Optimization of the MISHAPS Data Pipeline

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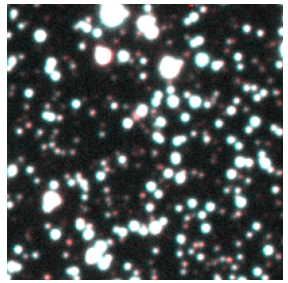
Abstract
The Multi-band Imaging Survey for High-Alpha PlanetS (MISHAPS) is a transiting planet survey of the Galactic bulge performed with DECam. MISHAPS will measure the occurrence rate of hot Jupiters in order to determine the effects of alpha element abundances on hot Jupiter formation. I will present our work to optimize the MISHAPS data processing pipeline by implementing the Trend Filtering Algorithm to remove systematic effects and discuss ongoing work to optimize the difference imaging parameters.

Intro
- The formation mechanisms of hot Jupiters are still debated, but can be categorized into two groups: *in situ* formation vs. migration
- The effects of high α-element abundances on planet occurrence rates have not been well-studied and could potentially point towards one of the mechanisms

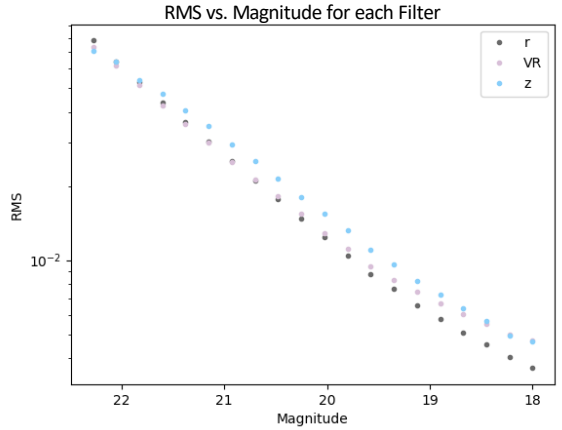
The Survey
- MISHAPS – Multiband Imaging Search for High-Alpha PlanetS
- Surveying the Galactic Bulge

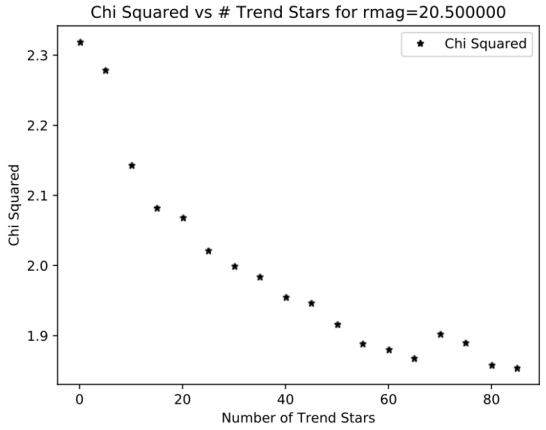
Survey Details	
Instrument	DECam, CTIO 4-m
Filters	r, VR, z
Exposure Times	150s
Nights	38 over 3 years
Expected Observations	~100 hot Jupiters
False Positive Rejection	~90%



Methods
- ISIS Difference Imaging Photometry
- Trend Filtering Algorithm

Results

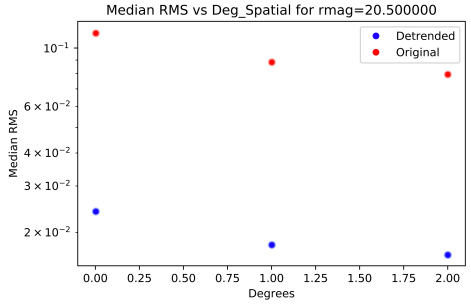


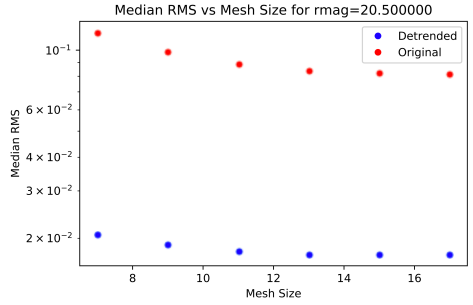


Top: Binned RMS after detrending for each filter. From this we determine that, though VR is a wider filter, r is a better choice because it has lower systematics.

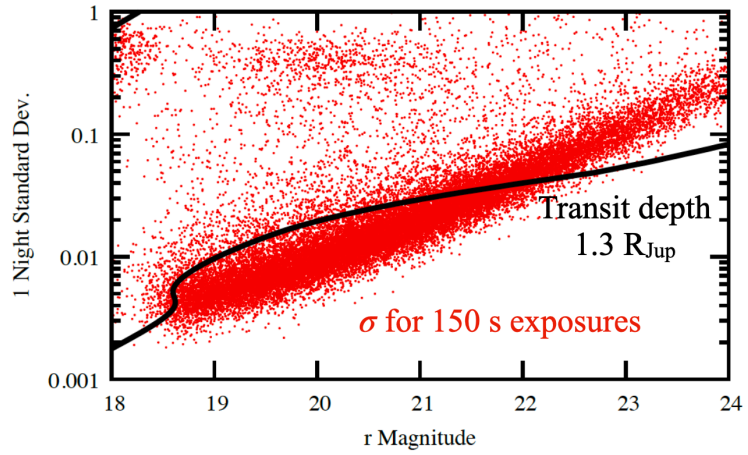
Middle: The chi-squared statistic was calculated for a range of trend stars numbers to determine what number of stars we could select for the detrending to get the most effect. We opted for 15.

Bottom: The median RMS for two most effective parameters tested so far – the kernel's spatial variations and the mesh size used. The binned RMS before detrending is in red, while the detrended RMS is in blue. Note that the ordinate is on a log scale.





MISHAPS r-band precision



Goals
- Decrease or remove systemic effects in lightcurves
- Decrease overall RMS values to increase chance of transit detection

Future Work
- Continue photometric optimization
- Run transit candidate search

References
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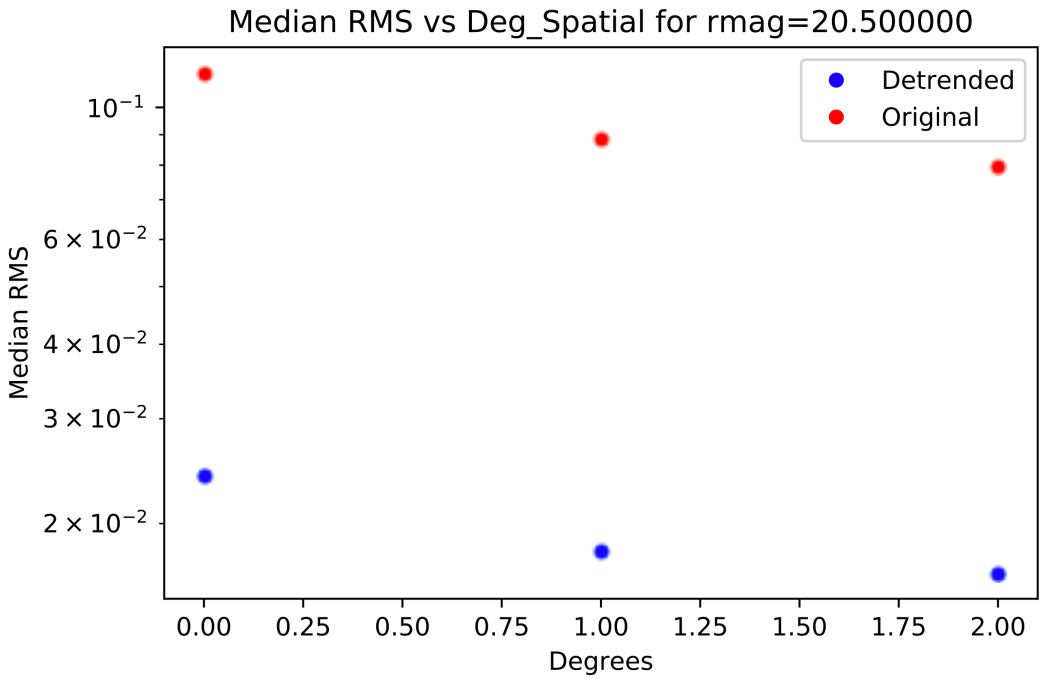
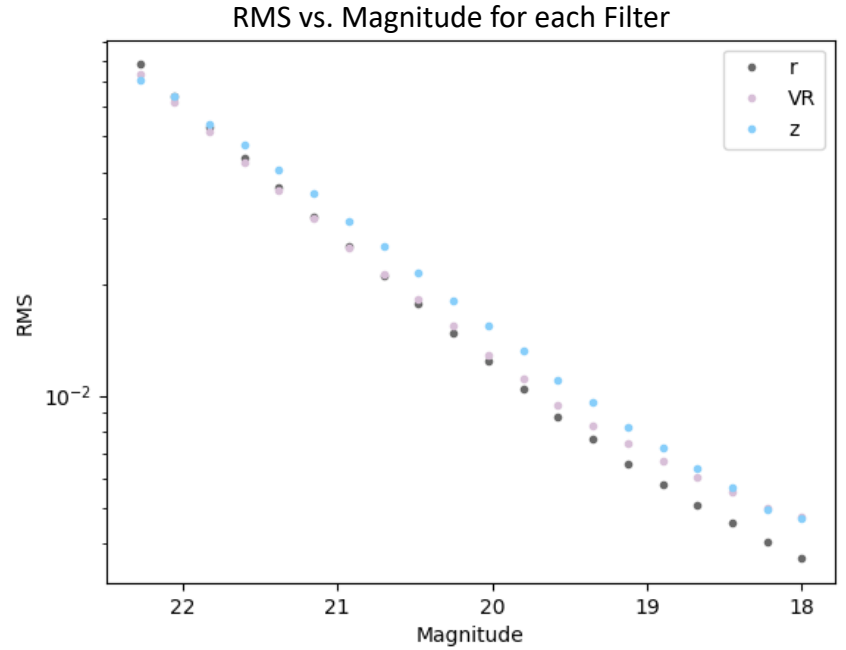
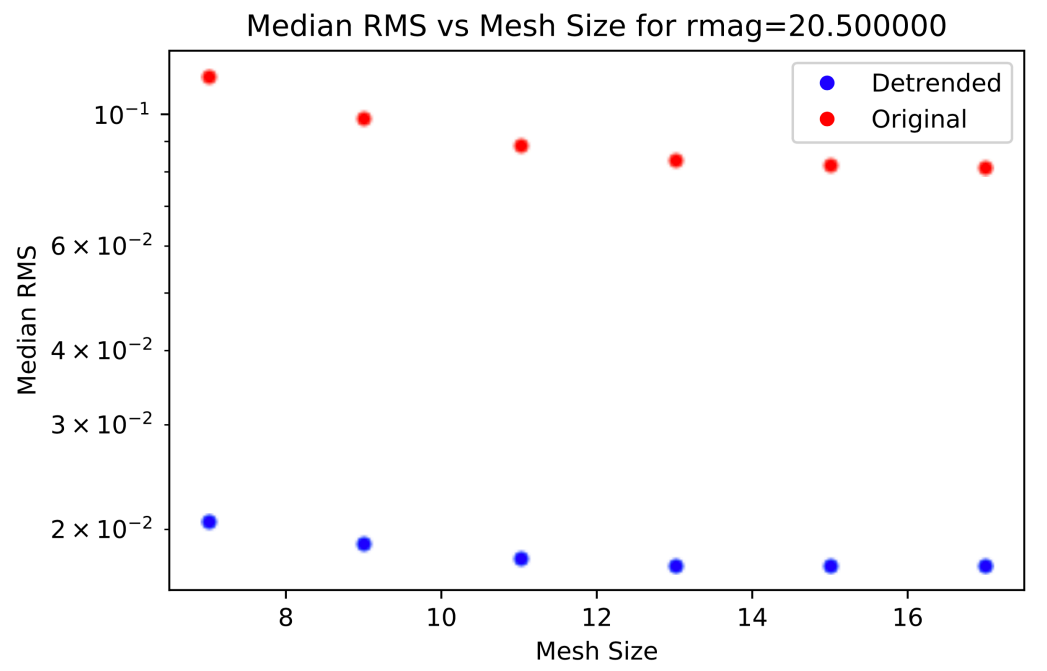
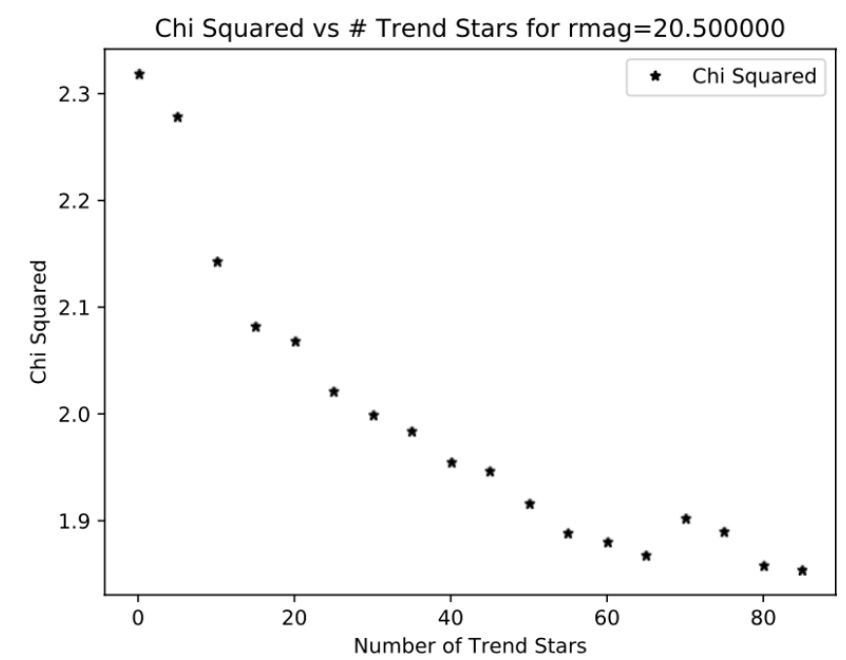
Larger plots on p. 2 for your screen viewing efficiency.


Median RMS vs Deg_Spatial for rmag=20.500000
Detrended
Original
Median RMS
10^{-1}
6×10^{-2}
4×10^{-2}
3×10^{-2}
2×10^{-2}
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Degrees


RMS vs. Magnitude for each Filter
r
VR
z
RMS
10^{-2}
22
21
20
19
18
Magnitude


Median RMS vs Mesh Size for rmag=20.500000
Detrended
Original
Median RMS
10^{-1}
6×10^{-2}
4×10^{-2}
3×10^{-2}
2×10^{-2}
8
10
12
14
16
Mesh Size


Chi Squared vs # Trend Stars for rmag=20.500000
Chi Squared
Chi Squared
2.3
2.2
2.1
2.0
1.9
0
20
40
60
80
Number of Trend Stars