io>
- ▷ APIs: <https://ssp.imcce.fr/webservices>

SsODNet in a nutshell

- **A massive source of information**

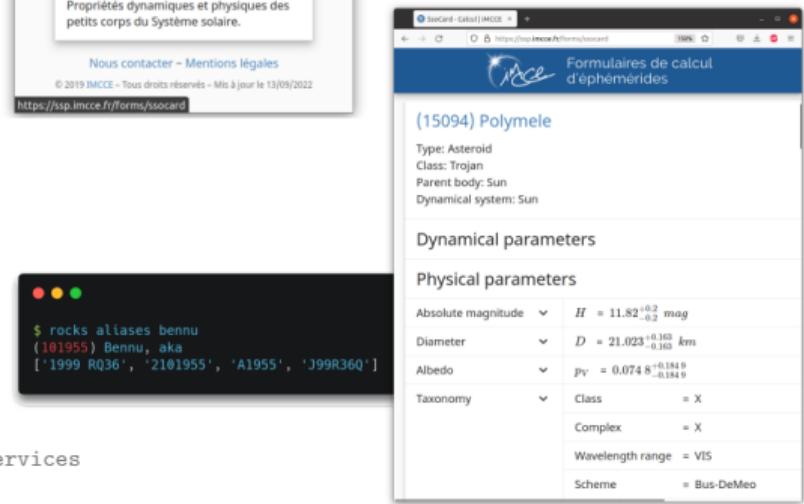
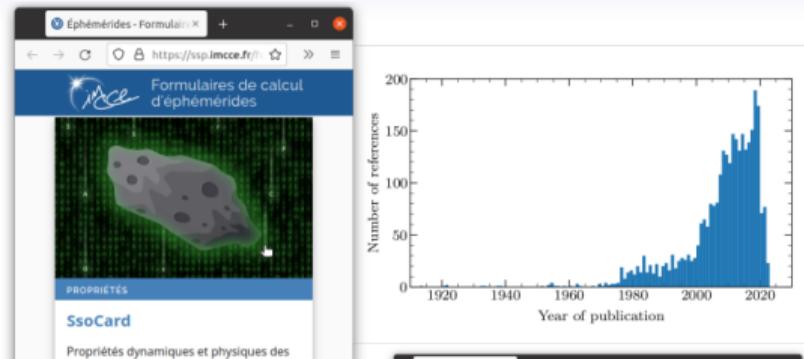
- **5.3 million** designations
- **1.2 million** SSOs
- **105 million** properties
- **3041** compiled articles

- **With dedicated APIs**

- **quaero** Name resolution
- **datacloud** All the data
- **ssoCard** Best estimates only
- **BFT** All ssoCards at once

- **Open access to everyone**

- ▷ Web form <https://ssp.imcce.fr>
- ▷ **rocks** python client <https://rocks.readthedocs.io>
- ▷ APIs: json/text/votable <https://ssp.imcce.fr/webservices>



quaero: name resolver

- **Translates identification**

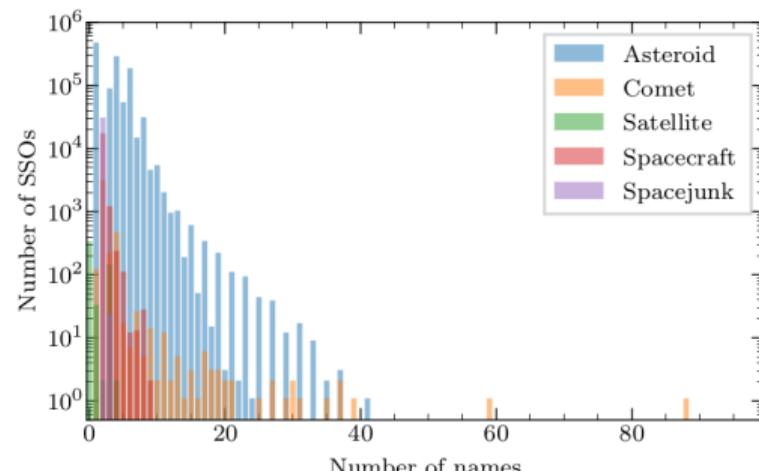
- From **any** alias
- To current designation
- With all others aliases

- **Usages**

- Resolver Alias to sky coordinates
- Fuzzy search
- Auto-completion in Web forms

- **Performances**

- **5.3 millions** of designations
- **1.2 million** of SSOs
- 10k-100k identifications in 2-3s



Example: Moshup

= 66391

= 1999 KW4

= 2066391

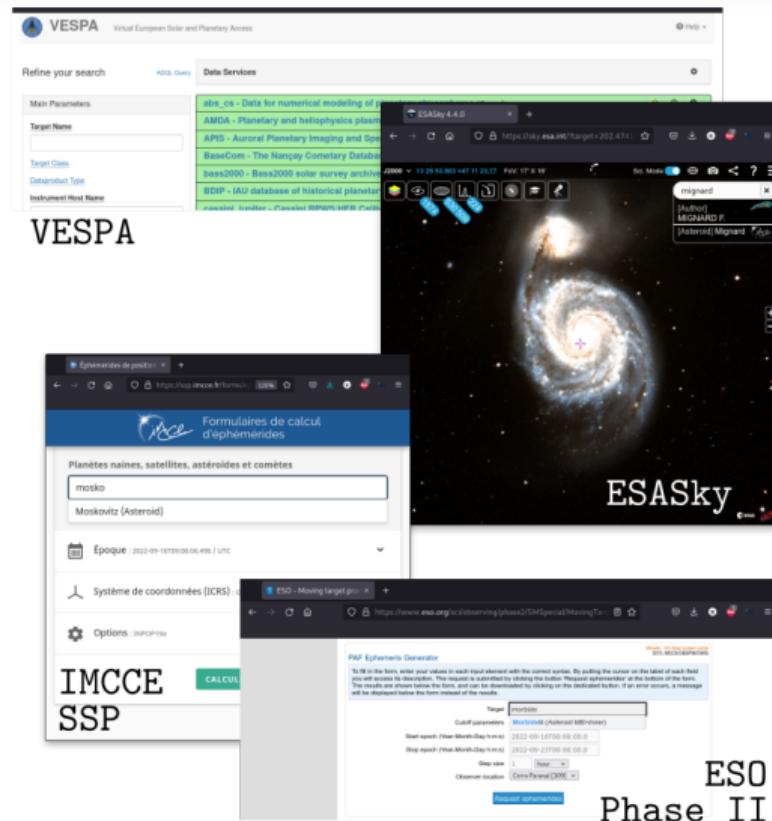
= J99K04W

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quaero: name resolver

- **Translates identification**

- From **any** alias
- To current designation
- With all others aliases

```
$ rocks aliases Bennu
(101955) Bennu, aka
['1999 RQ36', '2101955', 'A1955', 'J99R36Q']
```

- **Usages**

- Resolver Alias to sky coordinates
- Fuzzy search
- Auto-completion in Web forms

```
>>> import rocks

>>> ids = [1159, '1938 SW', 'rYugU']

>>> num_name = rocks.identify(ids)

>>> for nn in num_name:
...     print(nn[1], nn[0])

1159 Granada
1495 Helsinki
162173 Ryugu
```

- **Performances**

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datacloud: compilation of properties

- **Massive data compilation**

- Most data **were not** available

- **Dynamics**

Osculating & proper elements,
pairs & families,
Yarkovsky

- **Physics**

Diameter, spin, mass, density

- **Surface**

Colors, albedo, phase function,
thermal inertia & taxonomy

▷ **180 millions** parameters

- **Philosophy**

- Identification

- Parameter & Uncertainty

- Method

- Bibliography

- Ancillary information

dataset	#	#SSO
Colors	5 M	428 k
Density	49	29
Diameter	261 k	149 k
Families	493 k	262 k
Masses	2 k	422
Pairs	340	236
Phase	330 k	228 k
Spin	47 k	29 k
Taxonomy	274 k	141 k
Thermal inertia	4 k	2 k
Yarkovsky	800	578

Number of entries for each resource

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	mass	err_mass_up	err_mass_down	method	shortbib
1	9.3483e+20	5.967e+19	-5.967e+19	DEFLECT	Goffin1991
2	9.55e+20	4.38e+19	-4.38e+19	DEFLECT	Williams+1992
3	9.54e+20	1.69e+19	-1.69e+19	DEFLECT	Słtarski+1992
4	9.94e+20	3.98e+19	-3.98e+19	DEFLECT	Viateau+1995
5	9.19e+20	1.41e+19	-1.41e+19	DEFLECT	Słtarski+1995
6	8.27e+20	3.78e+19	-3.78e+19	DEFLECT	Kuzmanoski+1996
7	9.29e+20	1.79e+19	-1.79e+19	DEFLECT	Carpino+1996
8	9.52e+20	7.76e+18	-7.76e+18	DEFLECT	Viateau+1997b
9	9.47e+20	4.57e+18	-4.57e+18	DEFLECT	Viateau+1998
10	8.73e+20	7.96e+18	-7.96e+18	DEFLECT	Hilton+1999
11	9.35e+20	7.96e+18	-7.96e+18	DEFLECT	Michalak+2000
12	9.35e+20	5.97e+19	-5.97e+19	DEFLECT	Goffin+2001
13	9.57e+20	1.99e+18	-1.99e+18	DEFLECT	Ptjevar+2001
14	9.45e+20	3.98e+18	-3.98e+18	DEFLECT	Ptjevar+2004
15	9.45e+20	4.18e+18	-4.18e+18	EPHEM	Ptjevar+2005
16	9.35e+20	5.57e+18	-5.57e+18	DEFLECT	Konopliv+2006
17	9.42e+20	5.17e+18	-5.17e+18	DEFLECT	Kova+2007
18	9.46e+20	7.96e+17	-7.96e+17	EPHEM	Fienga+2008
19	9.45e+20	5.97e+18	-5.97e+18	DEFLECT	Baer+2008a
20	9.32e+20	9.32e+19	-9.32e+19	EPHEM	Folkner+2009
21	9.39e+20	5.97e+18	-5.97e+18	EPHEM	Ptjevar+2010
22	9.46e+20	1.43e+18	-1.43e+18	DEFLECT	Baer+2011
23	9.52e+20	4.63e+18	-4.63e+18	DEFLECT	Zielenbach+2011
24	9.4636e+20	5.5692e+18	-5.5692e+18	EPHEM	Fienga+2011
25	9.4e+20	3.1e+18	-3.1e+18	DEFLECT	Zielenbach+2011
26	9.42e+20	2.65e+18	-2.65e+18	DEFLECT	Zielenbach+2011
27	9.42e+20	2.68e+18	-2.68e+18	DEFLECT	Zielenbach+2011
28	9.31e+20	6.46e+18	-6.46e+18	EPHEM	Konopliv+2011
29	9.04e+20	1.39e+19	-1.39e+19	DEFLECT	Kova+2012
30	9.29e+20	3.68e+18	-3.68e+18	EPHEM	Fienga+2013
31	9.41e+20	5.69e+18	-5.69e+18	EPHEM	Kuchynka+2013
32	9.39e+20	1.57e+18	-1.57e+18	EPHEM	Ptjeva+2013
33	9.40797e+20	0.0	0.0	EPHEM	Folkner+2014
34	9.44e+20	5.97e+17	-5.97e+17	DEFLECT	Goffin+2014
35	9.29e+20	3.84e+18	-3.84e+18	EPHEM	Fienga+2014
36	9.384e+20	1e+17	-1e+17	SPACE	Russell+2016
37	9.394e+20	1.312e+18	-1.312e+18	EPHEM	Baer+2017
38	9.38e+20	2.21e+18	-2.21e+18	EPHEM	Viswanathan+2017
39	9.38348e+20	2.28689e+18	-2.28689e+18	EPHEM	Fienga+2019
40	9.39e+20	2.31e+18	-2.31e+18	EPHEM	Fienga+2020

datacloud: compilation of properties

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▷ **180 millions parameters**

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\$ rocks masses ceres
(1) Ceres

	mass	err_mass_up	err_mass_down	method	shortbib
1	9.3483e+20	5.967e+19	-5.967e+19	DEFLECT	Goffin1991
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Green: preferred entry

ssoCard: best estimates

- **Best estimates?**

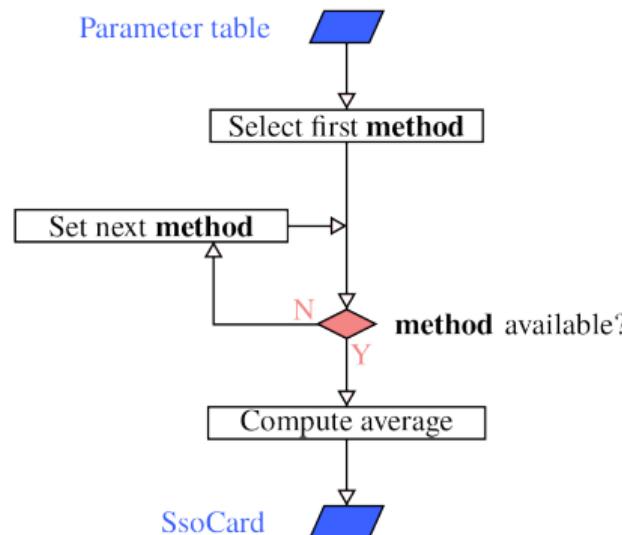
- Decision trees for each parameter
- Based on methods
- With a weighted average
- ▷ Stored in ssoCards

- **Added values**

- Tisserand's parameter
- Recompute albedo
- Compute density
- etc.

- **Usage & performance**

- Request ssoCard via API/rocks
- 30 ms per request 11 ms from cache
- Full traceability with bibliography
<https://ssp.imcce.fr/data/ssodnet.bib>



E.g., for masses: Space mission

- ↳ Binary system
- ↳ Deflection & ephemerides
- ↳ Yarkovsky estimate

ssoCard: best estimates

• Best estimates?

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```
>>> import rocks
>>> ssocard = rocks.Rock(17919)
>>> ssocard.number, ssocard.name
(17919, 'Licandro')

>>> ssocard.diameter.value
3.064

>>> ssocard.diameter.error.min_, ssocard.diameter.error.max_
(-0.039, 0.039)

>>> ssocard.diameter.method
[Method(doi='10.1006/icar.1999.6248',
        name='Near-Earth Asteroid Thermal Model',
        year=1999,
        title='Physical Characteristics ...',
        bibcode='1999Icar..142..464H',
        shortbib='Harris1999')]

>>> ssocard.diameter.bibref
[Bibref(doi='10.3847/PSJ/ac3232',
        year=2022,
        title='Analysis of Four-band WISE ...',
        bibcode='2022PSJ.....3...30M',
        shortbib='Myhrvold+2022'),
 Bibref(doi='10.1088/0004-637X/741/2/68',
        year=2011,
        title='Main Belt Asteroids with WISE/NEOWISE ...',
        bibcode='2011ApJ...741...68M',
        shortbib='Masiero+2011'),
 Bibref(doi='10.1088/2041-8205/759/1/L8',
        year=2012,
        title='Preliminary analysis of WISE/NEOWISE ...',
        bibcode='2012ApJ...759L...8M',
        shortbib='Masiero+2012')]
]
```

BFT: all ssoCards at once

- **It's a BIG table**

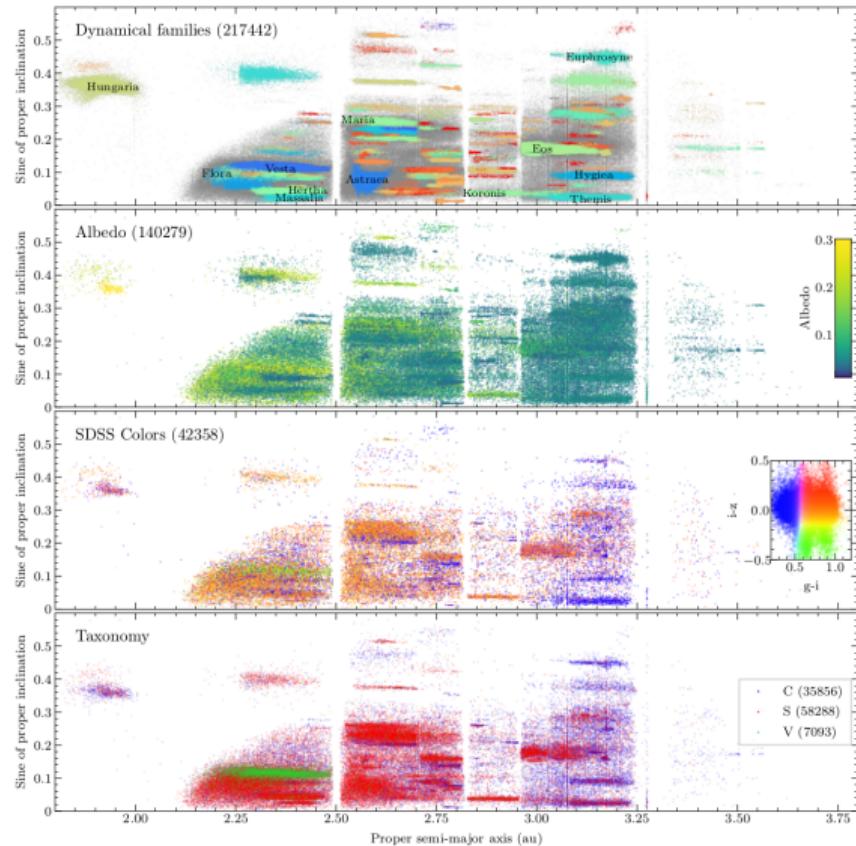
- 1.2M SSOs × 605 fields
- Filled at 14.6%

- **Usages**

- Data curation
- ▷ Data exploration
- ▷ Statistical studies

- **Access**

- Compressed eCSV 2.1 Gb uncompressed
<https://ssp.imcce.fr/data/ssoBFT-latest.ecsv.bz2>
- Apache parquet 279 Mb
<https://ssp.imcce.fr/data/ssoBFT-latest.parquet>
- ▷ Easy to use: TOPCAT, python, ...



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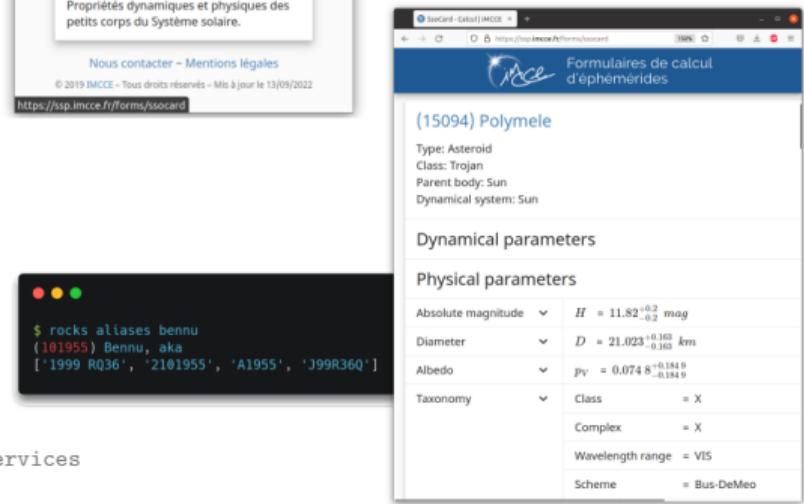
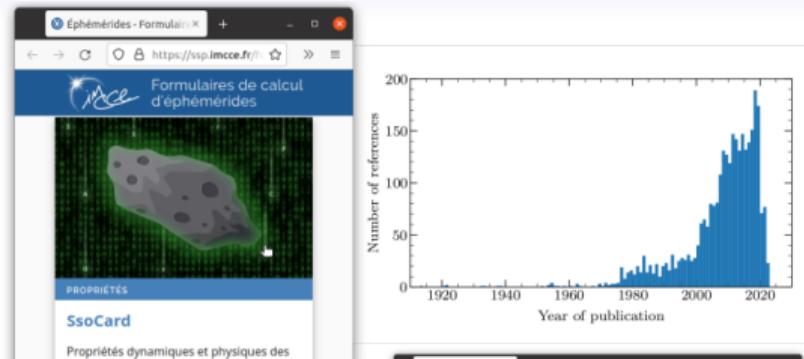
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- ▷ APIs: json/text/votable <https://ssp.imcce.fr/webservices>



What's next?

- **Data compilation**

- Continuous addition of data
- ▷ Any feedback welcome!

- **Expand the set of parameters**

- MOIDs, NEA source regions, ...
- ▷ Any suggestion welcome!

- ▶ **Aiming at completeness**

- **Types of SSO**

- Comets, planets & satellites
- ▷ Set of parameters? Decision trees?

- **User interface**

- Advanced data queries
- ▷ What do **you** need/want?

- ▶ **Structural improvements**

SsODNet is a service for & by the community

SsODNet is ready for large data releases (LSST, Gaia, Euclid, ...)