

Improving Photometry and Stellar Signal Preservation with Pixel-Level Systematic Error Correction

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The Kepler Mission has demonstrated that excellent stellar photometric performance can be achieved using apertures constructed from optimally selected CCD pixels. The clever methods used to correct for systematic errors, while very successful, still have some limitations in their ability to extract long-term trends in stellar flux. They also leave poorly correlated bias sources, such as drifting moiré pattern, uncorrected. We will illustrate several approaches where applying systematic error correction algorithms to the pixel time series, rather than the co-added raw flux time series, provide significant advantages. Examples include, spatially localized determination of time varying moiré pattern biases, greater sensitivity to radiation-induced pixel sensitivity drops (SPSDs), improved precision of co-trending basis vectors (CBV), and a means of distinguishing the stellar variability from co-trending terms even when they are correlated. For the last item, the approach enables physical interpretation of appropriately scaled coefficients derived in the fit of pixel time series to the CBV as linear combinations of various spatial derivatives of the pixel response function (PRF). We demonstrate that the residuals of a fit of so-derived pixel coefficients to various PRF-related components can be deterministically interpreted in terms of physically meaningful quantities, such as the component of the stellar flux time series which is correlated with the CBV, as well as, relative pixel gain, proper motion and parallax. The approach also enables us to parameterize and assess the limiting factors in the uncertainties in these quantities.