Calibration instructions

Note 1: By convention the first column in a data file is 'column 0', the second is 'column 1', etc
Note 2: The calibration scripts only work for RDI data (will change that in the near future) and only work for stars beginning with 'HIP'

Theory

Currently contrast (or '5sig') is measured as: $5sig(old) = \frac{F_m}{F_{psf}}$

Where F_m is the minimum measureable flux (per unit time) at a particular radial point in an image and F_{psf} is the measured flux of the psf.fits calibration image, which is an image of BD+45_598. However, F_{psf} should actually be F_{star}, the flux of the host star to get the true 5sig contrast. It is possible to get the true 5sig using: $5sig(true) = \frac{F_m}{F_{psf}}\frac{F_{psf}}{F_{star}} = \frac{5sig(old)}{f}$

Where f is **calibration factor 1** and is found using: $f = \frac{F_{star}}{F_{psf}} = 10^{-\frac{m_{star}-m_{psf}}{2.5}}$

Where m_{star} is the apparent magnitude of the star and m_{psf} apparent magnitude of the psf.

This however, is not enough as F_m required a calibration too (**calibration factor 2**): $F_m = \frac{k\,\sigma_R}{T_R}$

Where k is a factor (5 in this case, for 5sig contrast), σ_R is the standard deviation or noise of the flux and T_R is the throughput or signal attenuation (dimensionless). In total:
$5sig(true) = 5sig(old)\frac{1}{f} = \frac{F_m}{F_{psf}}\frac{1}{f} = \frac{k\sigma_R}{T_R F_{psf}}\frac{1}{f}$

σ_R is measured using a parameter Starphot (S):
$S = F_{psf}\tau_{cube}$

Where τ_{cube} is the exposure time of one image in the cube, inserting into5sig: $5sig(true) = \frac{k\sigma_R\tau_{cube}}{T_R S}\frac{1}{f} = \frac{k\Delta C_R}{T_R S}\frac{1}{f}$

Where ΔC_R is the standard deviation of the counts. Starphot should differ for each star (because they have different exposure times), but the RDI script assumed it to be constant with $\tau_{cube} = 5s$. Therefore to actually find S requires an additional correction: $S = S(RDI)\frac{\tau_{cube}}{5}$

Where S(RDI) is the constant value of S used in the script, applying this to the equation for 5sig above (note $\sigma_R(old) = \frac{\Delta C_m}{5}$):
$5sig(true) = \frac{5k\Delta C_R}{T_R S(RDI)\tau_{cube}}\frac{1}{f} = \frac{5k\Delta C_R}{5T_R F_{psf}\tau_{cube}}\frac{1}{f} = \frac{5}{\tau_{cube}f}\frac{k\sigma_R(old)}{T_R F_{psf}} = \frac{5}{\tau_{cube}f}\frac{F_m(old)}{F_{psf}}$

The total required correction (1 and 2) is then:

$$5sig(true) = \frac{5}{\tau_{cube}f}5sig(\text{original})$$

Procedure

1. Access analysis:
   ssh -XY abc123@analysis.astro.ex.ac.uk
   typing in your password when prompted. Navigate to the calibration folder:
   cd ../../data/shinkley/Keck_Data/completed_stars/calibration
2. I have already produced a file containing the value of correction 1 (or f) in a file known as: **output.csv.** This file can also be found in github, under **common/calibration.** If you don't want to reproduce this file, skip to step 4.
3. You will need the following files: **cal_name.txt, cal_date.txt, cal_name_file.txt and mag.txt.** Examples of these files can be found on github. Run the script **cal.py** using:
   python cal.py cal_name.txt cal_date.txt cal_name_file.txt mag.txt output
   This script will output a file: **output.csv** in DangerZone that contains the f value for each epoch of each star.
4. Make a file: **star_data.txt** containing 4 columns of:
   Star name (no 'HIP') star epoch f filename of contrast curve data
   eg: 59608 2011feb06 12.37086307 RDI_contrast_curve_2011feb06_0.8.txt
   If the star has more than one epoch, have 2 lines for the different epochs with the same star name
5. Run the script **cpm2.py:**
   python cpm2.py
   The script will find the value of correction 2 for each epoch of each star and combine with correction 1 to get the total calibration required. It will output this in a file called: **stars_calibration.txt**, which contains 3 columns of:
   Star name (no HIP) star epoch calibration
6. Run the script **cal3.py:**
   python cal3.py
   This will apply the calibration to the contrast curves and will create a new txt file in each RDI directory for each star of the name: **RDI_calibrated_contrast_{epoch}.txt**
   It will also produce a new plot of the name: **RDI_calibrated_contrast_curves_{epoch}.png**
7. These new files can be downloaded from analysis; navigate (not on analysis) to the directory where you want the new files to be and use:
   scp abc123@analysis.astro.ex.ac.uk:/data/shinkley/Keck_Data/completed_stars/DangerZone/HIP***/RDI/{filename}.png .**
   The decimal ('.') is needed. Type in your password when prompted.