Early results from reprocessing with SuperWASP

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Reducing RMS Noise

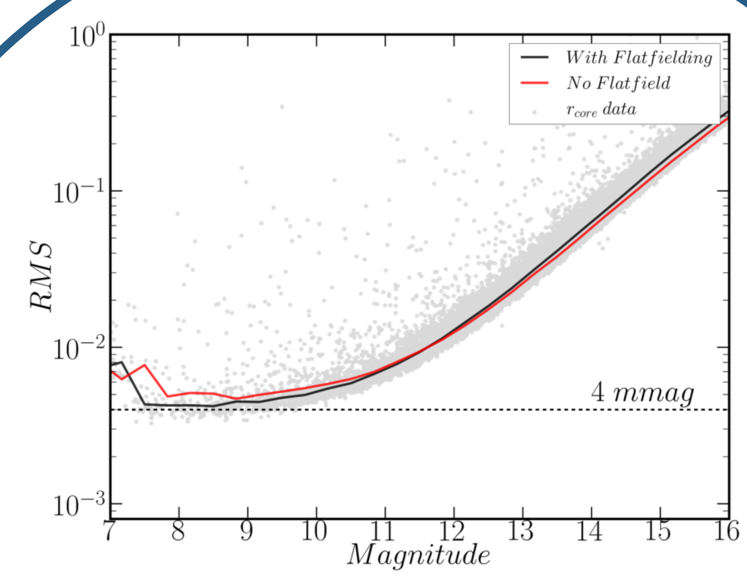

Figure 1: RMS noise dependence on flatfielding

Role of Flatfielding

Flatfielding does not significantly improve the SuperWASP noise characteristics. This may be due to flatfields being taken at twilight, when the sky is bluer, causing flatfields to add their own noise as well as accounting for pixel sensitivities.

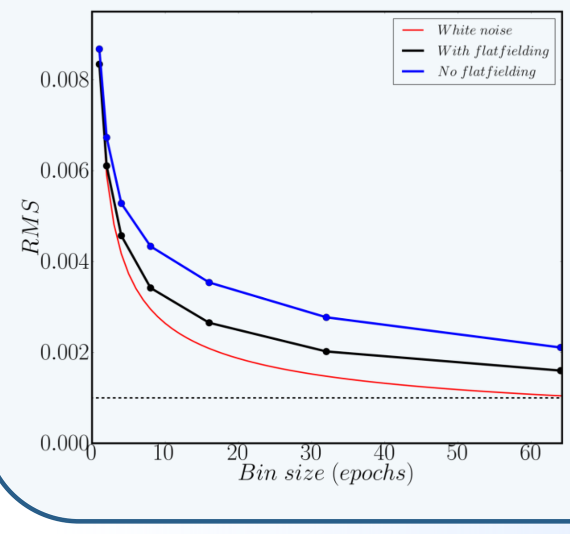

Figure 2: RMS noise binning for non-flatfield corrected images

Binning the data up to transit duration timescales reveals that flatfielding does go some way to de-reddening the noise but that systematics still remain.

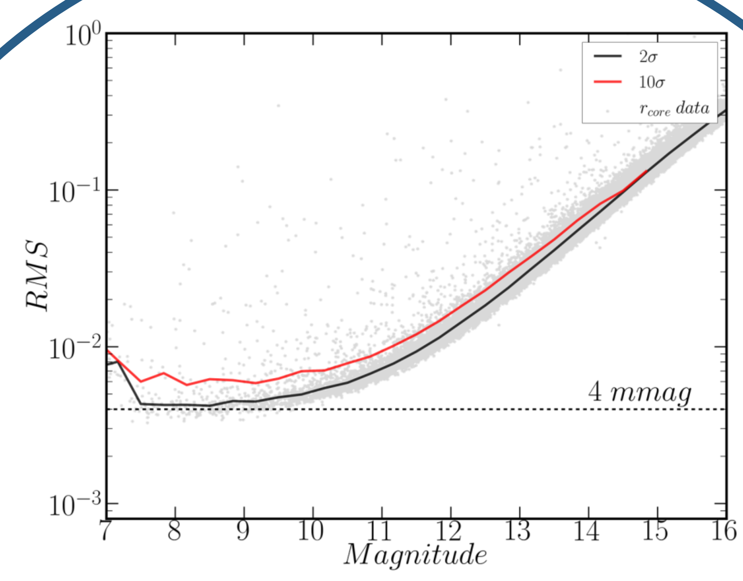

Figure 3: RMS noise dependence on source detection threshold

Don't ignore faint stars

Figure 3 shows the rms noise when 2 sigma and 10 sigma thresholds for source detection are applied. The latter only detected sources brighter than V=14.8. The 2 sigma threshold allows the dimmer stars' flux to be accounted for when within an aperture, causing the reduction in rms noise even for the brightest stars.

Optimising apertures

Larger apertures generally increase the contribution from the sky background, resulting in much higher rms noise.

However, the brightest stars benefit from increasing aperture size, even when the centre is saturated, as seen by the reduced rms in Figure 4.

This may allow information to be recovered from outer wings of saturated stars, resulting in WASP being able to observe even brighter targets.

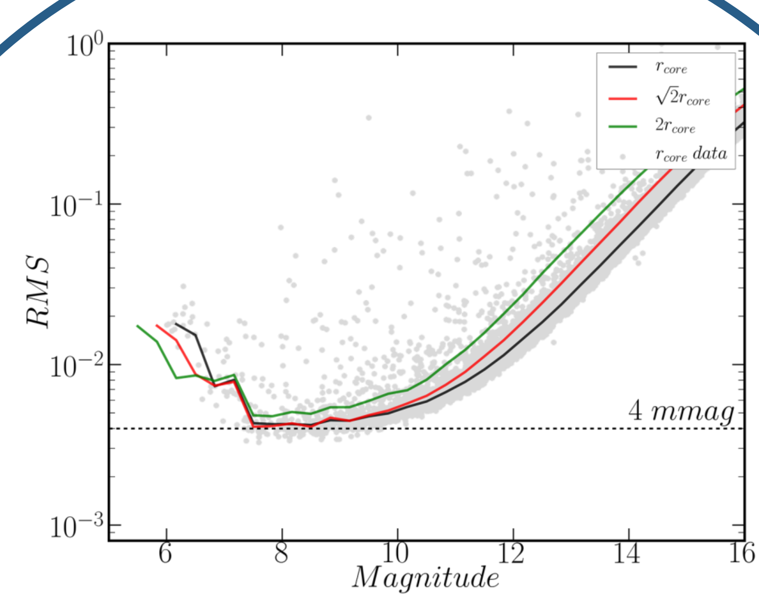

Figure 4: RMS noise dependence on aperture size

Improved Precision

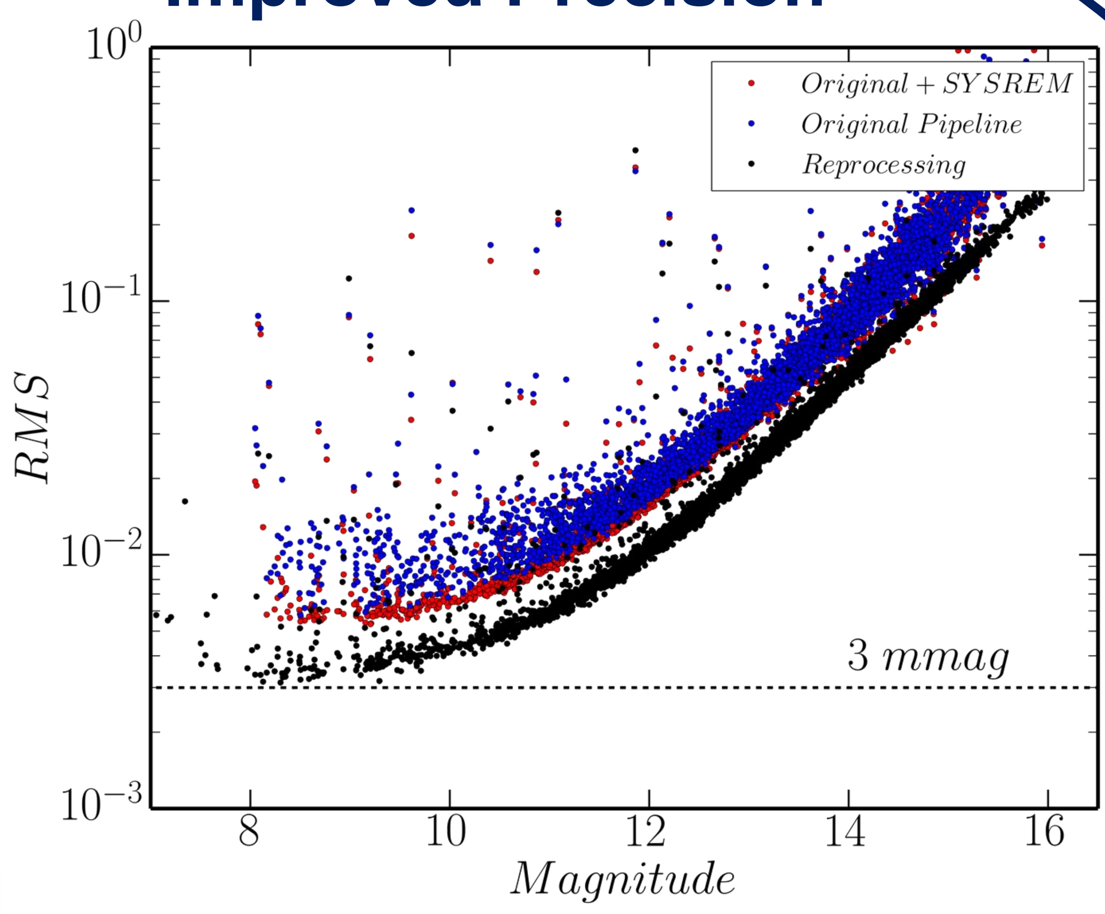

Figure 5: RMS-magnitude diagram of a single field containing ~20,000 stars over ~2000 epochs in January 2009 for our SuperWASP reprocessing (black), the original pipeline (blue) [1] and their pipeline's results after removing systematics (red).

When these factors are combined to make lightcurves [2], Figure 5 shows our clear improvements in lowering the rms noise when compared to the post-systematics correction results from the previous pipeline using SYSREM detrending [3].

This significant decrease in rms noise even for dimmer stars allows more precise photometry around K and M dwarfs. As these are among the most common stars in the galaxy and have relatively small radii, they are favourable for planetary transit surveys.

Dwarfs in SuperWASP

K/M Dwarf Selection

We selected late K and M stars in 8 reprocessed SuperWASP fields, following the method in Gaidos et al [4] as follows:

V < 15, V- J > 2

The original method used V < 14. We search down to V=15 due to our improved noise statistics.

Dwarf stars were distinguished from giants, by requiring their reduced proper H_J motion satisfy $H_J > 2.2(V-J) + 2.0$

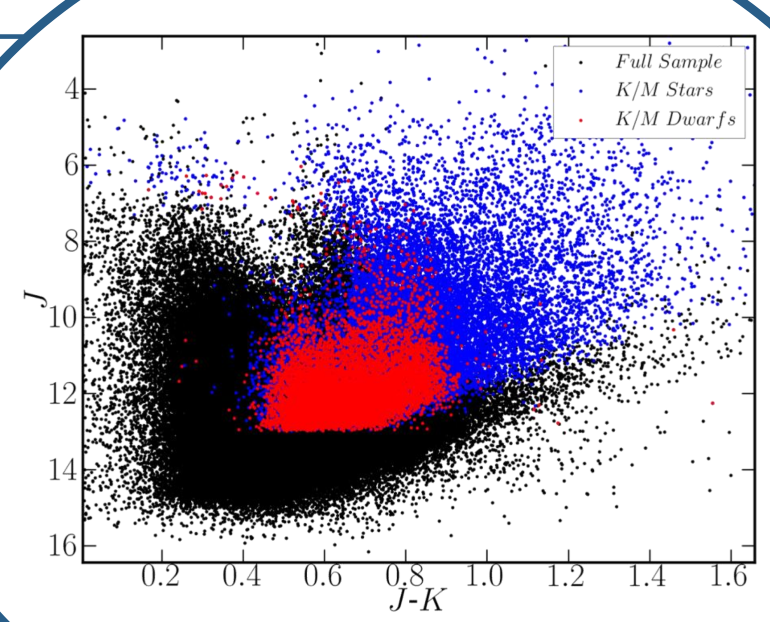

Figure 6: SuperWASP K/M Dwarf Selection

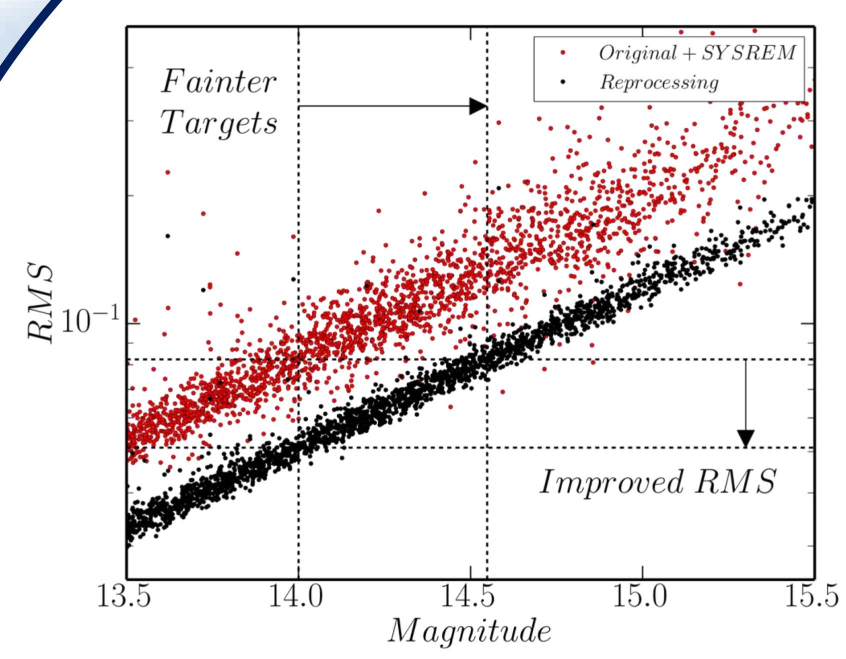

Figure 7: RMS noise gains

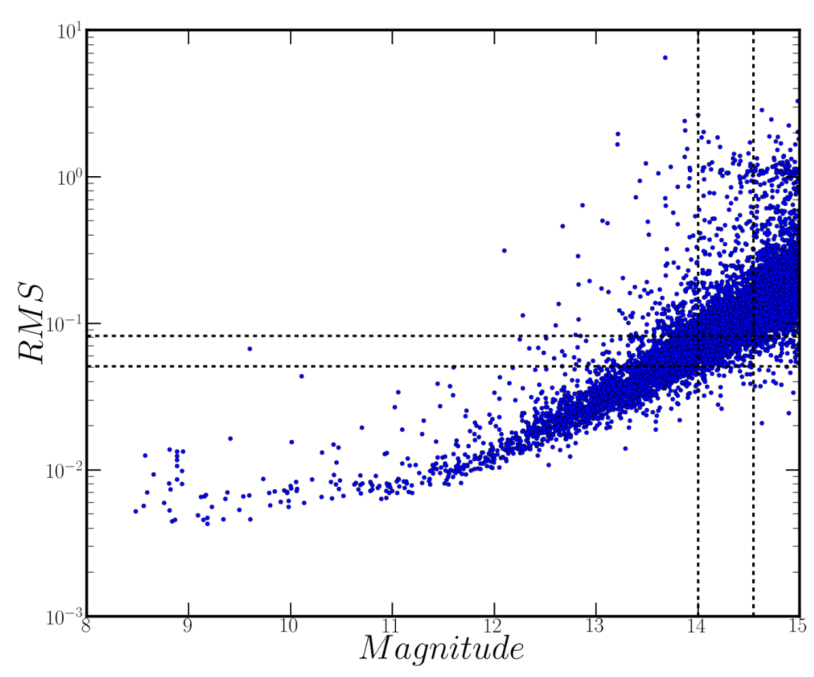

Figure 8: RMS noise of SuperWASP K/M Dwarfs

8 fields, ~480 square degrees
~200,000 stars
~30,000 K/M stars
~9,000 K/M dwarfs

More Dwarf Stars, Less Noise

As seen in Figure 7, our reprocessing results in rms errors of 0.05 mag at V = 14, marked by dashed lines. This an improvement over the 0.08 mag rms noise for Gaidos et al's previous analysis [4] at the same brightness, which used the original SuperWASP pipeline.

Figure 8 details the selection of K and M dwarfs in SuperWASP from Figure 6. Our improved noise distribution allows an increase in the number of M dwarfs searchable for transits at the same noise value compared to the original pipeline. These may be suitable targets for exoplanet transit searches.

References

[1] D. L. Pollacco et al., Publ. Astron. Soc. Pac. **118** 1407 (2006)
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[3] O. Tamuz, T. Mazeh and S. Zucker, MNRAS **356** 1466 (2005)
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