CORRECTING THE ASTROPHOTOMETRY: A STATUS REPORT. G. V. Williams[1]
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Introduction: An on-going project at the IAU's Minor Planet Center (MPC) has been trying to improve the absolute magnitudes of the minor planets. A brief status report on the progress of this project is presented here.

Historical Background: In the past, the MPC has concentrated on improving the astrometric quality of the reported observations and improving the accuracy of the generated orbits. Consideration of the photometry has been a secondary concern. Historically, the absolute magnitudes generated by the MPC have been derived exclusively from the photometric estimates provided by the observers on the astrometric observation records. This astrophotometry is of wildly-variable quality [1] and most of it is not on standard photometric systems. The MPC attempted to reconcile data from different observers by applying offsets to the reported magnitude estimates and by judicious use of weights. No use was made of lightcurve photometry published in the literature that was not associated with astrometric observations.

A small number of absolute magnitudes incorporated into the MPC datafiles were supplied by third parties [2] and were based (typically) solely on reliable differential or all-sky photometry.

Improving the Astrophotometry: The typical astrophotometry measurement is derived from comparison of the instrumental magnitudes obtained from a CCD image to the magnitudes in a specific band in a reference catalogue. These catalogue magnitudes are known to be of indifferent quality [3] and the magnitudes are only approximately on standard systems. If accurate magnitudes on standard systems are available for the comparison stars used to reduce a particular observation, it is possible to derive transformations relating the catalogue magnitudes in a band *c* to the magnitudes in a standard band *s*. This step fixes the systematic error in reported magnitudes caused by the poor comparison-star magnitudes.

The non-availability of a suitable all-sky photometric catalogue at the start of this project led to the internal creation of two partial-sky catalogues containing objects with photometric uncertainties < 0.1 mag in *V*. The first catalogue, derived from the SDSS dataset and containing $UBVR_cI_c$ magnitudes, contains 57 million entries, while the second, derived from the CMC-14 catalogue and containing BVR_cI_c magnitudes, contains 67 million entries. Each of these catalogues was used as the basis for another catalogue, which added in the magnitudes given in a wide number of astrometric reference catalogues (including various versions of the GSC catalogue, USNO-A1.0, USNO-A2.0, USNO-B1.0, UCAC-1 and UCAC-2). The end result is two catalogues that can be queried on position and which return all the magnitudes available for a particular star.

Correcting The Raw Data: The raw data are the astrophotometric observations on the more than 80 million astrometric observations in the MPC archive. There are magnitude estimates on the majority of those observations. For each observation, a check is made to see whether it is within the regions covered by the two photometric catalogues. If it isn't, then it is not possible to correct for the systematic catalogue error. If it is, then comparison stars, with their standard and catalogue magnitudes, are extracted from a region (typically 15 to 30 arc-minutes wide) around the observed position. A transformation is then derived relating the relevant catalogue magnitude to the appropriate standard magnitude. This transformation is then used to correct the reported magnitude.

Complications arise when an observer uses one reference catalogue for the astrometric reduction and another for the photometric reduction (e.g., the Catalina Sky Survey) or when some preprocessing of the catalogue magnitudes is performed (e.g., the LINEAR survey).

Once all the observations are corrected for the catalogue systematic error, the observer-specific systematic error can be corrected. This is a result of the fact that the observer is not observing through standard filters and shows up as an offset in the mean of the residuals between the reported astrophotometry and the catalogue-corrected astrophotometry. The observer-specific correction for a particular observer is the value of the offset compared to some reliable observers and the amount of scatter in these residuals is a useful metric for weighting the corrected data when computing the absolute magnitude and slope parameter. This final step also incorporates photometry extracted from the literature.

Conclusions: This is by necessity a brief report and has to omit much detail. Full details will be published later in the year. The end result will be a complete set of absolute magnitudes that should be a significant improvement on what has been available heretofore.

References: [1] Herget P. (1951) *Minor Planet Circ.*, 603. [2] Marden B. G. and Williams G. V. (1990) *Minor Planet Circ.*, 17257. [3] Monet, D. et al. (2003) *Astron. J.*, 125, 984–993.