Red Magnitudes

Abstract : In which various sky survey red magnitudes are compared to Cousins R

Methodology

The current loneos.phot file created by Brian Skiff was downloaded from his ftp space and coordinates, V magnitudes and $V{-}R_c$ values subtracted. R_c values were calculated using that photometry.

The coordinates were used to batch query the CDS' VizieR service using 2 arcsec search radii for each of the catalogues CMC14 (Wynn Evans et al), UCAC2 (Zacharia et al) and USNO B1.0 (Monet et al). The respective red magnitudes were extracted from each of these catalogues.

CMC14 :- the r', or more properly r'_{CMT} red magnitude, an SDSS r' passband filter was used on a red sensitive Kodak chip in drift scan mode. Though the survey is primarily astrometric attempts were made to utilise photometric quality observations.

UCAC2 :- the UCAC2 instrumental red magnitude, essentially stars were imaged upon an unfiltered red sensitive Kodak chip. An astrometric survey, no attempt was made to ensure any photometric quality beyond the astrometric needs.

USNO B1.0 :- as numerous surveys were used in the creation of this catalogue, in this instance the R1 data only for objects North of 0 degrees declination were used, which should lead to a homogeneous collection of red E emulsion Kodak glass plates taken on the Palomar Schmidt camera as part of POSS in the 1950s.

All these surveys calibrate using Tycho2 (Hoeg at al) photometry.

The magnitudes were individually tested against the loneos.phot derived R_c values to add some quantitative assessment to the usual anecdotal qualitative assessments these survey magnitudes enjoy.

loneos.phot comprises of a reference collection of critically assessed literature and database photometry compiled by Brian Skiff for use in all sky calibration of asteroidal magnitudes as part of the LONEOS survey.

Results

CMC14

For ~ 2530 stars of a range of magnitudes from ~ 9 to ~ 17 and $V–R_c$ from -0.2 to +2.2 the mean, median and standard deviation for the simple difference $r'–R_c$ are 0.23, 0.23 and 0.14 respectively.

For a subset of ~ 1980 of these stars where $V–R_c$ lay within the range of 0.0 to +0.60 the mean, median and standard deviation are little different at 0.21, 0.22 and 0.13 respectively. Therefore

$$R_c = r' - 0.21 +/- 0.13 \quad r' > 9 \text{ and } r' < \sim 15.5 \text{ and } V-R_c > 0 \text{ and } V-R_c < +0.6$$

This tallies well with $R_c = r' – 0.2$ +/- 0.1 which I derived some years ago for CMC13.

The limiting magnitude in the above formula is taken from the consideration of the below figures which show the limits of the faint end photometry.

Alternatively, as shown in figure 2, a linear regression for R_c versus r' can be used, in this instance usefully allowing the correlation coefficient on the fit of 0.994 to be shown. The standard deviation on the fit is of course the same. This is for the full 2530 dataset.

$$R_c = 0.984\, r' +/- 0.13$$

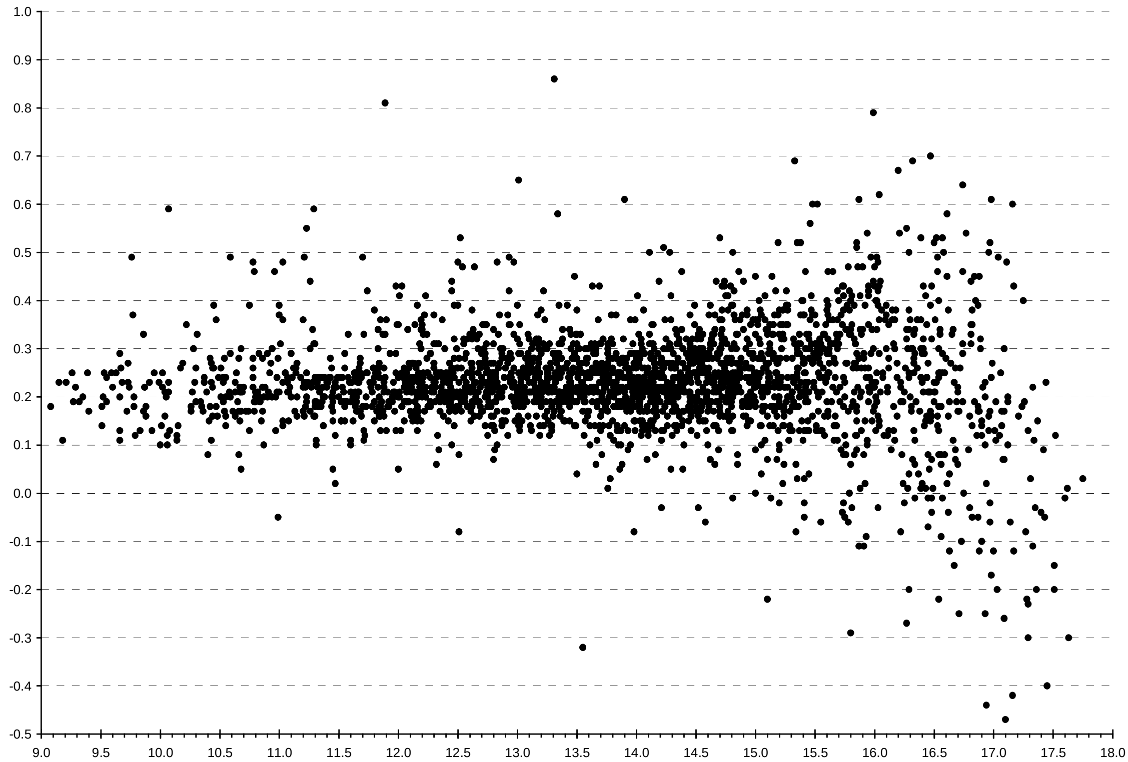


Figure 1 $r'-R_c$ y axis versus R_c x axis

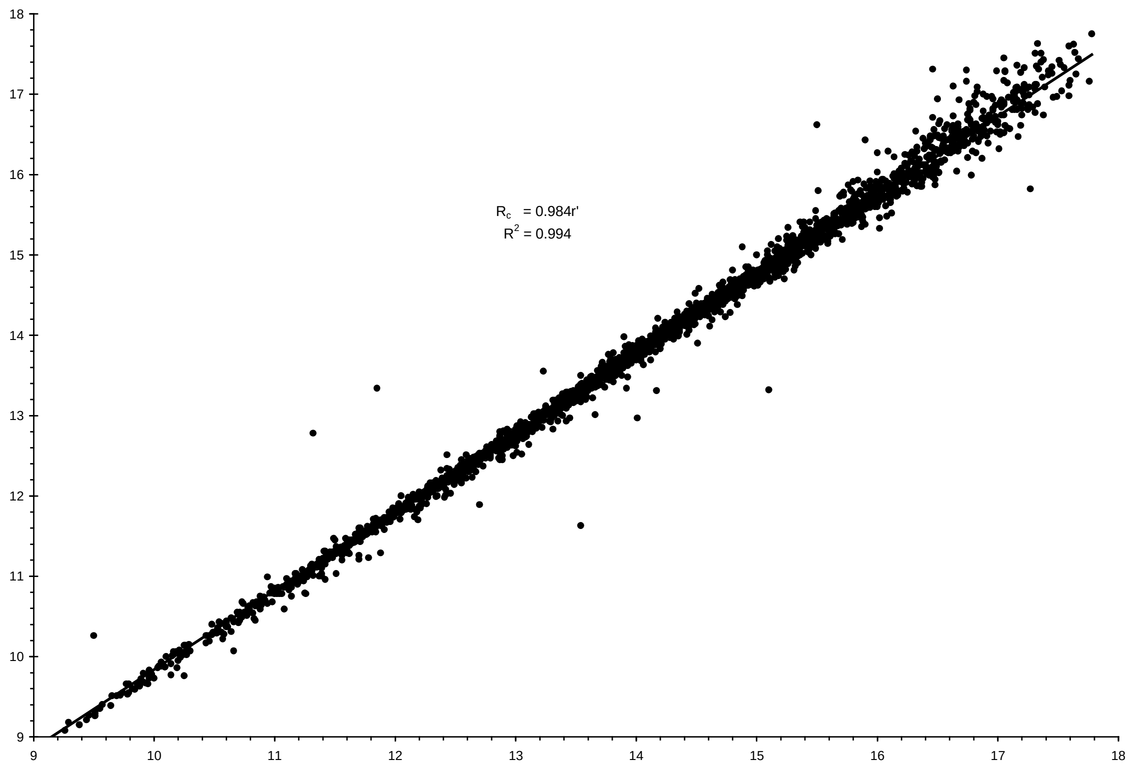


Figure 2 R_c y axis versus r' x axis showing the R_c = 0.984 r' fit has a high level of confidence

However, as is often the case, things are not quite as simple as that. There is a colour term, and although this is safely contained in the error estimation for colours between V–Rc > 0.0 and < +0.60, it can amount to an r'–R_c difference of 1 magnitude for objects as red as V–R_c ~ 2.0 (off the scale as plotted here), although the trend appears to be linear, so could be allowed for in purist treatments, probably using the 2MASS (Cutri et all) J and K_s magnitudes that accompany the CMC14 catalogue. Figure 3 shows the circumstances of the r' and R_c difference relative to V–R_c.

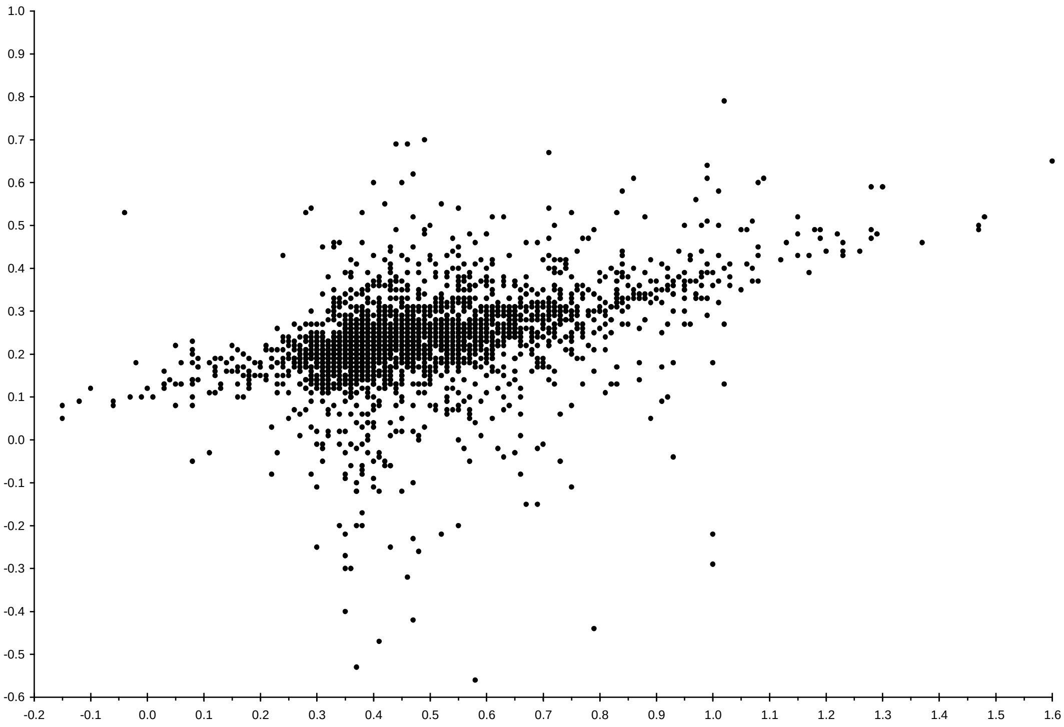


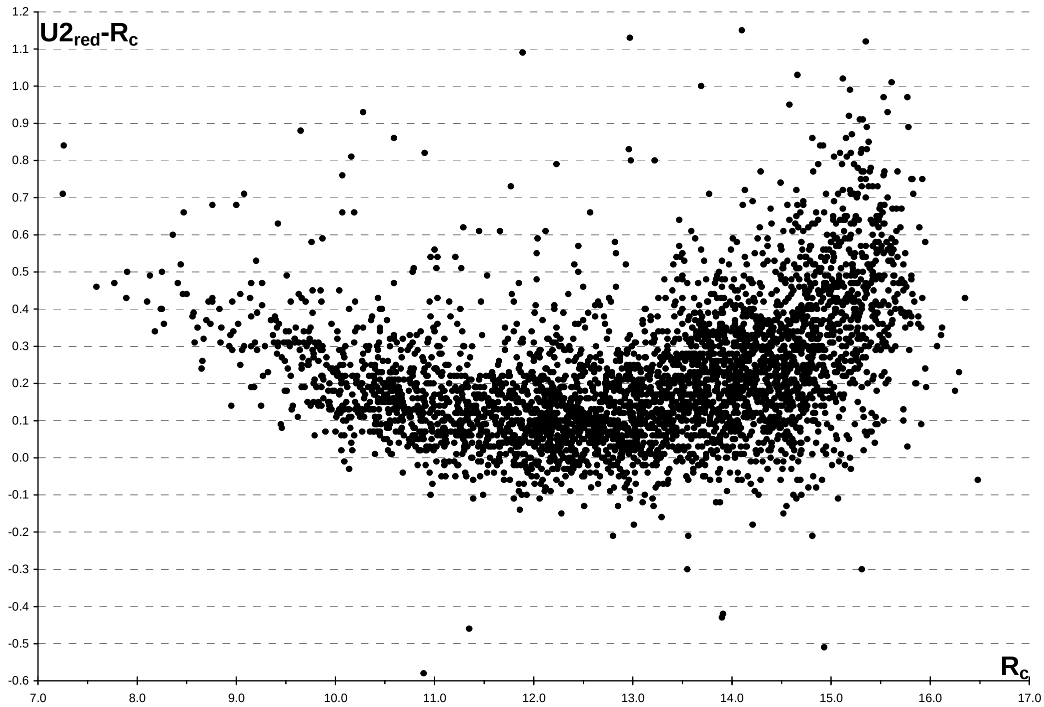
Figure 3 r'-R_c y axis versus V-R_c x axis : a colour term is involved in the difference between the two magnitude bands and appears to express itself as a linear relation

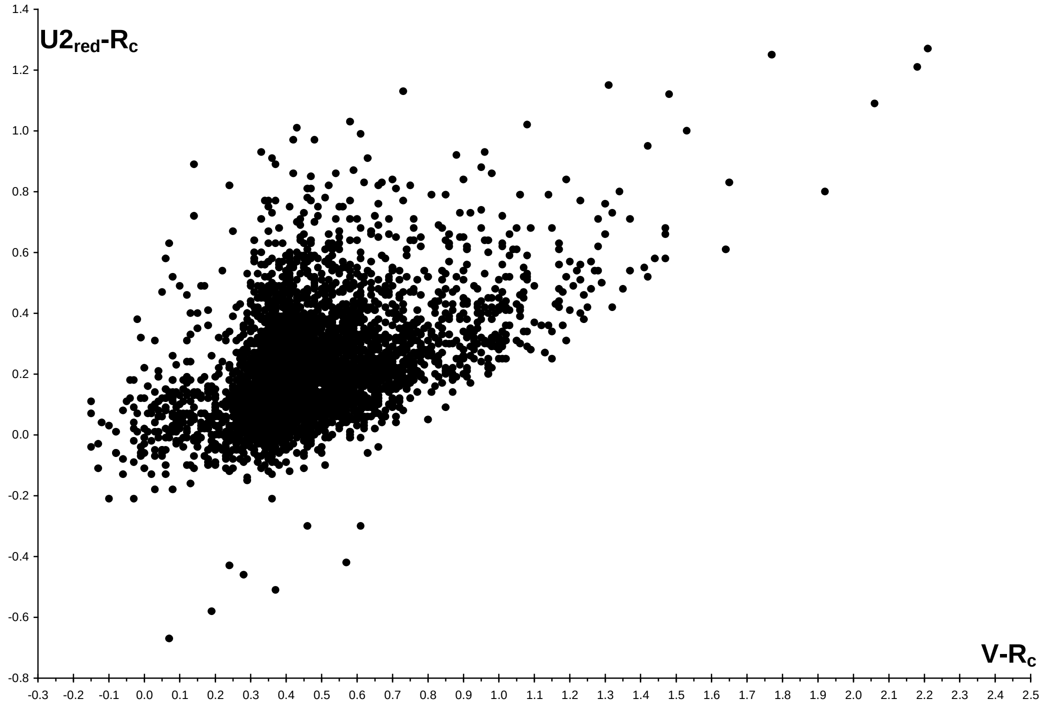
UCAC2

The authors of UCAC2 stress that it isn't a photometric catalogue. Nevertheless some will use it when there is no alternative available. Usually little quantitative assessment is given to it's use, however, except some general anecdotal feeling that it is as bad as using GSC 1.x and/or USNO An.0 or USNO B1.0 magnitudes. Although it is not good, it is nowhere near as bad as those photographic plate based magnitudes.

For ~ 3850 objects with R_c in loneos.phot the values ucac2_mag–Rc had a mean, median and standard deviation of 0.22, 0.19 and 0.20 respectively. The same analysis for the ~3040 objects with $V\text{–}R_c$ between 0.0 and +0.60 led to respective values of 0.19, 0.16 and 0.19. Thus it appears that R_c = ucac2_mag – 0.2 +/- 0.2 to a close approximation.

However, the plot of magnitude difference against R_c magnitude tells the true story, there even being a nonlinear brightness dependency between the two. A colour term also exists. Yet they are still much better than USNO A/B red magnitudes (*see next*).



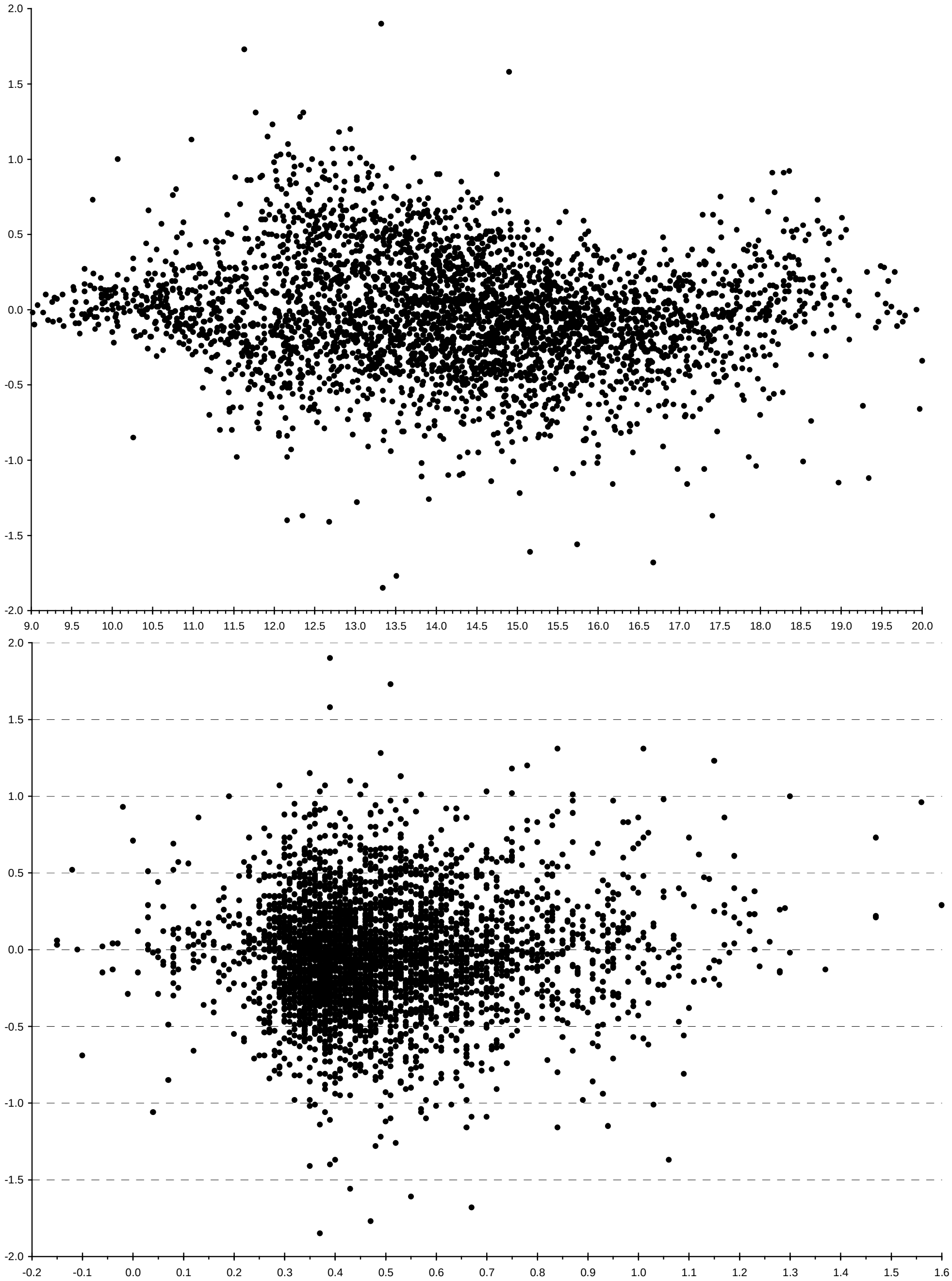


USNO B1.0

For completeness and comparison Northern USNO B1.0 magnitudes were also assessed, being representative of USNO B1.0 in general, and similar photographic survey sources based on POSS and similar images, such as the USNO An.0 and GSC n.n catalogues.

For 3610 objects R1–R_c had a mean and median of -0.01 and -0.03 respectively for objects of all colour, and of -0.02 and -0.05 for the ~2740 objects with V–R_c between 0.0 and +0.60. However, as I showed once before for USNO B1.0, the standard deviation is 0.5 (0.51 and 0.52 for the respective cases, compare with the determination for R1 given at http://www.aerith.net/astro/color_conversion/JG/USNO-B1.0.html). Thus much worse than for UCAC2 and far worse than for CMC14, even if it does go fainter than those.

There appears to be no colour term to speak of but the scatter is large: R_c = R1 +/- 0.5.



Top figure: USNO B1.0 R1-R_c y axis versus R_c **Bottom figure:** USNO B1.0 R1-R_c versus V-R_c