7th IAA Planetry Defence Conference

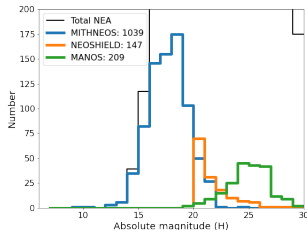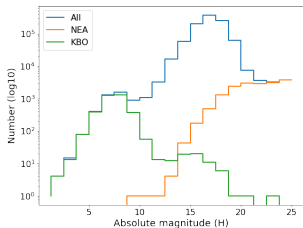# Photometry of Near-Earth asteroids in the Sloan Digital Sky Survey

Alexey Sergeyev and Benoit Carry

Observatory de Cote d'Asur

April 17, 2021

Motivation

Asteroids distribution by size:

Dynamical class	Number[*]
Near-Earth	23,424
Mars-Crosser	19,339
Main Belt	919,004
Kuiper Belt	3,536
Total	995,628

[*]The Asteroid Orbital Elements Database

Known NEOs Taxonomy:

Campaign	Number
MANOS[1]	210
NEOSHIELD2[2]	147
MITHNEOS[3]	1,039
Total	1,380

[1]Devogèle et al.(2019)
[2]Perna et al.(2018)
[3]Binzel et al.(2019)

OBSERVATOIRE
DE LA CÔTE D'AZUR
UNIVERSITÉ CÔTE D'AZUR

NEO ROCKS

Why the SDSS?

Sky coverage of the SDSS

- 14,555 deg^2 coverage area (1998-2008).
- 95% completeness sources in u,g,r,i,z filters up to 22.2 mag.
- Archive of the sources catalog and fits frames.
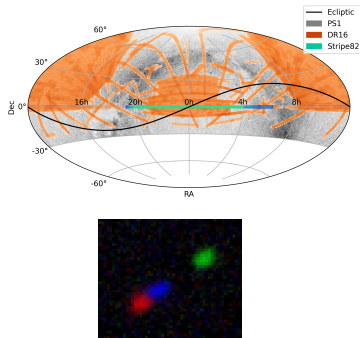- Quasi-synchronous multi-band observations.

Figure: g(green), r(red), i(blue) image of the asteroid 1990 SP

A new SDSS catalog of Solar System Objects

- The **previous** Moving Object Catalog MOC4 (Ivezic+2002)
  - 471,569 moving objects
  - 220,101 linked with asteroids
  - 104,449 unique asteroids
  - < 300 Near Earth asteroids

  Contains only **HALF** of available SDSS RUNs!

- The **new** SSOs SDSS catalog (Sergeyev and Carry 2021 submitted)
  - Repeated Ivezic query on all RUNs without fast moving rate limit
  - Query SkyBoT for known SSOs.
 - Extensive cross-match with PanSTARRS & Gaia

- The **new** Moving Object Catalog
  - 1,533,759 real moving objects!
  - 1,032,357 observations of
  - 380,753 known SSOs!

Dyn. class	$\#_{\text{SSOs}}$	$\#_{\text{obs}}$
Near-Earth	**1,652**	**2,874**
Mars-Crosser	4,242	9,024
Hungaria	6,362	12,841
Main Belt	363,188	994,812
Trojan	3,929	8,721
Centaur	123	522
KBO	1,024	3,143
Comet	233	420

OBSERVATOIRE
DE LA CÔTE D'AZUR
UNIVERSITÉ CÔTE D'AZUR
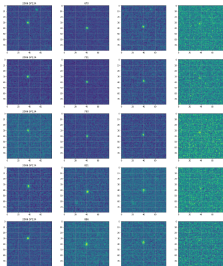
NEO ROCKS

Advanced photometry

A new photometry for NEAs:

- Fast-moving object from a couple of stationary SDSS sources.
- Recalculation zero-points from the reference stars.
- Photometry by elliptical apertures.
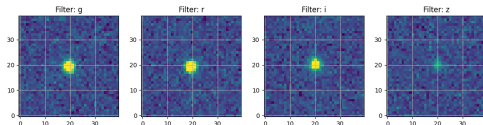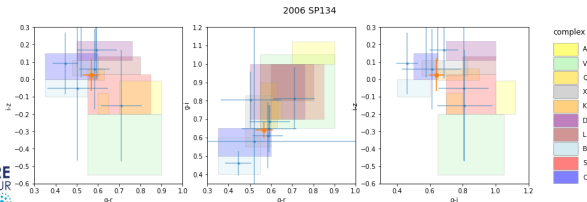- Summarizing asteroid images for better S/N ratio.
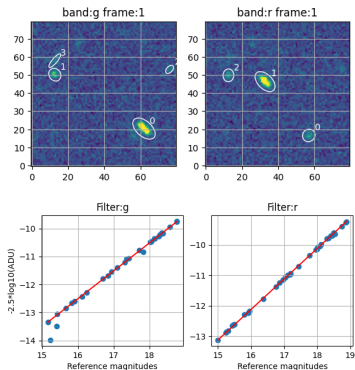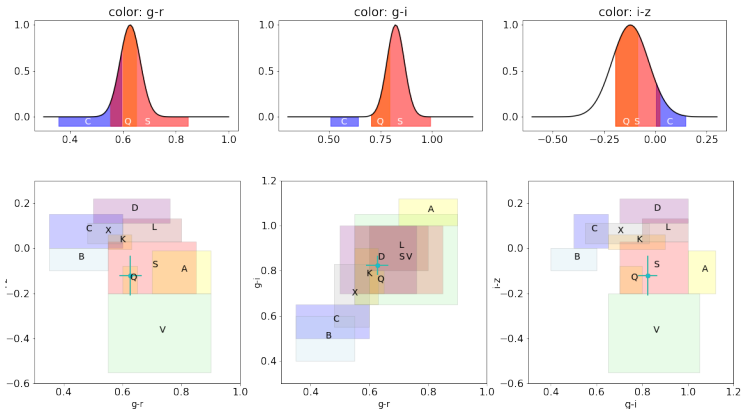
Advanced photometry

Images of the asteroid

Merged image of the asteroid 2006 SP134

Color diagrams of the individual frames and summarised image:
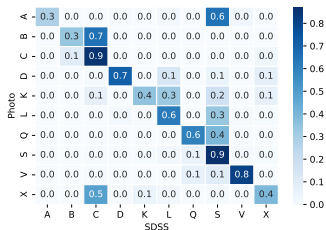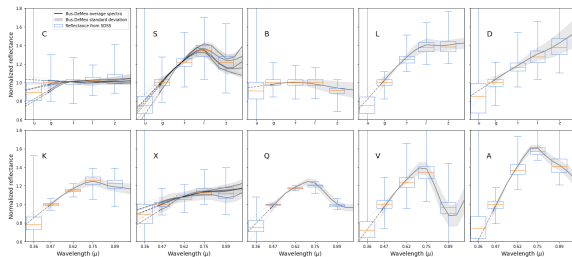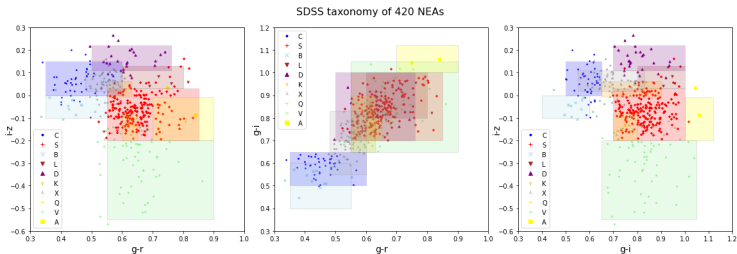
Taxonomy method

Taxonomy accuracy

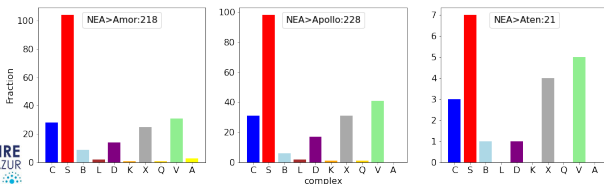Confusion matrix of the new SSOs SDSS taxonomy catalog versus published data:

Pseudo reflectance spectra of asteroids observed by SDSS, grouped by taxonomic class:
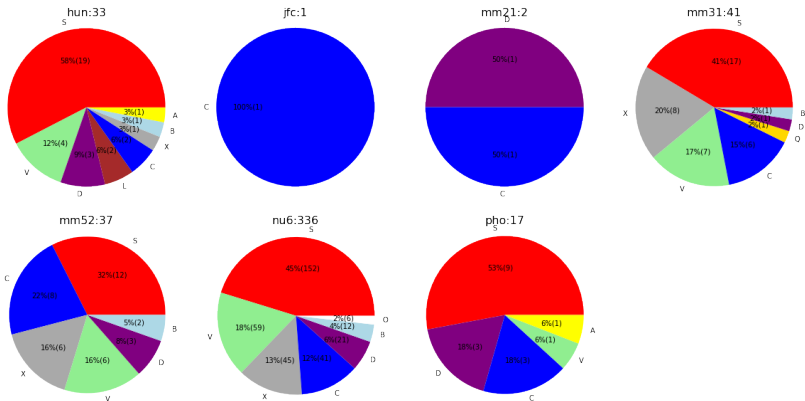
Results of NEA taxonomy

SDSS taxonomy of 420 NEAs

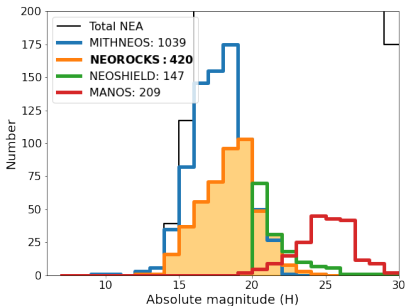Taxonomy distribution of NEAs by dynamical classes

Taxonomy distribution of the probably NEA region sources[*]:

[*]Based on the Granvik M., Morbidelli A., Jedicke R., et al., 2018, Icar, 312, 181

Conclusion

- New extraction of asteroids in the SDSS:
  - 1M observations of 300,000 asteroids
  - 1,600 NEAs + 4,200 Mars-Crossers
- Taxonomy of 420 NEAs
  - With an associated probability
  - Account for uncertainties
  - Taxonomy distribution
  - Source regions

- Future plans: Data mining in other sky surveys?
  SkyMapper, PanSTARRs, DES, LSST, Euclid, etc.

OBSERVATOIRE
DE LA CÔTE D'AZUR
UNIVERSITÉ CÔTE D'AZUR

NEO ROCKS