Online tools for planetary sciences

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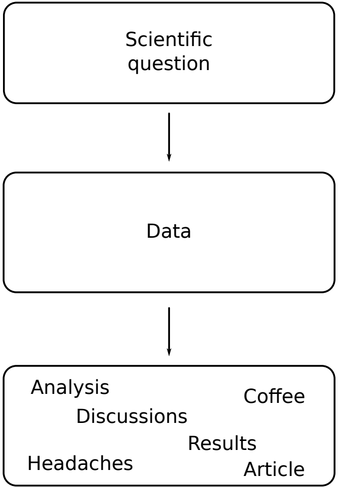
A typical research project



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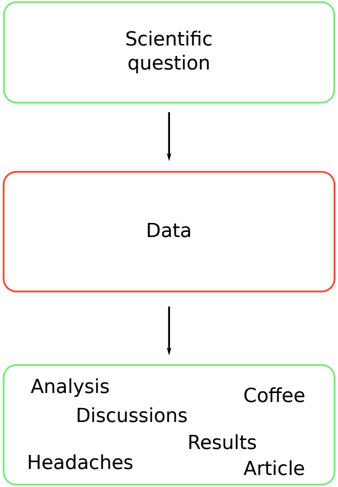

Repetitive (and tedious) tasks!

- **Planning and conduction of observations**
  - Observations already exist?
  - Target/sample available? visible?
- **Gathering ancillary data for the analysis**
  - Complementary information diameter, fall/find, ...
  - Context for research another population
- **Repetitive low-level analysis**
  - Spectral classification
  - Cross-matches & merges

Shared resources save community time

- **Tedious tasks? Share the load!**
  - Many agencies have the mission to support the community
    ESO/ESA/NASA, JPL/MPC/IMCCE, ...
  - The expertize is in the community → individual initiatives
    SSHADE, Meteoretical Bulletin, SMASS
  - ▶ More time for your research
- **Tedious tasks? Automatize them!**
  - Click, click, click... copy-paste, click...
  - Or code some processes to work for you
  - ▶ Virtual Observatory & Community librairies
- **Community services are less prone to errors!**
  - One user → one α-, β-tester, user...
  - Many users → bug reports! and community solutions & patches!
  - ▶ Robustness of analysis → results

Pointing a telescope

Example

Where do I point the telescope from the name of a target?

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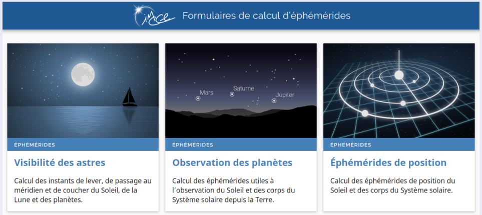
Answer: CDS, IMCCE Miriade, JPL SSD, MPC, Lowell AstEph



Visibility of targets

Example

Can I observe asteroids Raymond, Delsanti, 7561 and 10281? And M31 and M67?

Visibility of targets

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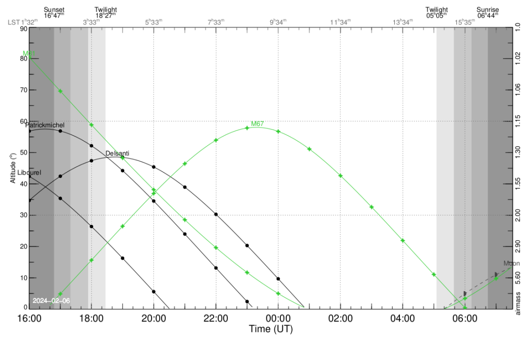
Can I observe asteroids Raymond, Delsanti, 7561 and 10281? And M31 and M67?

Answer: IMCCE ViSiON, Lowell AstObs, airmass.org



Accessing data

Example

What is the taxonomy of Vernazza? the diameter of Groussin?

Accessing data

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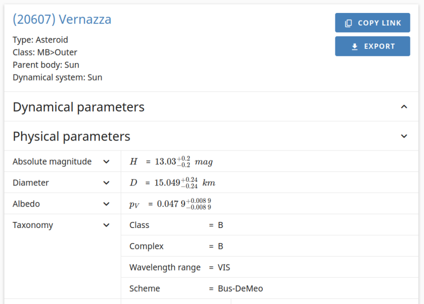
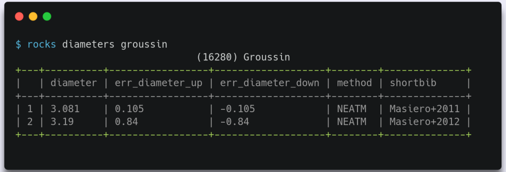
What is the taxonomy of Vernazza? the diameter of Groussin?

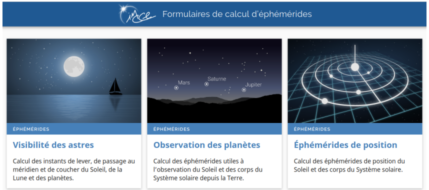
Answer: IMCCE SsODNet, JPL sbdb, OCA MP3C, Lowell AstInfo, SiMDA





Pimp my processing

- **Web forms** Access at human-scale
  - Reprocess archival observations
  - Need to contextualize and complement
  - Perform operations beyond our confort zone
- **Shared libraries** Automatize and rationalize
  - Local installation & calls
  - Part of codes, scripts → repeatability
- **Web services and APIs** Use remote resources
  - `Send query & get answer`
  - Maintenance on the provider side



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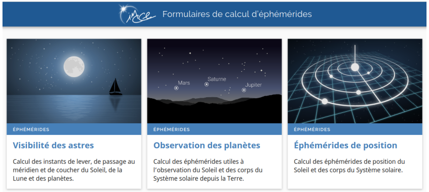

Broz (Astéroïde)

Date	α h	δ deg	d_{obs} au	m_V mag	Phase deg	Elong. deg	$\Delta\alpha\cos\delta$ arcsec/min	$\Delta\delta$ arcsec/min	v_r km/s
2024-02-06T21:00:00.000	9:20:29.0387	20°50'03.305"	1.452625003759	17.83	2.095	174.8183	-0.6516374	0.2428699	4.9870915

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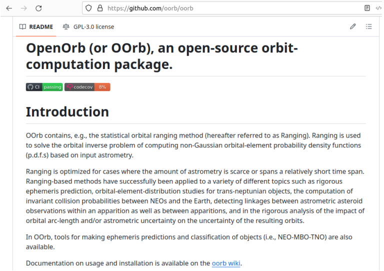

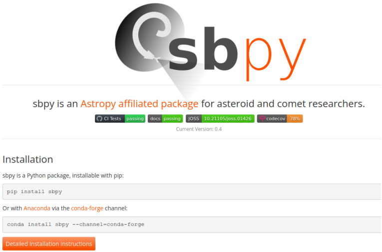

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Reddened solar spectrum

sbpy's `sbpy.spectroscopy.SpectralGradient` can be used to redden a solar spectrum, although this approach may be revised with future sbpy capabilities.

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
import astropy.units as u
from sbpy.spectroscopy import SpectralGradient
from sbpy.units import hundred_nm
from sbpy.calib import Sun
```

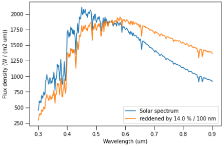
In [2]:
```
sun = Sun.from_builtin('E490_2014LR')
wave = np.linspace(0.3, 0.9, 300) * u.um
fluxd = sun.observe(wave)
S = SpectralGradient(14 * u.percent / hundred_nm, wave0=0.55 * u.um)
print(S)
```

```
WARNING: Source spectrum is tapered. [synphot.observation]
WARNING:astropy:Source spectrum is tapered.
14.0 % / 100 nm
```

`SpectralGradient` works with two-band photometry expressed as magnitudes. To use it for a spectrum, the function `to_color()` must be repeatedly called:

In [3]:
```
color_index = u.Quantity([S.to_color((0.55 * u.um, w)) for w in wave])
# express in linear units (reflectance)
r = 10**(0.4 * color_index.value)
```

In [4]:
```
ax = plt.gca()
ax.plot(wave, fluxd, label='Solar spectrum')
ax.plot(wave, r * fluxd, label='reddened by {}'.format(S))
plt.setp(ax, ylabel='Flux density ({})'.format(fluxd.unit),
        xlabel='Wavelength ({})'.format(wave.unit))
plt.legend()
plt.show()
```



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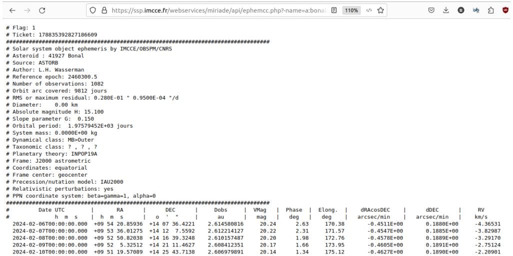
```
>>> from astroquery.mpc import MPC
>>> result = MPC.query_object('asteroid', number=56788)
>>> result[0]['name'], result[0]['tisserand_jupiter']
('Guilbertlepoutre', 3.2)

>>> result
[{'absolute_magnitude': '14.22',
  'aphelion_distance': '3.566',
  'arc_length': 9428,
  'argument_of_perihelion': '92.1275',
  'ascending_node': '317.2229202',
  'critical_list_numbered_object': False,
  'delta_v': 10.5,
  [...]
  'updated_at': '2024-01-16T13:32:14Z',
  'uranus_moid': 15.1713,
  'venus_moid': 1.77253}]
```



https://ssp.imcce.fr/webservices/miriade/api/ephemcc.php?-name=a:bonal

```
# Flag: 1
# Ticket: 178835392827186609
#################################################################################
# Solar system object ephemeris by IMCCE/OBSPM/CNRS
# Asteroid : 41927 Bonal
# Source: ASTORB
# Author: L.H. Wasserman
# Reference epoch: 2460300.5
# Number of observations: 1082
# Orbit arc covered: 9812 jours
# RMS or maximum residual: 0.280E-01 " 0.9500E-04 "/d
# Diameter:    0.00 km
# Absolute magnitude H: 15.100
# Slope parameter G:  0.150
# Orbital period:  1.97579452E+03 jours
# System mass: 0.0000E+00 kg
# Dynamical class: MB>Outer
# Taxonomic class: ? , ? , ?
# Planetary theory: INPOP19A
# Frame: J2000 astrometric
# Coordinates: equatorial
# Frame center: geocenter
# Precession/nutation model: IAU2000
# Relativistic perturbations: yes
# PPN coordinate system: beta=gamma=1, alpha=0
#################################################################################
#         Date UTC         |       RA       |      DEC       |     Dobs     | VMag  | Phase | Elong. |   dRAcosDEC   |     dDEC      |    RV
#               h  m  s    |  h  m  s       |   o  '  "      |      au      |  mag  |  deg  |  deg   |  arcsec/min   |  arcsec/min   |   km/s
  2024-02-06T00:00:00.000  +09 54 20.85936  +14 07 36.4221    2.614580816    20.24    2.63    170.38    -0.4511E+00    0.1880E+00    -4.36531
  2024-02-07T00:00:00.000  +09 53 36.01275  +14 12  7.5592    2.612214127    20.22    2.31    171.57    -0.4547E+00    0.1885E+00    -3.82987
  2024-02-08T00:00:00.000  +09 52 50.82038  +14 16 39.3248    2.610157487    20.20    1.98    172.76    -0.4578E+00    0.1889E+00    -3.29170
  2024-02-09T00:00:00.000  +09 52  5.32512  +14 21 11.4627    2.608412351    20.17    1.66    173.95    -0.4605E+00    0.1891E+00    -2.75124
  2024-02-10T00:00:00.000  +09 51 19.57089  +14 25 43.7138    2.606979891    20.14    1.34    175.12    -0.4627E+00    0.1890E+00    -2.20901
```

Typical tasks and some solutions

TBD

Let's get some hands-on experience

1. **From GUI to scripts**
   - Find objects in an image
   - **another example of API**
2. **Easy access to data and parameters of objects**
   - Common resources for meteorites and Solar System objects
   - Efficient data access with APIs
3. **Getting and analyzing spectra**
   - How to search and obtain spectra?
   - Tools for classification