All-Sky Camera Radial Distortion
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We measured the radial distortion in the all-sky camera (ASCAM) images, by pointing the Hale telescope to bright stars and comparing the apparent location of the stars in the ASCAM images to a linear mapping of the telescope location on the same image. The experiment was performed on 13 Dec. 2005, from 18:00 to 1900 PST. Table 1 summarizes the observations.

<table>
<thead>
<tr>
<th>PST</th>
<th>Star</th>
<th>Elevation (°)</th>
<th>( r_d )</th>
</tr>
</thead>
<tbody>
<tr>
<td>18:23</td>
<td>Capella</td>
<td>31.6</td>
<td>0.692</td>
</tr>
<tr>
<td>18:34</td>
<td>Denneb</td>
<td>47.2</td>
<td>0.521</td>
</tr>
<tr>
<td>18:43</td>
<td>Alpha Cas</td>
<td>66.7</td>
<td>0.295</td>
</tr>
</tbody>
</table>

**Table 1:** Observations of bright stars with ASCAM. \( r_d \) is the normalized, distorted radius (0 at zenith, 1.0 at the horizon).

We fit the following 5th order barrel distortion equation

\[ r_u = h_1 r_d + h_2 r_d^3 + h_3 r_d^5 \]

to the above data, where \( r_d \) is the normalized, distorted radius, and \( r_u \) is the normalized undistorted radius, linear with zenith angle \( \phi \)

\[ r_u = 2 \phi / \pi \]

The best-fit coefficients to these data, including the boundary condition that \( r_d = r_u = 1 \) at the horizon, are found to be:

\[ h_1 = 0.868706 \]
\[ h_2 = 0.160731 \]
\[ h_3 = -0.0294363 \]

The data and best fit functional form area shown in Fig. 1.

In addition to the radial distortion determination, the azimuthal offset angle was also determined to be \(-89.8°\).

We recommend that the ASCAM software be modified to incorporate the above distortion and azimuthal offsets as the default values.
**Figure 1:** *Solid:* Best fit 5th order function. *Dashed:* "standard fish-eye lens" distortion\(^1\). *Dotted:* Ideal, undistorted image.