ASTEROID SIZE ESTIMATION
WITH DATA FROM
THE RUBIN OBSERVATORY LEGACY SURVEY OF SPACE AND TIME

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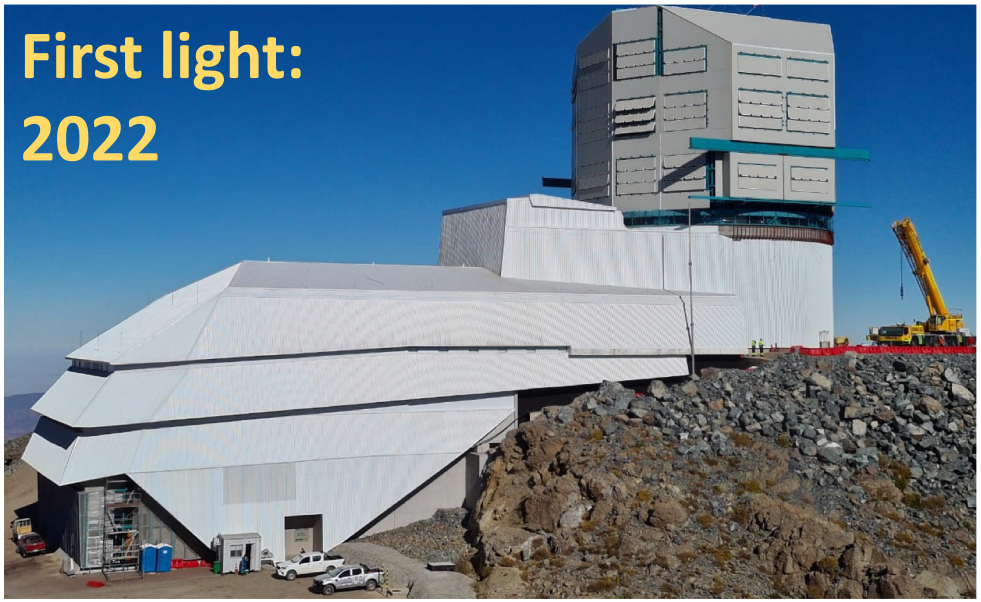
The Rubin Observatory Legacy Survey of Space and Time (LSST) will obtain several hundred measurements per object for over **5 million asteroids!**

For details, see LSST overview paper: https://ls.st/lop (Ivezić et al. 2019)



Asteroid sizes are important both for planetary defense and science!

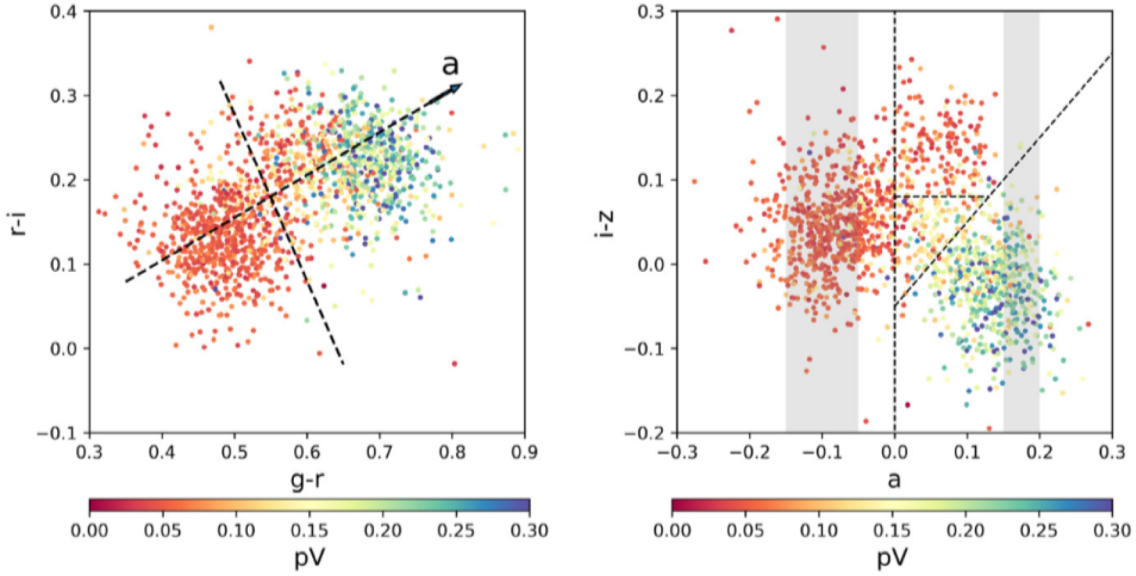
QUESTION: How accurately will asteroid sizes be estimated with LSST data?

OUR ANSWER: Asteroid Sizes with LSST data will have 20-25% accuracy
(almost as good as infrared-flux-based sizes!)

Asteroid Sizes with LSST will have 20-25% accuracy.

How did we find that out?

We used SDSS and WISE data, and LSST simulations, see
Ivezić & Ivezić (2021, Icarus 357, 114262; also arXiv:2007.05600)

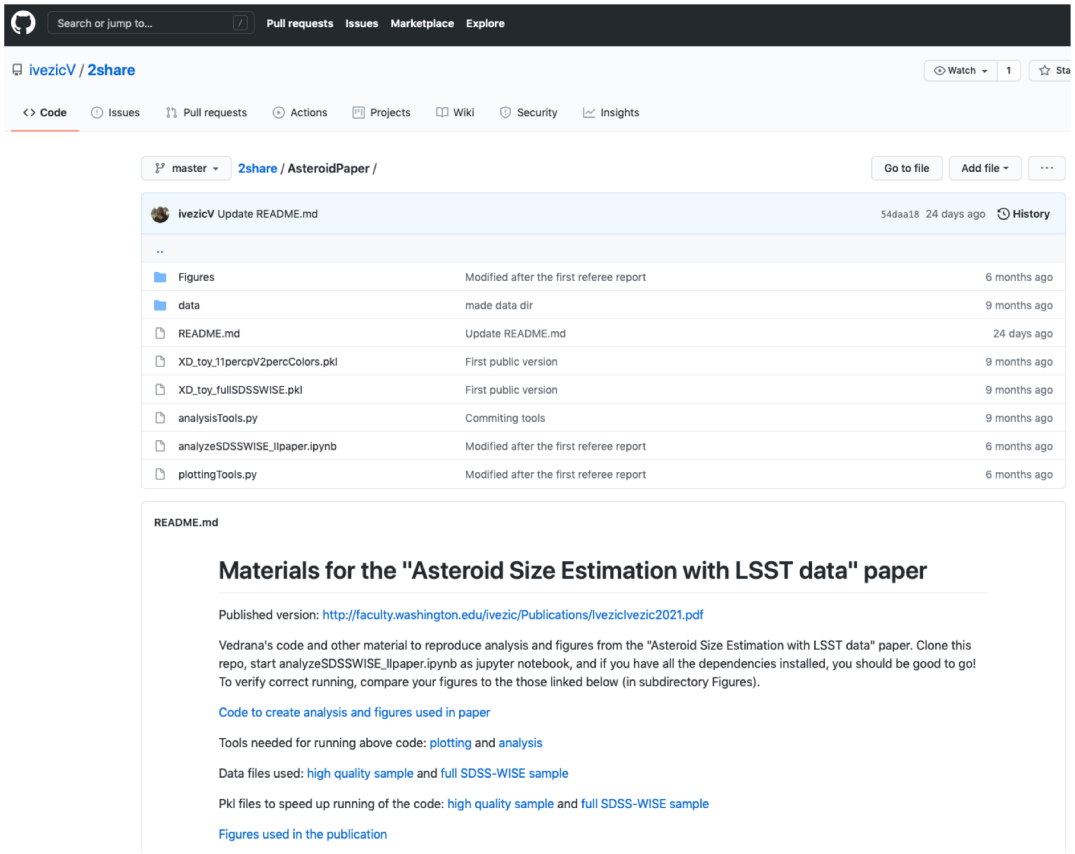


Key point: optical albedo of asteroids is strongly correlated with their colors.

1) measure colors and brightness
2) get albedo from colors, and
3) size from albedo and brightness

Second key point: everything we did, including input data and **python** code for numerical analysis and producing figures is publicly available at GitHub site:

https://github.com/ivezicV/2share/tree/master/AsteroidPaper




```
In [1]: %matplotlib inline
import numpy as np
from astropy.table import Table
from astropy.coordinates import SkyCoord
from astropy import units as u
from astropy.table import hstack
import matplotlib.pyplot as plt
import scipy
from scipy.stats import norm
from sklearn.mixture import GaussianMixture
# for astroML installation see https://www.astroml.org/user_guide/installation.html
from astroML.plotting import hist
from astroML.utils.decorators import pickle_results
from astroML.density_estimation import XDGMM
```

```
In [51]: ## automatically reload any modules read below that might have changed (e.g. plots)
%load_ext autoreload
%autoreload 2
# importing Ved's tools (in the same directory as this notebook):
import plottingTools as vpt
import analysisTools as vat
np.random.seed(0)
```

```
The autoreload extension is already loaded. To reload it, use:
  %reload_ext autoreload
```

Define paths and catalogs

```
In [3]: # you may want to move fig15_data.csv to the same directory as this notebook
dataDir = "data"
# data dump for fig. 15 from the MMI paper (produced by Joachim Moeyens)
SDSSWISEfile = dataDir + "/" + "fig15_data.csv"
```

```
In [4]: # describe data structure
colnames = ['ID', 'mjd', 'mjdMOC', 'u', 'g', 'r', 'i', 'z',
            'Hmag', 'Vsdss', 'pV', 'pVsdss', 'Ratm', 'Rsdss',
            'phaseatm', 'phasesdss', 'logDatm']
```

```
In [5]: dataAll = Table.read(SDSSWISEfile, format='csv', names=colnames)
# we want to add a bit of random noise to magnitudes to avoid aliasing in plots
vat.randomizePhotometry(dataAll, 0.005)
vat.assignColors(dataAll)
np.size(dataAll)
```