

Online tools for planetary sciences - Part II



rocks

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Databases and Data Aggregators



We all need data, we all generate data.

- **Databases**

- Websites, CDS, on request
- Mostly static, single bibliographic reference
- Mixture of formats



Databases and Data Aggregators

```
$ ls data/
CAPS      demen2006      lol20002023      sergeyev2021
aast      demen2009      lucas2017        shevchenko2022
akari     devogele2018   lucas2019        smss
astdys    ecaa           mahlke2021       splitzer
astorb    emery2011      mahlke2022       svo
atran     emery_brown2003  meteorites       tholen1984
beck2021  eschrig2021    micronegs        timeout_rjuno2024
birlan2007  formater2014   npc              usgs
blanco2023  gaffey1976     nebulae          verma2020B04
burkhardt2017  gals          nirs3            vstsmovis
carry2016  gallardo2020   nu6              wang2017
carry_unpublished  gietzen2012   orox             yang_jewitt2007
classy     hat            perna2018        yang_jewitt2011
cloutis2011  kaplan2020     popescu2011      zellner1905
daitt      lant2017       relab
deloren2018  lant2018       smss4mc
```

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- **Data Aggregators**

- Collection of data **with processing**
- Dynamic, large number of bibliography references
- Uniform output



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astdys    ecaa           mahlke2021       spitzer
astorb    emery2011      mahlke2022       svo
atran     emery_brown2003  mteorites        thaler1984
beck2021  eschrig2021    microwegs        tinout_rapon2024
birlan2007  formaster2014  npc              usgs
blanco2023  gaffey1976     nebulae          verma2020B04
burkhart2017  gals          nux3             vstsmovis
carry2016   gallardo2020   nu6              wong2017
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Data aggregation takes effort but saves time and energy.




Data Aggregators

NAME	OBJECTS	PARAMETERS	URL
ECOCCEL	Asteroids	Physical, Orbital	http://www.ecocel-database.com/
JPL SBDB	Asteroids, Comets	Physical, Orbital	https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html
Lowell	Asteroids	Physical, Orbital	https://asteroid.lowell.edu/astinfo/
MP3C	Asteroids	Physical, Orbital	https://mp3c.oca.eu/
NEOExchange	Near-Earth Objects	Orbital	https://neoexchange.lco.global/
SiMDA	Asteroids, Comets	Size, Mass, Density	https://astro.kretlow.de/simda/
SsODNet	Asteroids	Physical, Orbital	https://ssp.imcce.fr/forms/ssocard

Demo

The next slides show an outline of the demoed material.

Demo


Lowell Minor Planet Services
 Access to astorbDB and tools

[UpObjects](#)
[CribLists](#)
[AstEph](#)
[AstInfo](#)
[AstObs](#)
[AstFinder](#)
[QueryBuilder](#)
[Comets](#)
[astorb.dat](#)

Asteroid Information

Use this tool to query available orbital and physical properties of asteroids.

Query object by name / number ->

Number	Name	Primary Designation	Alternation Designation(s)	Dynamical Family
221	Eos	Eos	A882 BA	Eos

Orbital + Physical Parameters

Elements		Albedo/Diameter		Survey		# Obs.	# Bands	Technique	Ref.
Epoch	2823-12-22T00:00:00	Albedo	\pm	Diam. (km)	\pm				
Type	mbs,outer_belt	0.131	± 0.005	187.74	± 1.51	6	2	Mid IR photometry	[icon]
a	3.012	0.14	± 0.01	183.87	± 3.6	15	3	Infrared Astronomical Satellite (IRAS)	[icon]
e	0.182	0.182	± 0.023	91.197	± 2.213	68	4	Mid IR photometry	[icon]
i	10.898	0.166	± 0.013	95.469	± 1.684	24	2	Mid IR photometry	[icon]
M	216.969	0.14	± 0.042	94.925	± 22.238	32	2	Mid IR photometry	[icon]
Peri	192.550	0.151	± 0.002	87.123	± 21.393	31	2	Mid IR photometry	[icon]
Node	141.732								
H	7.780								

Taxonomy

Type	System	Survey	Technique	Ref.
S	Tholen_ECAS	Tholen (1989)	Visible photometry	[icon]
5	Barucci_Gmode	Barucci et al. (1987)	Visible photometry, Mid IR photometry	[icon]
K	Tedesco_Sparameter	Tedesco et al. (1989)	Visible photometry, Mid IR photometry	[icon]
K	Howell_Neural	Howell et al. (1994)	Visible photometry, Near IR spectroscopy	[icon]
K	Bus_SMASSII	SMASSII	Visible spectroscopy	[icon]
K	Bus-DeMao	DeMao et al. (2009)	Near IR spectroscopy	[icon]
K	Bus-DeMao	MITHNEOS	-	[icon]

Orbit

Arc	137.554
First Observed	1885-11-26
Last Observed	2823-06-18
# Apparitions	68
# Obs. Used	3971
Orbit Quality	6.95
T _J	3.2141


Colors

Bibliographic references ->

16:08:10 UTC 09:08 MST 13:08 GMT-3 06:08 HST
 [astorb Citation](#)
 [Status](#)
 [Docs](#)
 [FAQ](#)
 [f](#)
 [t](#)
 [@](#)
 [v](#)

<https://asteroid.lowell.edu/>

Demo


MP3C
[Search](#)
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[Documentation](#)
[Citations](#)
[Contact](#)

Ceres

Eos

00221, 1882BA, 182B00A

^ Query object by name / number

All data for this body: [vot] <- Static URL to results in VOTable

MPC data

Name (number)	Eos (221)	n_{obs}	3325
Packed designation	00221	n_{app}	71
a	3.00997	Years observed	1885-2022
e	0.10228	rms	0.61
$i / \sin(i)$	10.8932 / 0.18898		
q	2.70211		
Q	3.31784		
ω	192.3274		
Node	141.7334		
m	85.1583		
n	0.1887		
Epoch	2459600.5		

Orbital + Physical Parameters

Best values

[raw, vot]

	Value	Standard error		Value	Standard error
Parent	Eos (221)		G	0.150	
a_p	3.013		H	7.800	
e_p	0.074		Mass	1.133e+18	3.650e+17
$\sin(i_p)$	0.172		D	100.15	0.878
			pV	0.147	0.0055


Family data

[raw, vot]

Parent	Parent name	Family ID	Family name	C_f	Author	Bibliographic references	Method
221	Eos	606	Eos	-2.3700	Nesvorny	doi.org/10.26033/6cg5-pt13	HCM-2020-08-14

<https://mp3c.oca.eu/>

Demo


MP3C

[Search](#)
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Ceres

Plots

This form lets you plot 2- or 3-axis graphs (X, Y and optional marker color) from the MP3C data by selecting the axes. It allows for filtering of the data by several criteria.

[Example query](#)
Fast and versatile 2D plots + histograms

Filter rules

Names list (optional):

Numbers list (optional):

Parents (families) list (optional):

Include "0" to match bodies not in any family.

Parent names list (optional):

Include "None" to match bodies not in any family.

Constraints on quantities (optional):

0	≤	D	≤	10	Clear
	≤	---	≤		Clear
	≤	---	≤		Clear
	≤	---	≤		Clear
	≤	---	≤		Clear

[More](#)

Axes


X axis:

Y axis:

Color axis (optional):

<https://mp3c.oca.eu/xyz-plot/>


Demo

 Formulaires de calcul d'éphémérides

SsoCard

This form allows to display the best estimates of the dynamical and physical properties of the small bodies of the solar system, namely *ssoCard*, compiled by the SsODNet service.

[DOCUMENTATION](#)

 Solar system objects : Eos (Asteroid) ^

Asteroids and dwarf planets

Eos (Asteroid) <- Query objects by name / number

✓ Désignation officielle du corps

[SEARCH](#)

Orbital + physical parameters, references, static URL to JSON format

(221) Eos

Type: Asteroid
Class: MB>Outer
Parent body: Sun
Dynamical system: Sun

[COPY LINK](#)
[EXPORT](#)

Dynamical parameters ^

<https://ssp.imcce.fr/forms/ssocard>

Demo

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[Orbits & Ephemerides](#)
[Planets](#)
[Planetary Satellites](#)
[Small Bodies](#)
[Tools](#)
[Extras](#)

[Home](#) / [Tools](#) / Small-Body Database Lookup

67P/Churyumov-Gerasimenko

Classification: Jupiter-family Comet [NEO]
 SPKID: 1000012
 Related Links: [Ephemeris](#)

[Orbit Viewer](#) [\[show\]](#)

[Orbit Parameters](#) [\[hide\]](#)

Select Orbit:

Osculating Orbital Elements

Epoch 2457305.5 (2015-Oct-10.0) TDB
 Reference: [J2000](#) (heliocentric) [J2000](#) (ecliptic)

Element	Value	Uncertainty (1-sigma)	Units
e	0.6409061297452731	2.7466E-8	
a	3.462249488233078	1.5491E-7	au
q	1.243265644018067	9.8838E-8	au
i	7.040295031286642	2.7143E-6	deg
node	50.13557349079007	2.2796E-5	deg
peri	12.79825003360463	2.3023E-5	deg
M	8.859927433499202	2.7804E-6	deg
tp	2457247.588657805554	1.7755E-5	TDB
	2015-Aug-13.08865781		
period	2353.076065970291	.00015792	d
	6.442371159398469	4.3236e-7	y
n	0.1529912293130881	1.0268E-8	deg/d
Q	5.68123332448069	2.5419E-7	au

Miscellaneous Details

solution date	2023-May-04 10:48:55
# obs. used (total)	8608
data-arc span	5442 days (14.90 years)
first obs. used	2008-06-01
last obs. used	2023-04-26
planetary ephem.	DE441
SB-pert. ephem.	SB441-N16
condition code	0
norm. resid. RMS	.55098
source	JPL
producer	Davide Farnocchia
Earth MOID	.256932 au
Jupiter MOID	.0837763 au
T_jup	2.746

Model Parameters

Parameter	Value	Uncertainty (1-sigma)	Units
A1	1.042492137165642E-9	1.321E-11	au/d^2
A2	-6.739448129852418E-11	2.918E-12	au/d^2
A3	2.957443603656012E-10	1.147E-11	au/d^2
DT	45.6855341067259	1.18	d

Physical Parameters [\[hide\]](#)

Parameter	Value	Units	Sigma	Reference	Notes
[M1] comet total magnitude	12.9		0.8	K213/5	2 parameter fit from 3526 observations, ...
[K1] comet total magnitude slope	7.5			K213/5	autocomd 3.0e
diameter	3.4	km	0.1	Sierks et al., Science 34...	
GM	662.2e-9	km^3/s^2	0.2e-9	Patzold et al., Nature 53...	

https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html

Data Aggregators

And the meteorites?

- Meteoritical Bulletin <https://www.lpi.usra.edu/meteor/>
 - Name, classification, fall/find
 - Meteorite Name Checking Utility <https://www.lpi.usra.edu/meteor/metbullcheck.php>
- Antarctic Meteorite Classification Database <https://curator.jsc.nasa.gov/antmet/>
 - Has an API :-)
 - Only records antarctic meteorites :-)

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Need for a meteorite database + API!

The N-Body Problem

• Graphical User Interfaces do not scale

- Many bodies → Many clicks
- Repeated queries to update data
- Bibliography management

→ Data aggregators need programmatic APIs

• Different degrees of simplification

- Static URLs pointing to text files
- Common service such as the *Table Access Protocol*
- Secondary client such as python packages

```
$ ls data/
CAPS      demo2006      lolzeau2023      sergayev2021
aars      demo2009      lucas2017        shavchenko2022
akari     devogele2018  lucas2019        smass
astdyn    eca3          mahlke2021       spitzer
astorb    emery2011     mahlke2022       svo
atran     emery_brown2003  meteorites       tholen1084
beck2021  eschrig2021   micromega        timeout_runo2024
bislap2007  formasier2014  nsc              usps
bishop2021  gaffey1976    newwise          vernazza2014
burkhardt2017  gala          nls3             vlstamovis
carry2016   gallardo2020  nup              wong1937
carry_unpublished  gietzen2012  orex             yamg_jewitt2007
classy     hst           perna2018        yamg_jewitt2011
clovis2011  kaplan2020    popescu2011      zellner1985
datt       lant2017      rel30
deleon2010  lant201X      sdss4mc
```



Tutorial

[20min] Tutorial notebook on data access

- Basic: Programmatic data access with `astroquery` and `rocks`
- Advanced: Analysis of catalogue data with `rocks`
- Expert: Building our own `meteorite`-classification lookup tool