Abstract
A number of popular software tools in the public domain are used by astronomers, professional and amateur alike, but some of the tools that have similar purposes cannot be easily interchanged, owing to the lack of a common standard. For the case of image distortion, SCAMP and SExtractor, available from Astromatic.net, perform astrometric calibration and source-object extraction on image data, and image-data geometric distortion is computed in celestial coordinates with polynomial coefficients stored in the FITS header with the PV_1 keywords. Another widely-used astrometric-calibration service, Astrometry.net, solves for distortion in pixel coordinates using the SIP (Simple Imaging Polynomial) convention that was introduced by the Spitzer Science Center. Up until now, due to the complexity of these distortion representations, it was very difficult to use the output of one of these packages as input to the other. New Python software, along with faster-computing C-language translations, have been developed at the Infrared Processing and Analysis Center (IPAC) to convert FITS-image headers from PV to SIP and vice versa. It is now possible to straightforwardly use Astrometry.net for astrometric calibration and then SExtractor for source-object extraction. The new software also enables astrometric calibration by SCAMP followed by image visualization with tools that support SIP distortion, but not PV. The software has been incorporated into the image-processing pipelines of the Palomar Transient Factory (PTF), which generate FITS images with headers containing both distortion representations. The software permits the conversion of archived images, such as from the Spitzer Heritage Archive and NASA/IPAC Infrared Science Archive, from SIP to PV or vice versa. This new capability renders unnecessary any new representation, such as the proposed TPV distortion convention.

PV Distortion
- Implemented in SCAMP, SExtractor, Swarp & Aperture Photometry Tool
- Performed in intermediate world coordinate space (units are degrees)
- No special CTYPE fits keyword settings required
- Only forward transformation available (pixel to sky)

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\begin{align*}
\bar{x}' &= \sum_{i=1}^{n} A_i x^i + \sum_{i=1}^{n} B_i y^i \\
\bar{y}' &= \sum_{i=1}^{n} C_i x^i + \sum_{i=1}^{n} D_i y^i
\end{align*}
\]

SIP Distortion
- Implemented in M0PEX, DS9, WCSTools, Aperture Photometry Tool, etc.
- Performed in image coordinate space (units are pixels)
- Suffix “-SIP” required in CTYPE fits keyword settings
- Useful when the distortion is constant from image to image
- Forward and reverse transformations included (iterative solution not req.)

\[
\begin{align*}
\begin{bmatrix} x' \\ y' \end{bmatrix} &= \begin{bmatrix} C11 & C12 \\ C21 & C22 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} + \begin{bmatrix} A1 \ \\
A2 \end{bmatrix} \begin{bmatrix} u^2 \\ v^2 \end{bmatrix}
\end{align*}
\]