

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



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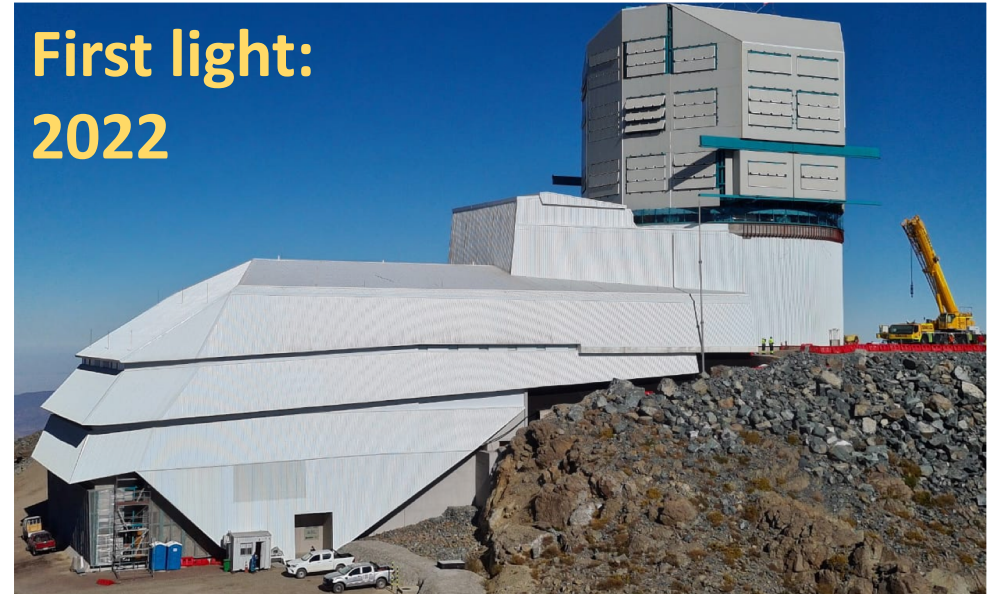


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The Rubin Observatory Legacy Survey of Space and Time (LSST) will obtain several hundred measurements per object for over **5 million asteroids!**

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

Asteroid sizes are important both for planetary defense and science!



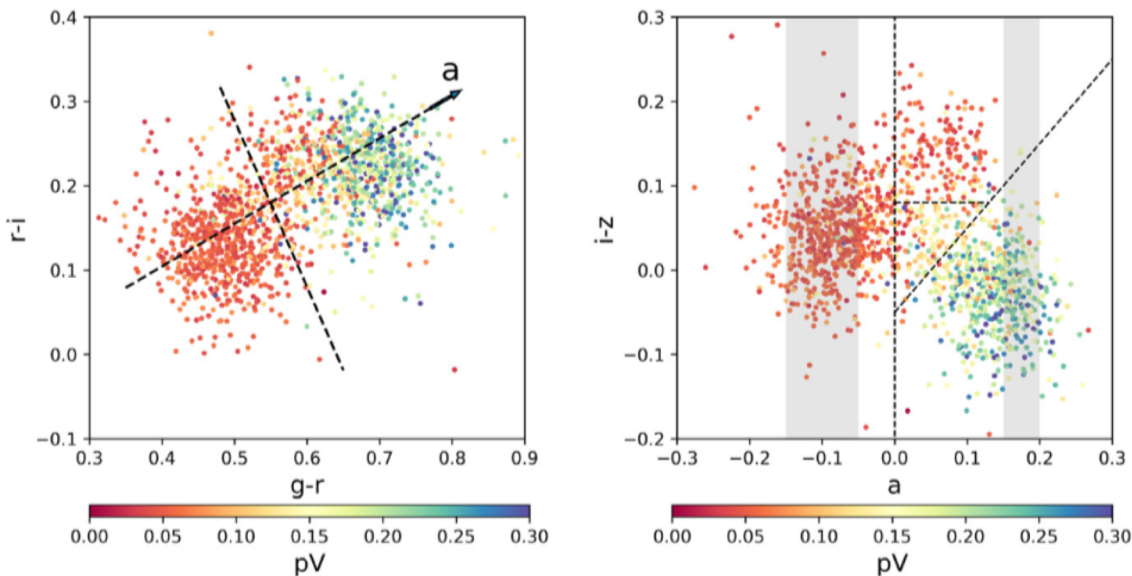
QUESTION: How accurately will asteroid sizes be estimated with LSST data?

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)

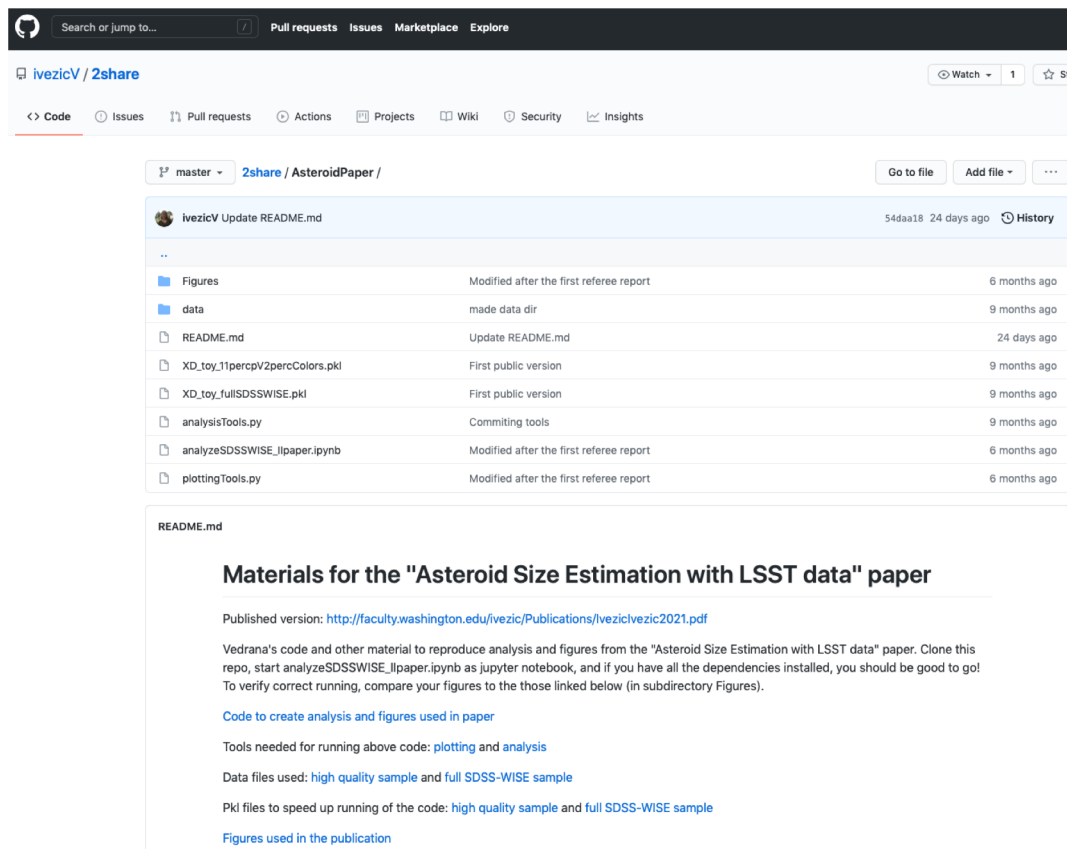


Key point: optical albedo of asteroids is strongly correlated with their colors.

- 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>



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Figures	Modified after the first referee report	6 months ago
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README.md	Update README.md	24 days ago
XD_toy_11percV2percColors.pkl	First public version	9 months ago
XD_toy_fullSDSSWISE.pkl	First public version	9 months ago
analysisTools.py	Committing tools	9 months ago
analyzeSDSSWISE_1lpaper.ipynb	Modified after the first referee report	6 months ago
plottingTools.py	Modified after the first referee report	6 months ago

README.md

Materials for the "Asteroid Size Estimation with LSST data" paper

Published version: <http://faculty.washington.edu/ivezic/Publications/ivezicIvezic2021.pdf>

Vedrana's code and other material to reproduce analysis and figures from the "Asteroid Size Estimation with LSST data" paper. Clone this repo, start analyzeSDSSWISE_1lpaper.ipynb as jupyter notebook, and if you have all the dependencies installed, you should be good to go! To verify correct running, compare your figures to the those linked below (in subdirectory Figures).

[Code to create analysis and figures used in paper](#)

Tools needed for running above code: [plotting](#) and [analysis](#)

Data files used: [high quality sample](#) and [full SDSS-WISE sample](#)

Pkl files to speed up running of the code: [high quality sample](#) and [full SDSS-WISE sample](#)

[Figures used in the publication](#)

```
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)
```