Calibrating the HiPERCAM data of Janus

January 27, 2022

First, I calculate the airmass of Janus and of the standard star at the time of the observations. All the information about the standard stars (coordinates and magnitudes in the HiPERCAM filters) come from the file `hcam_flux_stds.csv` that Alex sent us. I use the astropy library, using the secant of the zenith angle as the estimate of the airmass:

```
coord_wd = coord.SkyCoord(ra_wd,dec_wd,
   unit=(u.deg, u.deg), frame='icrs')
coord_std = coord.SkyCoord(ra_std,dec_std,
   unit=(u.deg, u.deg), frame='icrs')
loc = coord.EarthLocation.of_site('Roque de los Muchachos')
airmass_wd= coord_wd.transform_to(AltAz(obstime=time_wd,location=loc)).secz
airmass_std=coord_std.transform_to(AltAz(obstime=time_std,location=loc)).secz
```

Then, for calibrating the magnitude of the reference stars, I compare to the standard in this way:

$$\begin{aligned}\mathrm{m\_ref_i} = &-2.5\log_{10}((\mathrm{counts\_ref_i}/\mathrm{exp\_time\_ref})/(\mathrm{avg(counts\_std)_i}/\mathrm{exp\_time\_std})) \\ &+ \mathrm{m\_std_i} + \mathrm{k\_ext_i} * (\mathrm{airmass\_wd} - \mathrm{airmass\_std})\end{aligned}$$

where $\mathrm{m\_ref}_i$ is the magnitude of the reference star in a HiPERCAM filter, $\mathrm{counts\_ref}_i$ are the counts detected in that filter and exp_time_ref is the exposure time for each observation, and similarly for the standard star with _std. avg indicates a robust mean that removes outliers. $\mathrm{k\_ext}_i$ is the extinction coefficient in that filter; I am using 0.48, 0.17, 0.10, 0.05 and 0.05 for u, g, r, i and z respectively.

Then, to get the magnitude of Janus:

$$\mathrm{m\_wd_i} = -2.5\log_{10}(\mathrm{counts\_wd_i}/\mathrm{counts\_ref_i}) + \mathrm{avg(m\_ref_i)}$$

The values that I get using different stars are very consistent. Unfortunately though, I get pretty different values for the two different nights, with one night being consistently brighter. Here are the average values:

Night	u	g	i	r	z
Sep 6	19.35	19.86	20.23	20.61	20.90
Sep 9	19.17	19.72	20.17	20.54	20.87

I think that the night of Sep 6 is closer to reality because it agrees better with PanSTARRS and makes more sense with the Swift observations (see Fig).