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# Application of NoiseChisel to detecting faint small-body activity with the LSST

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# Characterization of faint small body activity

LSST will bring a massive increase in number of known objects

- **What drives activity?**
- **What is the distribution of volatiles in the Solar System?**



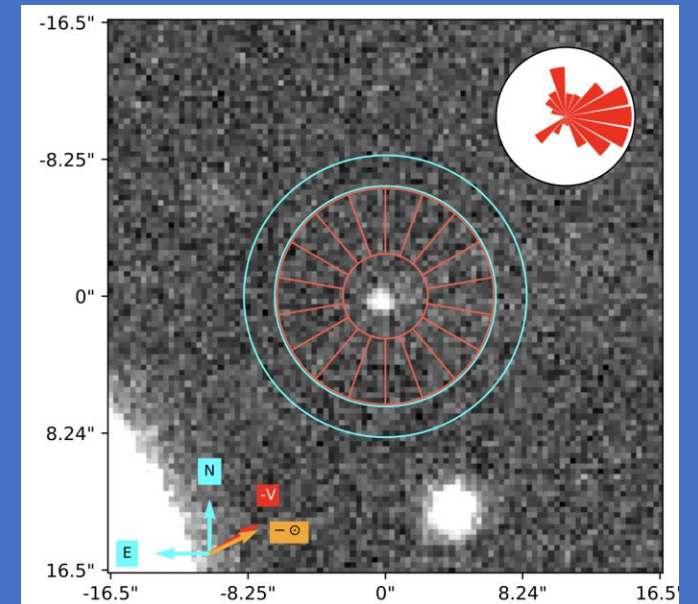
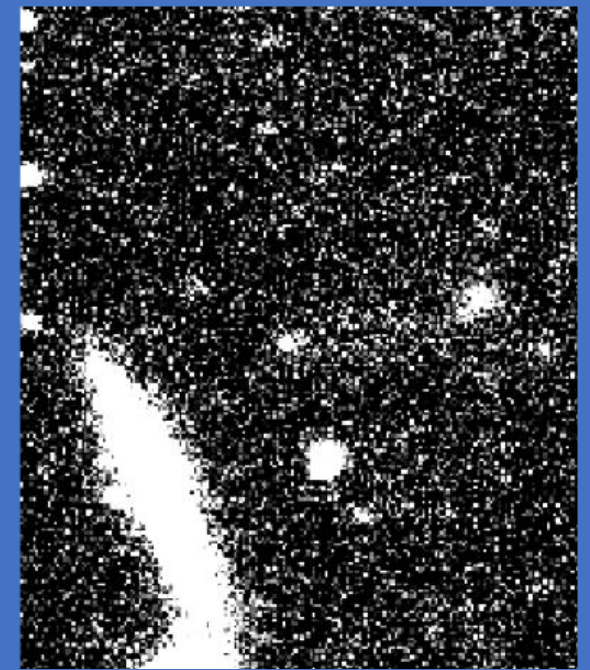
Problem:

- Early detection of activity in survey images
- Single/very few images
- Little known, faint objects

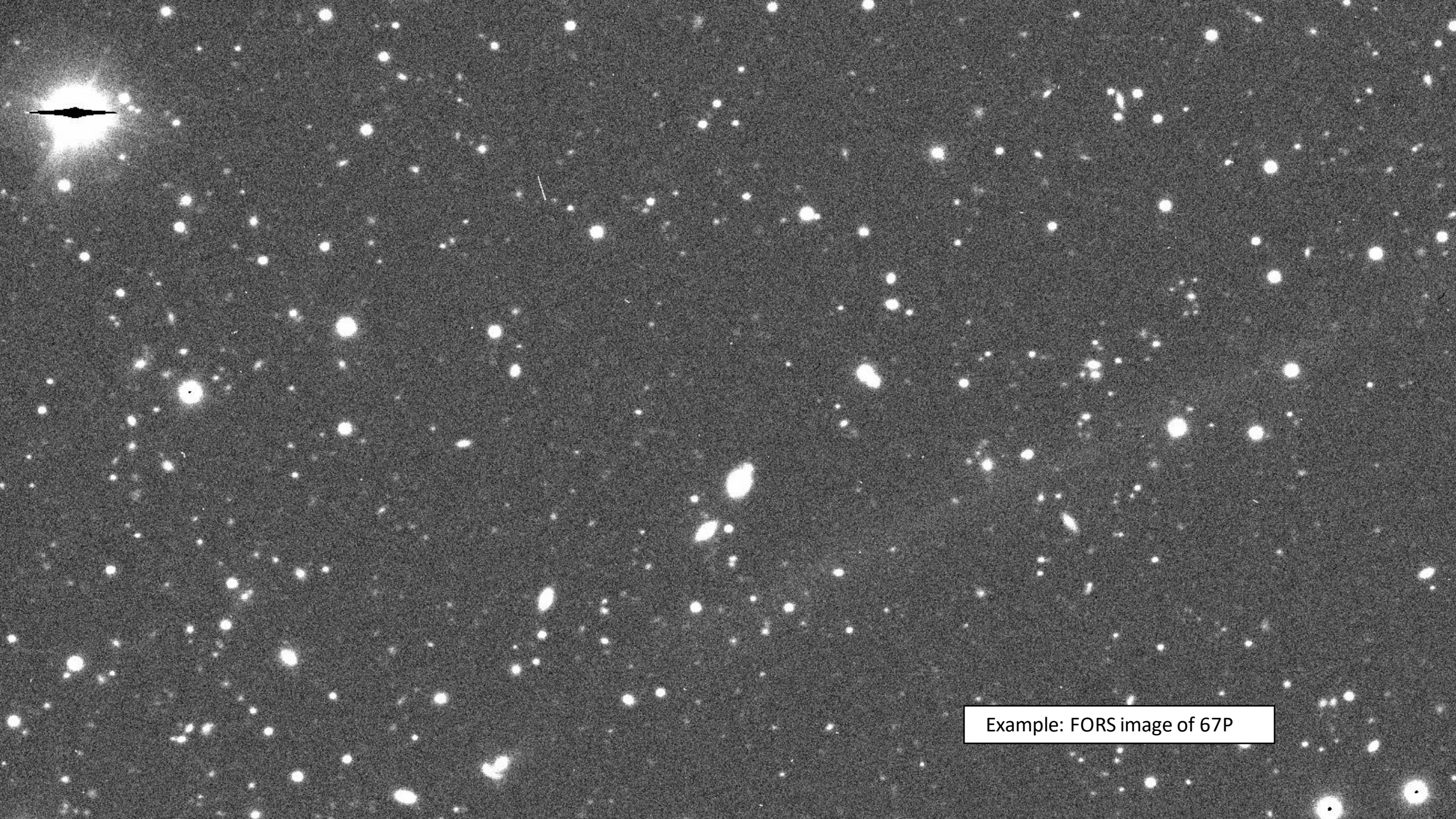
# Possible solutions

- **Visual inspection** (not practical)
- **PSF width comparison** (basic would be in alert stream)
- **Multi-azimuth photometry** (for asymmetric activity)  
based on *Sonnett et al. 2011* – work done by Léa Ferellec to apply to INT WFC
- **NoiseChisel** (How well will it work on difference images?)  
*Akhlaghi & Ichikawa 2015, Akhlagi 2019*

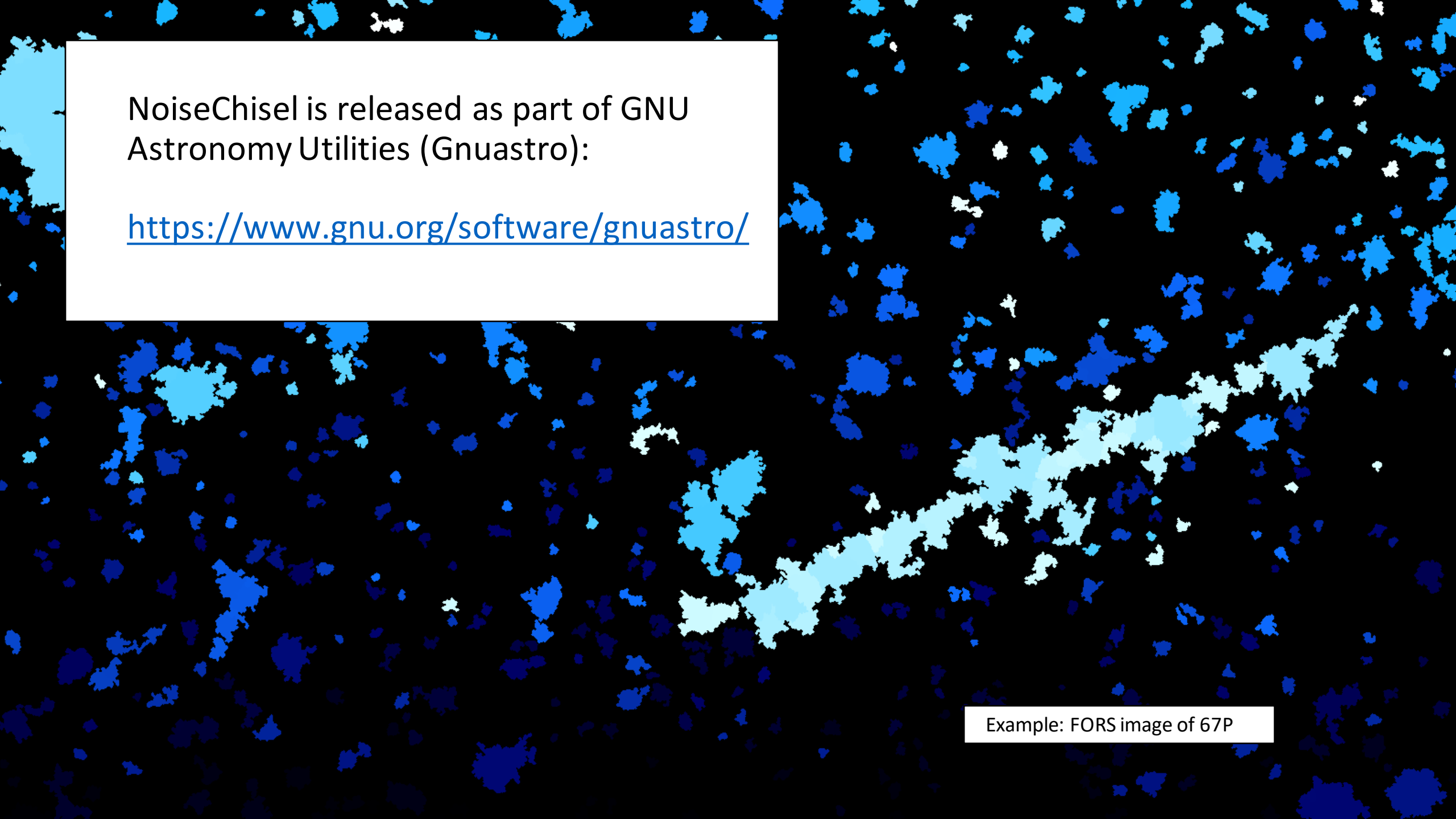
H. Hsieh et al. 2019 (<https://arxiv.org/abs/1906.11346>)



Wednesday, 5pm, SolarSystem1



Example: FORS image of 67P



NoiseChisel is released as part of GNU  
Astronomy Utilities (Gnuastro):

<https://www.gnu.org/software/gnuastro/>

Example: FORS image of 67P

# Asteroid Terrestrial-impact Last Alert System

- Tests on a sample of ATLAS difference images
- 1417 Images when the asteroid 4985 was  $<19.5$  mag
- 572 images when the comet 73P was  $<3$ au from the Sun

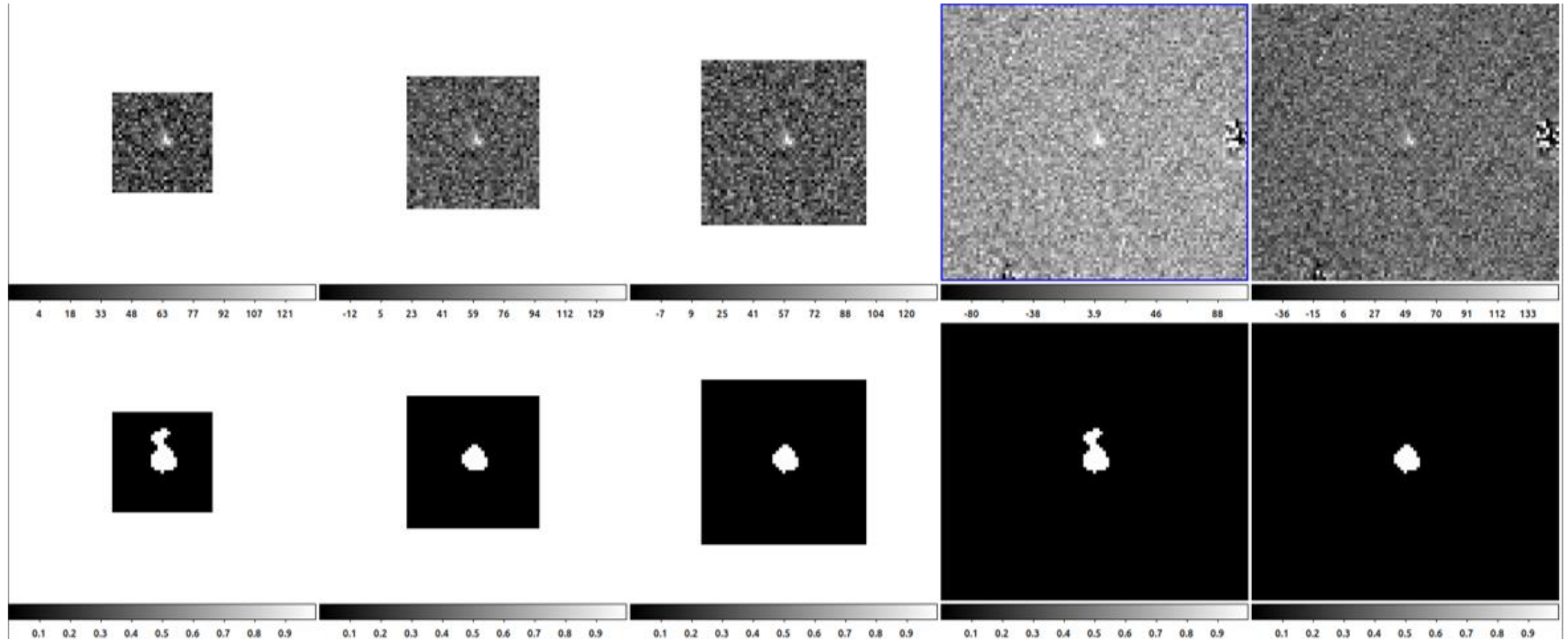


Crop size	NoiseChiseled	catalogued
151	569	524
101	569	509
51	568	493
41	530	454
31	398	337

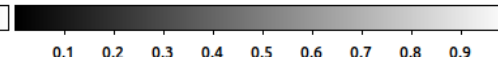
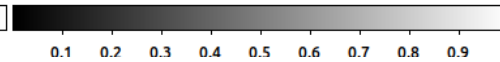
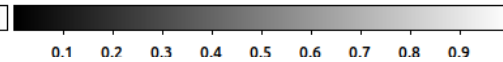
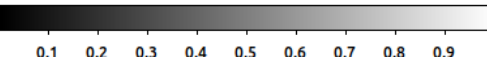
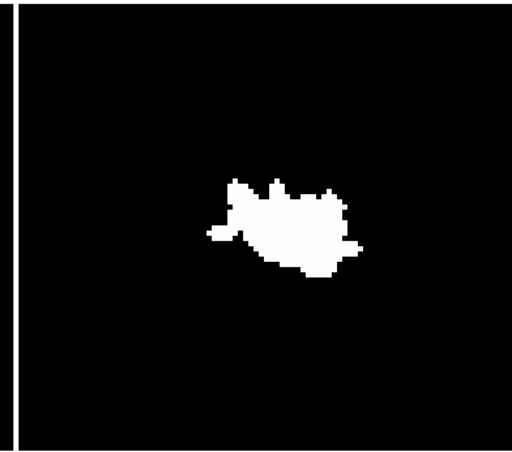
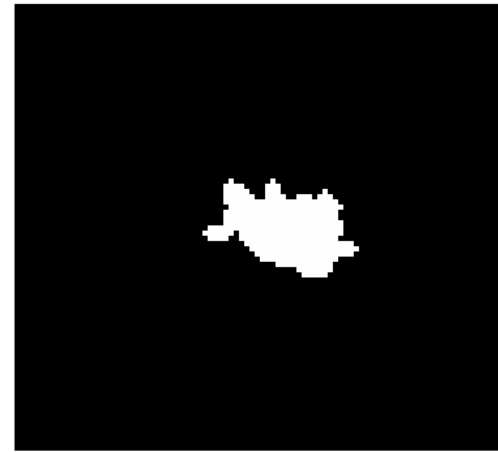
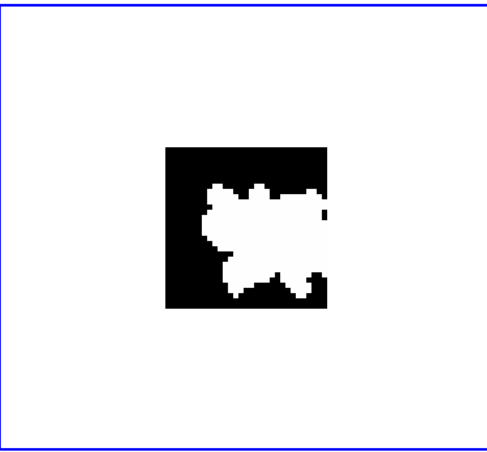
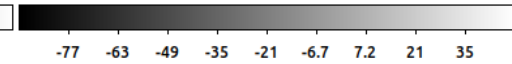
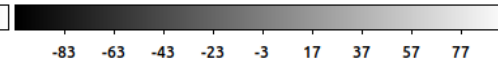
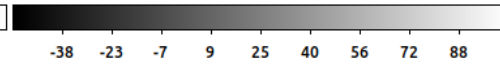
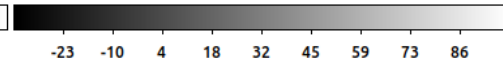
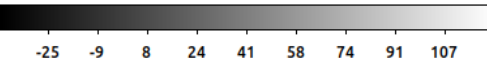
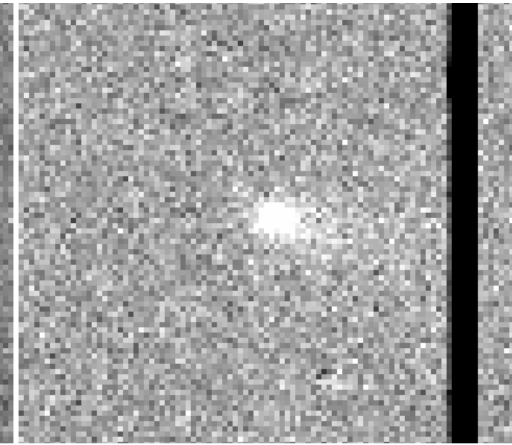
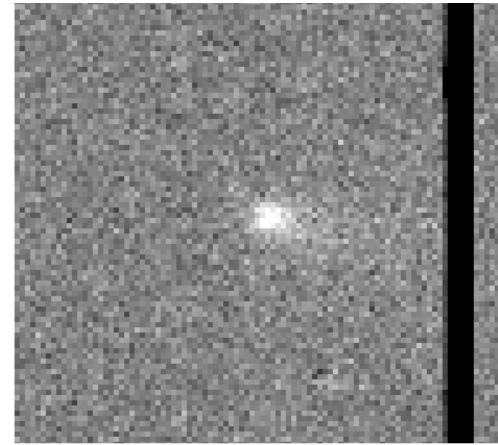
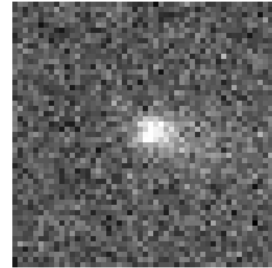
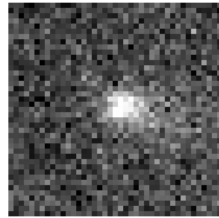
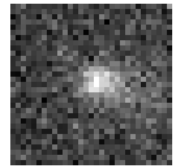
Crop size	NoiseChiseled	catalogued
151	1415	1122
101	1412	962
51	1408	907
41	1363	845
31	1125	669

**How small can the cutouts be?** Cutouts in alert stream no smaller than 30px, average likely around 45 px ([https://github.com/lstt-dm/sample\\_alert\\_info](https://github.com/lstt-dm/sample_alert_info))

# Example: asteroid detection



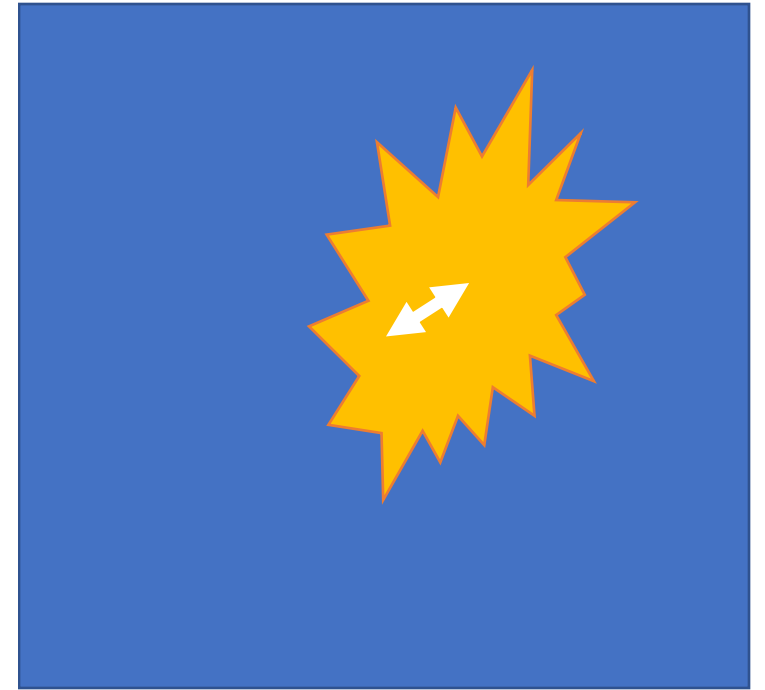
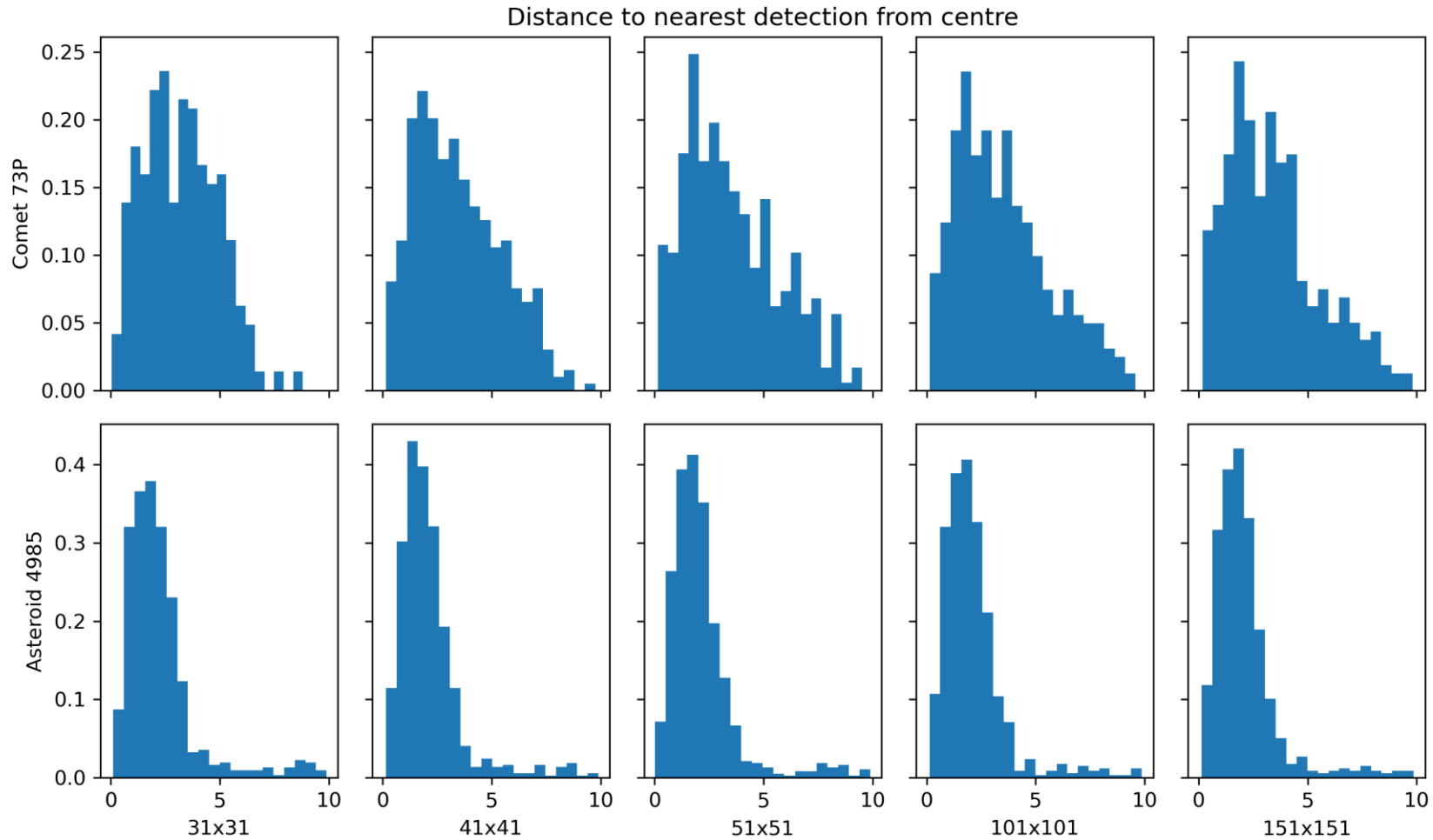
# Example: comet detection



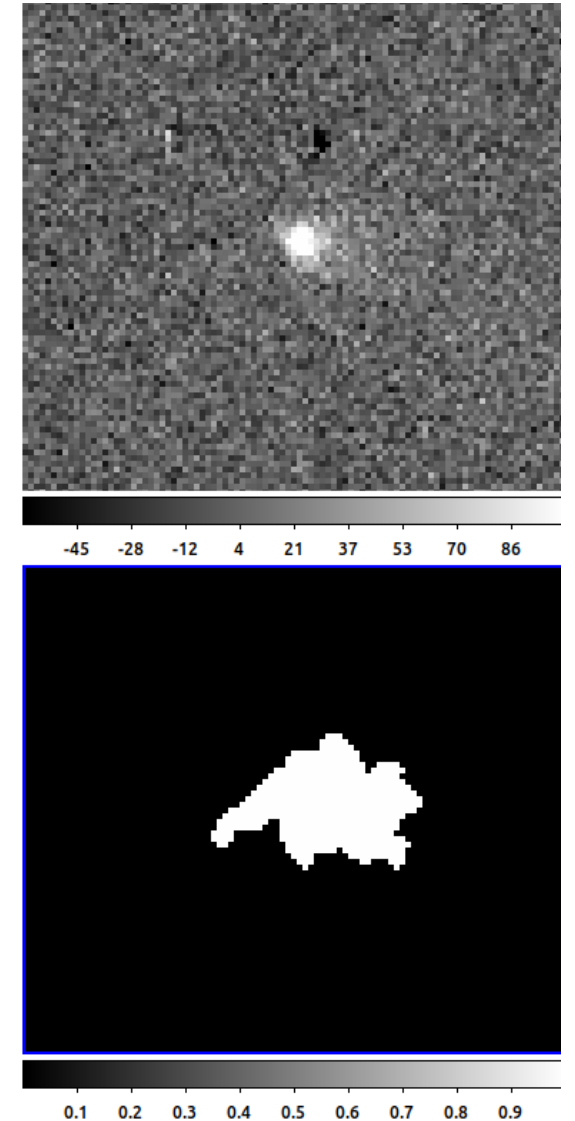
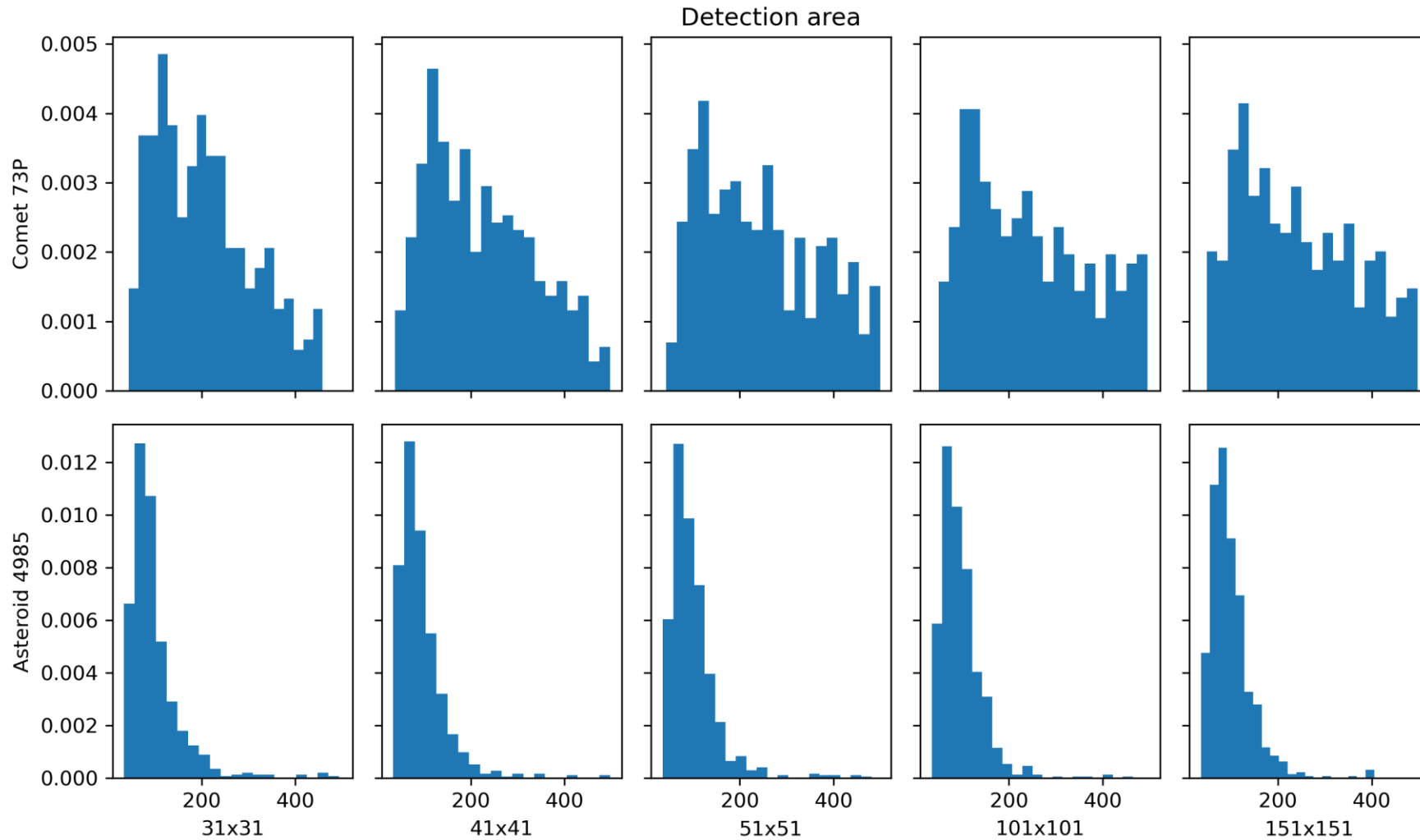




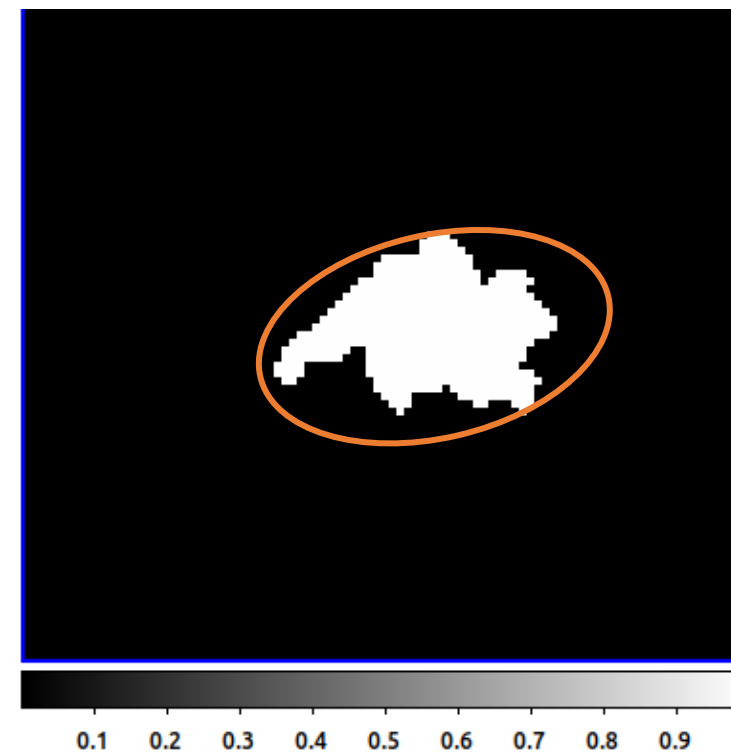
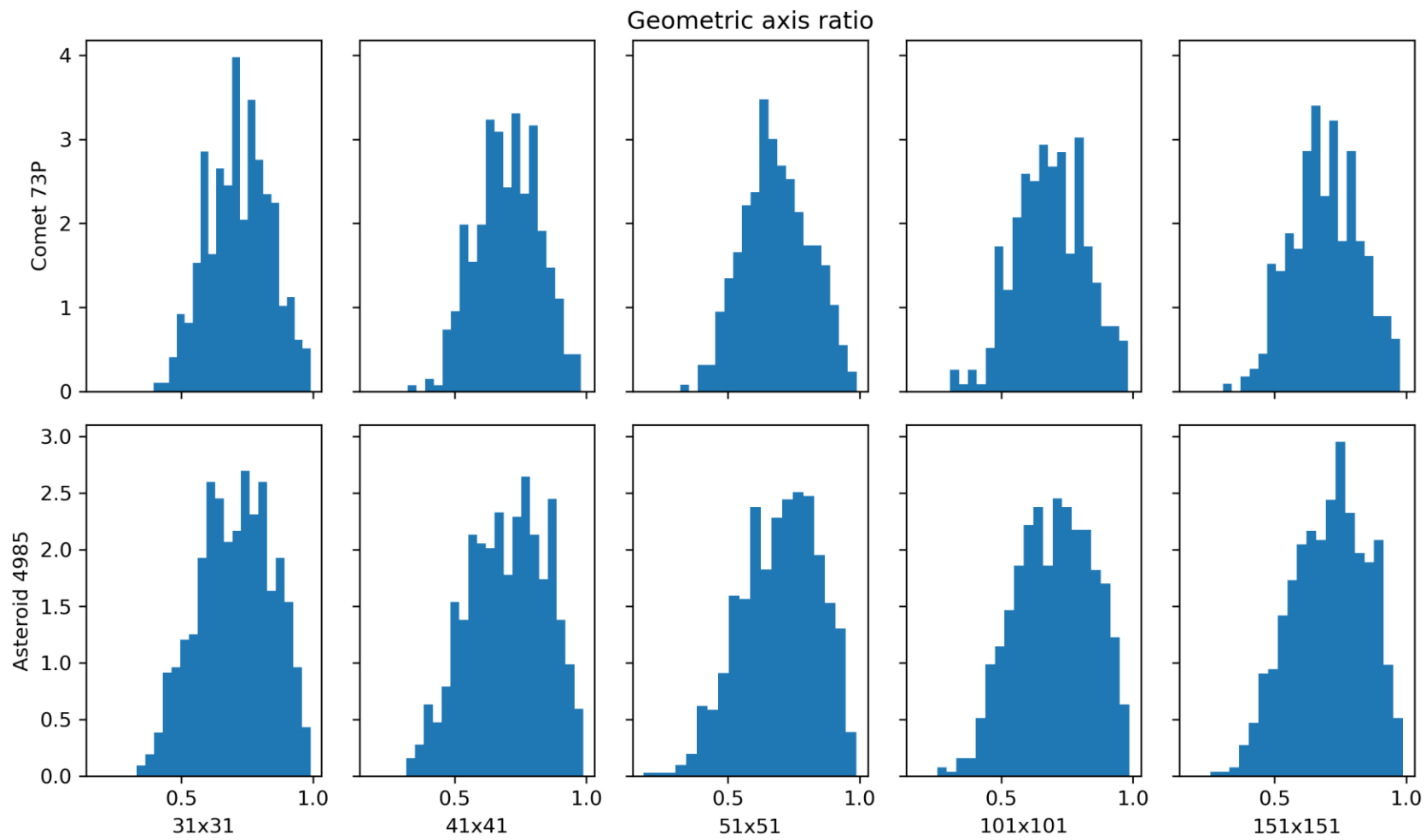
# How far are detections from cutout centre?



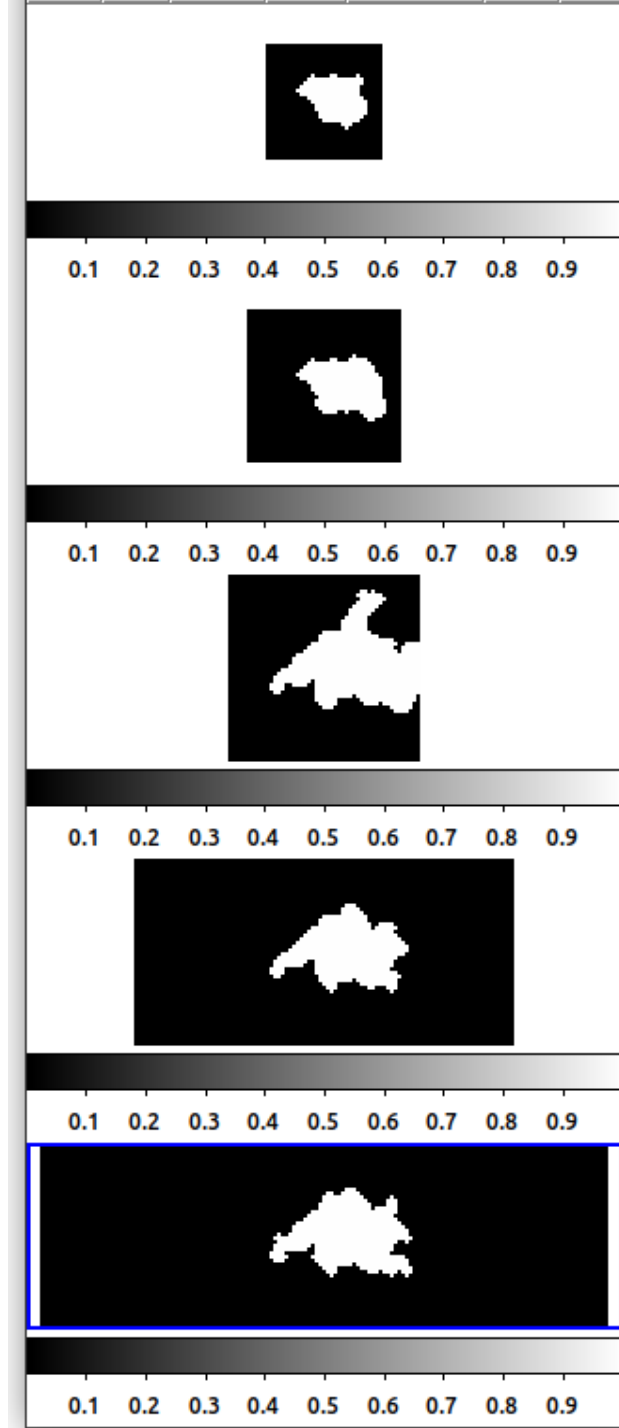
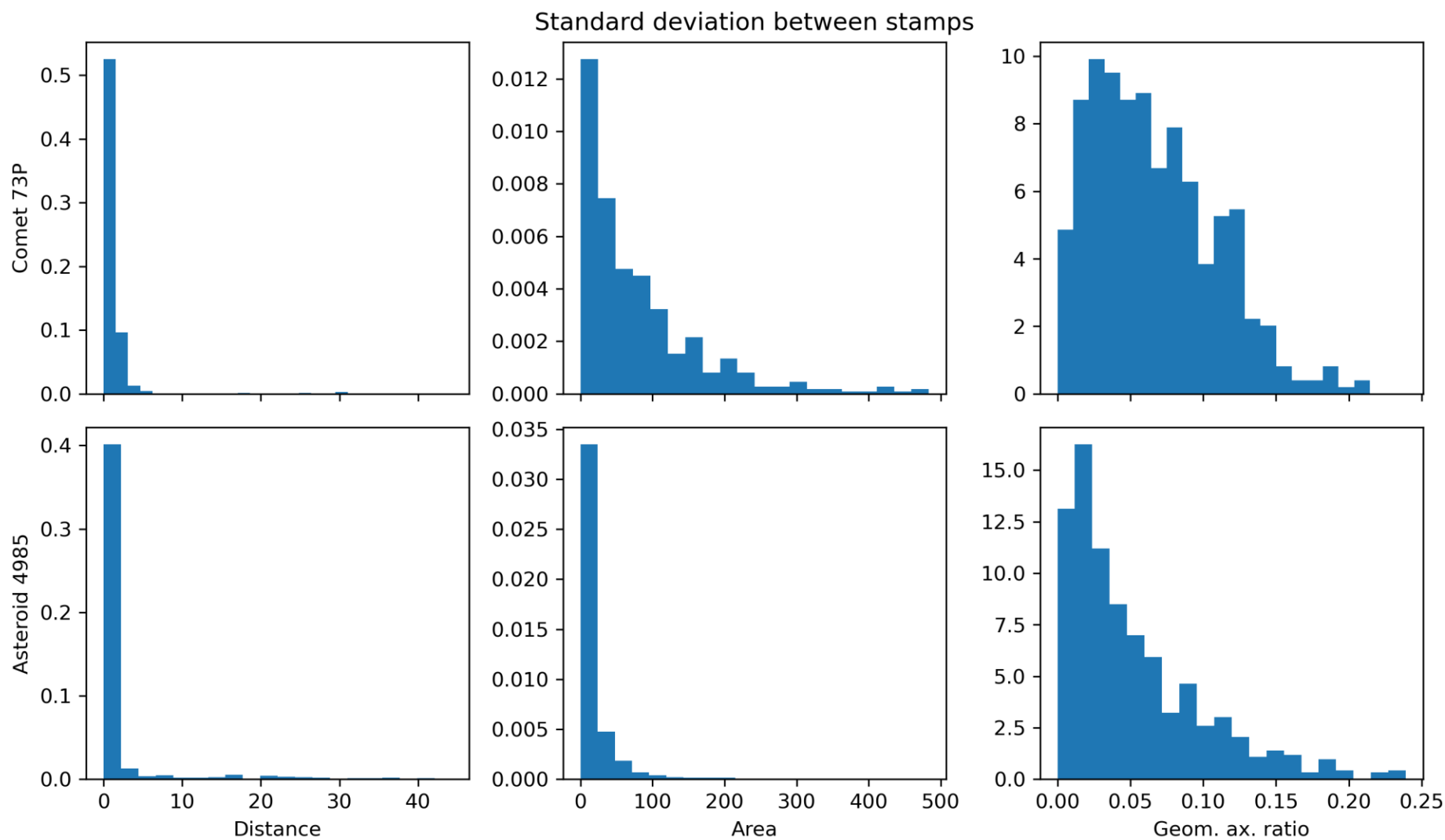
# Area of the detection



# Geometric axial ratio



# Consistency between stamps



# Summary

- Noise Chisel consistently detects even very faint sources
- 51pix likely preferred stamp size
- The test data set needs cleaning (possible issues include target being close to the image edge, artefacts, and cosmic rays)
- Object area appears to be better activity indicator than axial ratio

