

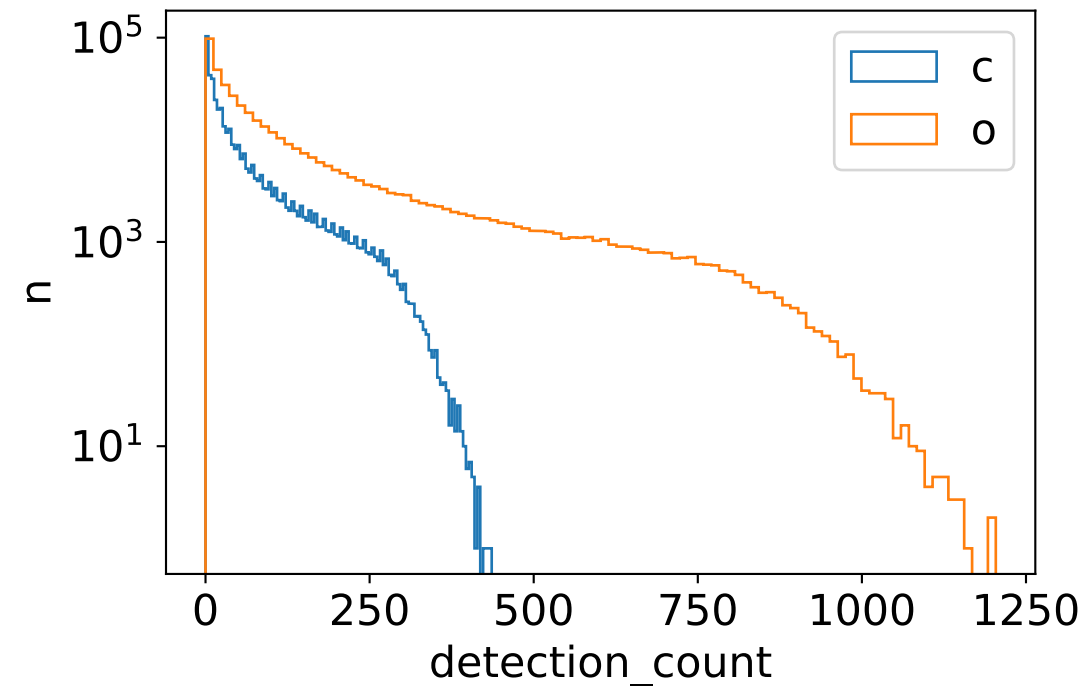
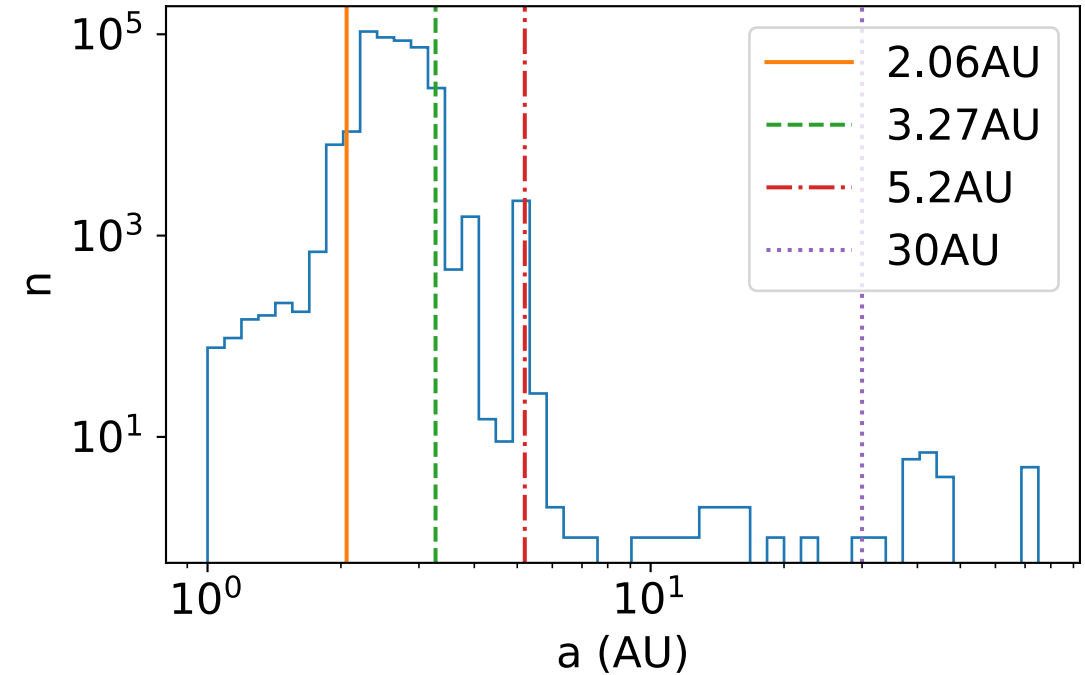
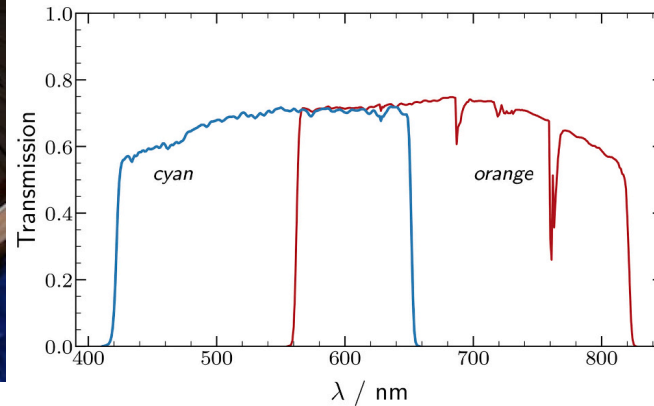
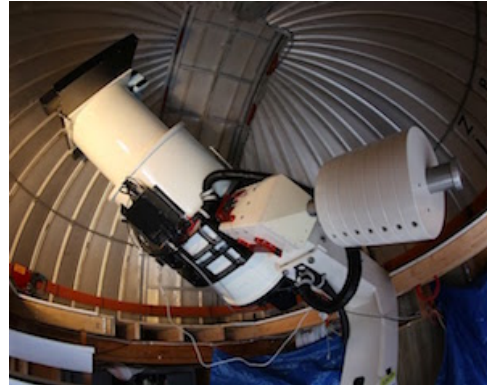
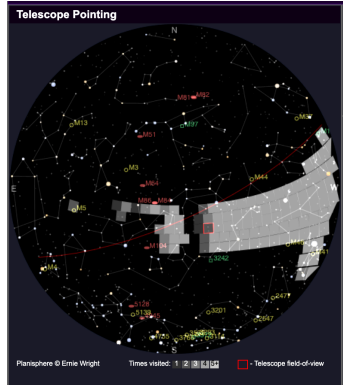
Asteroid Phase Curves with ATLAS, a Precursor to LSST

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LSST:UK All Hands Meeting
12/05/21

ATLAS

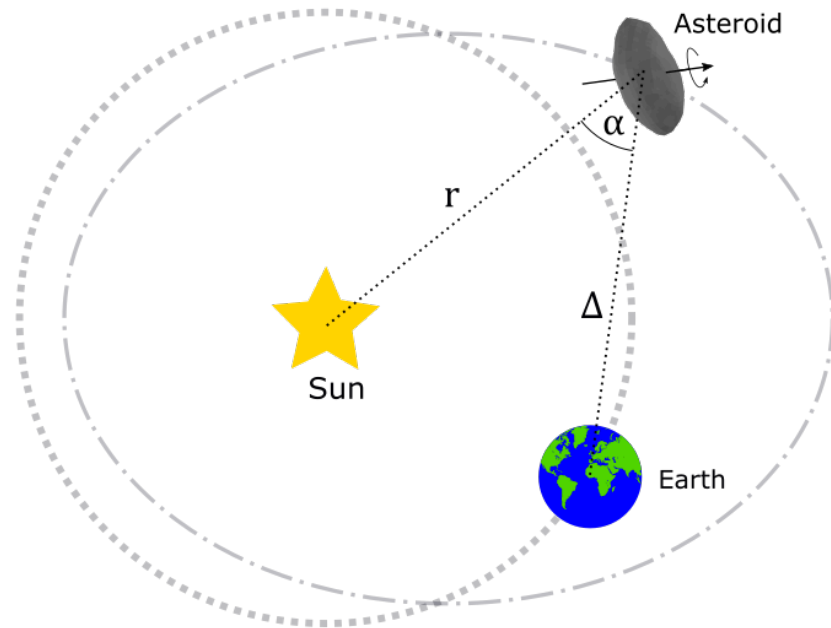


<https://atlas.fallingstar.com/>

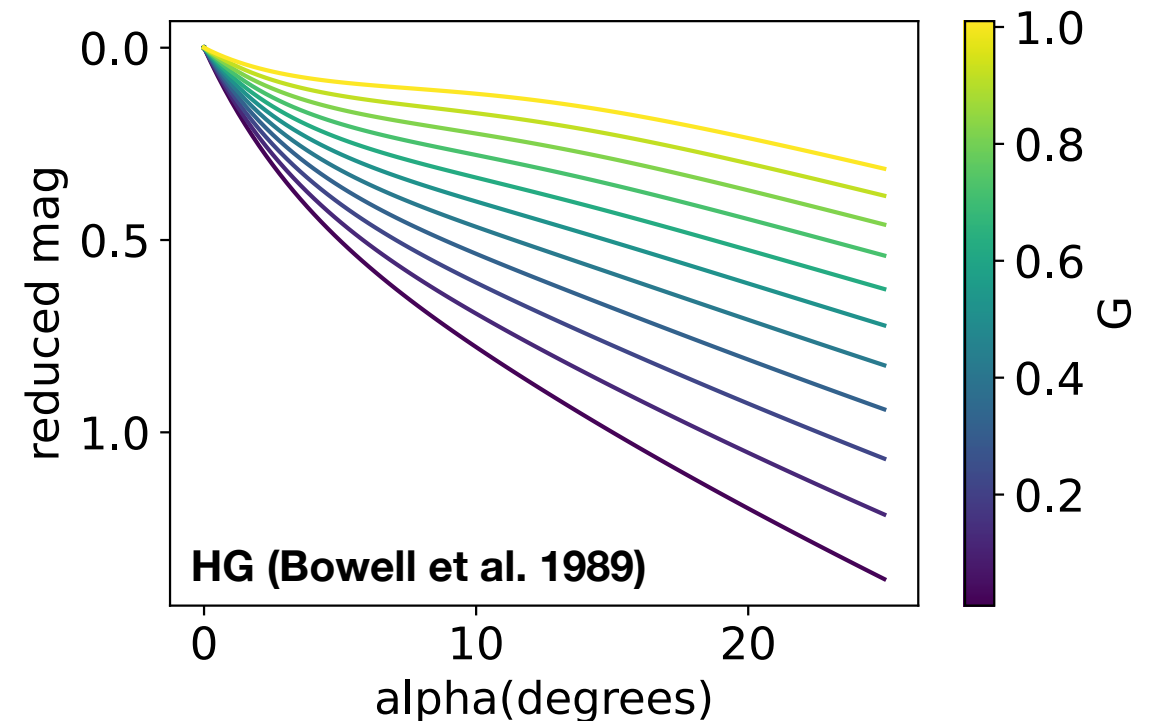
Mahlke et al. 2021

- Asteroid Terrestrial-impact Last Alert System (ATLAS) - two 0.5m telescopes in Hawaii
- Scans the visible night sky ever two nights, searching for hazardous NEOs
- Many transients are detected - supernovae and main belt asteroids

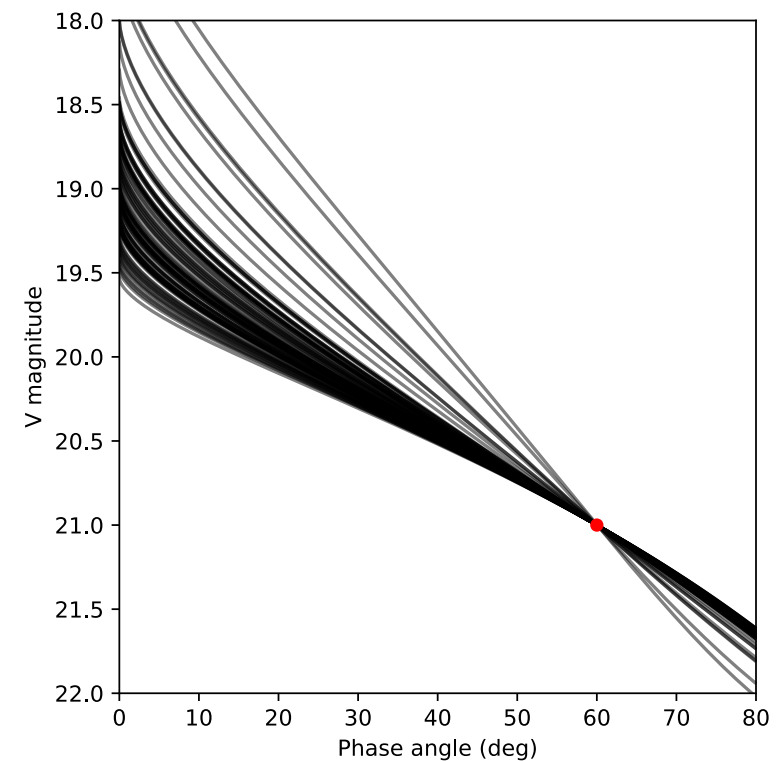
Asteroid Phase Curves



Samuel Jackson www.open.edu

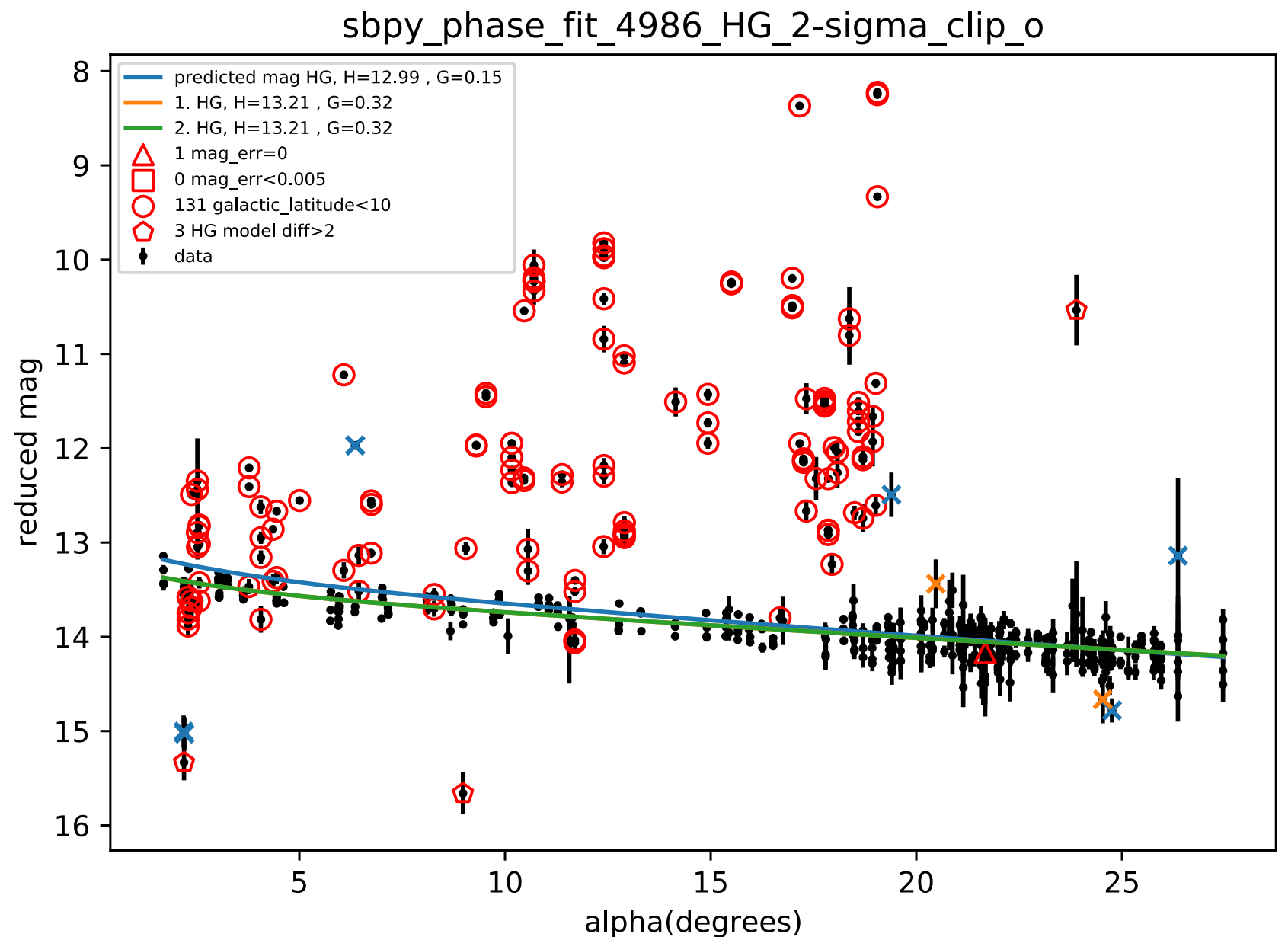


- Small bodies are compositional/dynamical tracers of Solar System Evolution
- Asteroid brightness changes with phase angle - phase curve models
- Phase curves give absolute magnitude H (~size) and G slope parameters (surface composition/structure)

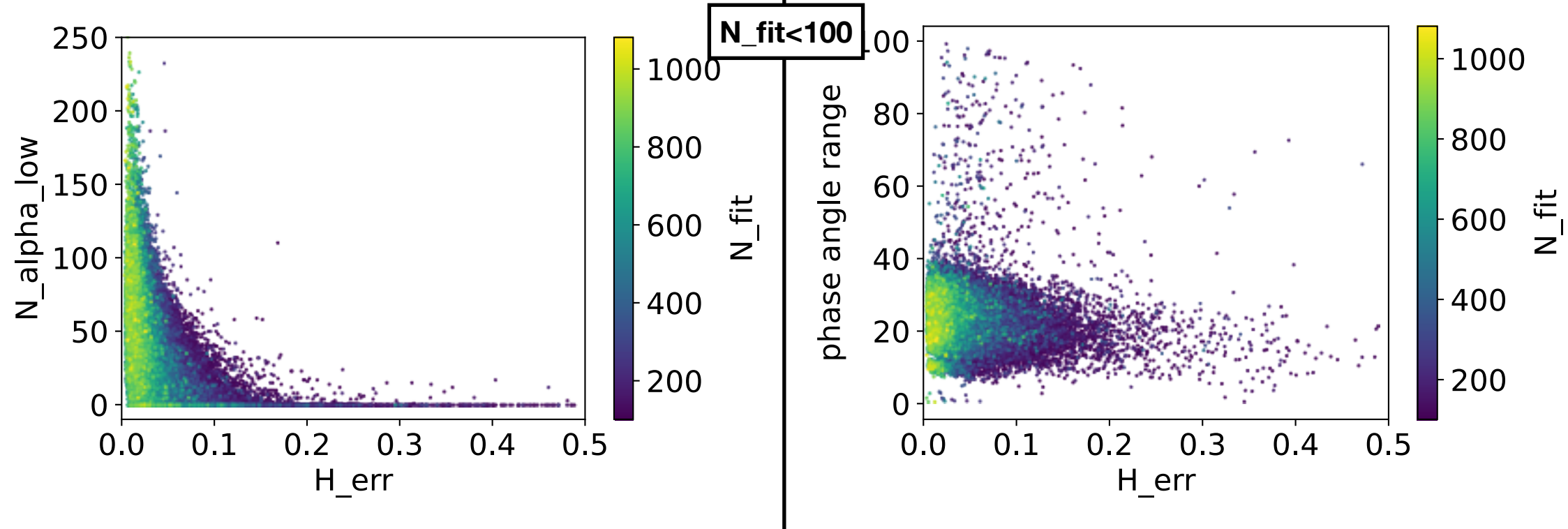
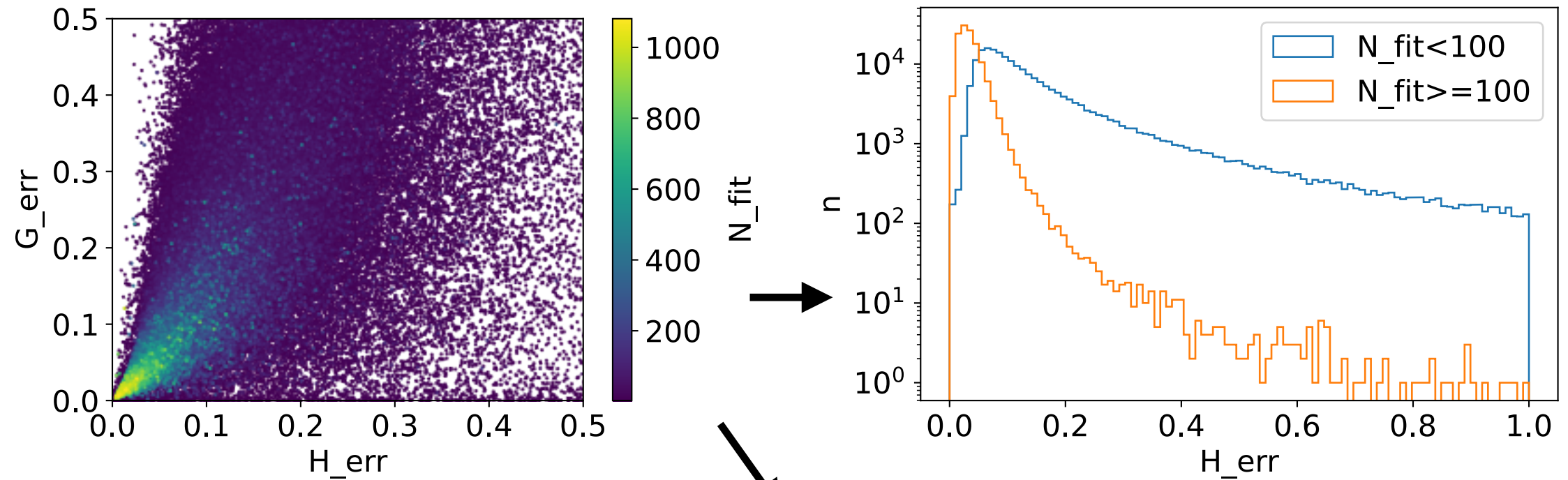


Phase Curve Fitting

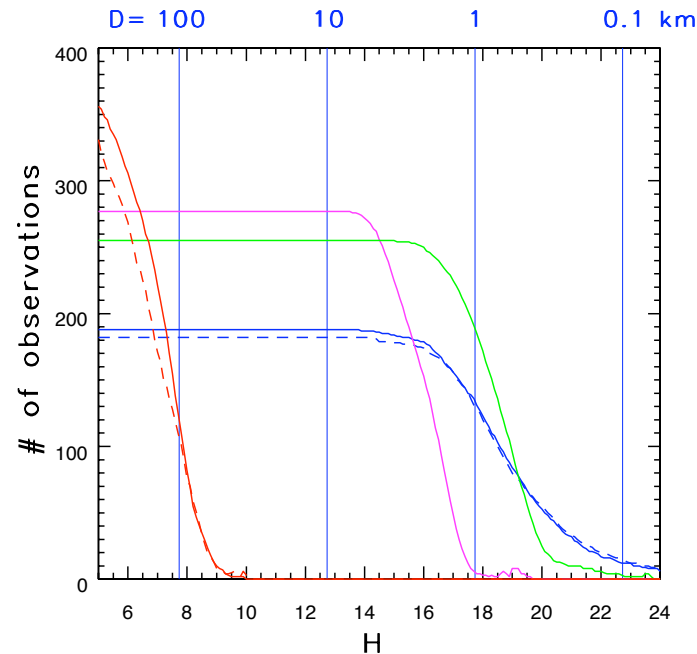
- Initial data cuts
- Iterative fit and clip (no parameter constraints unlike Mahlke et al. 2021)
- HG (Bowell et al. 1989)
- H,G1,G2 (Muinonen et al. 2010)
- H,G12 (Muinonen et al. 2010)
- H,G12 (Pentilla et al. 2016)



HG o filter Results



The future... (LSST)



Ch.5, The LSST Science Book

Table 1. Summary of small body populations observed with LSST

Population	Currently known ¹	LSST discoveries ²	Num. of observations ³	Arc length (years) ³
Near Earth Objects (NEOs)	12,832	100,000	($H \leq 20$) 90	7.0
Main Belt Asteroids (MBAs)	636,499	5,500,000	($H \leq 19$) 200	8.5
Jupiter Trojans	6,387	280,000	($H \leq 16$) 300	8.7
TransNeptunian and Scattered Disk Objects (TNOs and SDOs)	1,921	40,000	($H \leq 6$) 450	8.5

Notes:

¹ As reported by the MPC (May 2015). ² Expected at the end of LSST's ten years of operations. ³ Median number of observations and observational arc length for the brightest objects near 100% completeness (as indicated).

Lynne Jones et al. 2015

- in 2014 - 2018 MPC obtained $\sim 2e7$ obs/yr, $5e6$ from ATLAS in 2017 *
- LSST: 90% Wide-Fast-Deep, $18\,000\text{ deg}^2$, ~ 800 visits/field
- "In total, the LSST will obtain approximately 1.8 billion observations of 5.5 million objects over 10 years" (Lynne Jones et al 2020)

* https://minorplanetcenter.net/mpc/obs_stats_2014_2018

Phase curves with LSST

- Decent ATLAS phase curves for $N_{\text{fit}} > 100$
- LSST should have comparable cadence of observations:
 - ATLAS - 4 detection tracklet per visit every 2 nights
 - LSST - 2 (x2) detection tracklet per visit every few days
- LSST "objects with more than 100 observations are 1,400 NEAs, 1.6 million MBAs, 80,000 Jovian Trojans, and 11,000 TNOs" (The LSST Science Book)
- Phase angle coverage is key
- LSST will go faint, 16-24.5 mag in the r-band, accessing small bodies that are currently not well defined