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Improved astrometry for the Bohannan & Epps catalogue⋆ *(Research Note)*

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ABSTRACT

Aims. Accurate astrometry is required to reliably cross-match 20th-century catalogues against 21st-century surveys. The present work aims to provide such astrometry for the 625 entries of the Bohannan & Epps (1974, A&AS, 18, 47; BE74) catalogue of Hα emission-line stars.
Methods. BE74 targets have been individually identified in digital images and, in most cases, unambiguously matched to entries in the UCAC4 astrometric catalogue.
Results. Sub-arcsecond astrometry is now available for almost all BE74 stars. Several identification errors in the literature illustrate the perils of relying solely on positional coincidences using poorer-quality astrometry.

Key words. astrometry – stars: emission-line, Be – magellanic clouds

1. Introduction

Although the use of digital detectors and computer manipulation of images is now ubiquitous, many pioneering surveys were conducted in the days of photographic observations. This is particularly true of the Large Magellanic Cloud (LMC), where precedent ensures that most of the brighter stars are still commonly identified by catalogue numbers from surveys conducted in the photographic era, such as the Henry Draper extension (HDE; Cannon 1936), the Radcliffe study by Feast et al. (1960; R numbers[1]), and work by Henize (1956; LHα120-S identifiers for LMC emission-line stars) and by Sanduleak (1970; Sk identifiers).

A difficulty confronting early authors was that the determination of precise equatorial co-ordinates involved time-consuming manual measurements with opto-mechanical plate-measuring machines, and subsequent tedious calculations (as well as requiring a dense, good-quality grid of reference stars). This laborious effort was invariably eschewed in favour of co-ordinates quoted to only ∼arcminute precision and, in most cases, provision of supporting finder charts.

In the modern era the identification problem is reversed: in large-scale digital surveys, precise co-ordinates are quickly and routinely obtained, but the task of visually checking many targets against numerous published finding charts is discouragingly burdensome. Cross-identification based solely on co-ordinate coincidences from crude astrometry is not reliable in dense LMC starfields, but has nevertheless proven enticing to a number of authors. As a result, the literature is littered with misidentifications based on approximate positional matches, unverified by checks against original sources.

Heroic efforts by Brian Skiff at Lowell Observatory have greatly improved the situation. His work (unpublished, but incorporated into CDS databases) includes ∼arcsecond astrometry for the HDE, Sk, and LHα catalogues, based on careful examination of original sources. There remain, however, two important, extensive surveys of bright Hα emission-line stars in the LMC for which only arcminute astrometry is available: the Lindsay surveys (Lindsay 1963; Andrews & Lindsay 1964) and the Bohannan & Epps study (Bohannan & Epps 1974; BE74).

Lindsay's papers give co-ordinates to the nearest arcminute, but no finder charts. Plausible identifications of many of the ∼800 targets may be possible, based on positional and brightness coincidences, but the absence of finder charts means that *secure* identifications are now not generally feasible[2]. Given the potential for errors, it is the present author's opinion that the conservative position is to consider Lindsay's stars lost to science, for the most part.

In contrast, Bohannan & Epps (1974) provided identification charts which should allow secure identification of nearly all their emission-line stars, and hence new astrometry with accuracy and precision suited to cross-identifications in modern large-scale surveys. The purpose of this paper is to report such astrometry.

2. Methods

Bohannan & Epps identified their Hα emission-line stars on images from the Hodge & Wright Atlas (Hodge & Wright 1967). In spite of the small plate scale, this allows subsequent secure identification of nearly all stars in larger-scale digital images. In practice, this identification was normally carried out using CDS's Aladin tool (Bonnarel et al. 2000) in conjunction with a much

⋆ Tables 1–3 are only available at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsarc.u-strasbg.fr/viz-bin/qcat?J/A+A/548/A16

[1] The CDS uses "RMC" to identify Radcliffe stars.

[2] The authors provide cross-identifications with 126 LHα objects; these sources are therefore reliably recoverable (through Henize's charts and Skiff's astrometry).

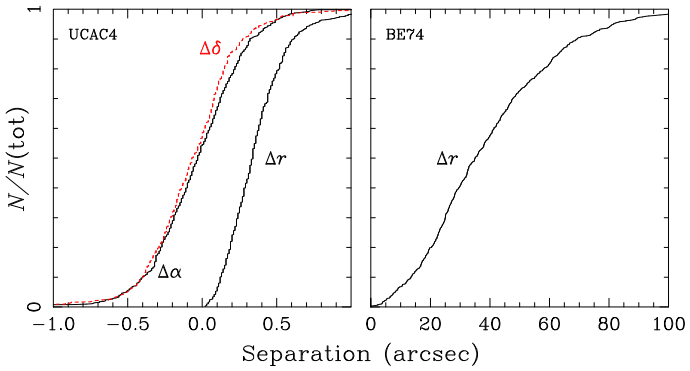

Fig. 1. *Left panel*: cumulative distribution functions for offsets between interactively measured co-ordinates and adopted UCAC4 positions, for right ascension, declination, and absolute differences. *Right panel*: cumulative distribution function for offsets between BE74's positions and the current astrometry.

magnified pdf copy of Bohannan & Epps (1974) from the NASA Astrophysics Data System. In a number of cases, the original Hodge & Wright Atlas was examined to resolve ambiguities.

Other than for a few bright targets, a semi-transparent window of the DSS2 red image from Aladin was overlaid on the pdf, at matching scales; where necessary, an image rotation was also applied, using the GNU Image Manipulation Program. In general, this allowed a positive identification of the BE74 target with a single object on the DSS2 image, for which a position was recorded interactively, and transferred to a data file by copy-and-paste. (With distance moduli of ~18.5, proper motions are negligible for these sources, so differences in epoch of observation are of no importance in this context.)

Correlating the results against UCAC4 (Zacharias et al. 2012) gave a positive match with a single target within 5″ in most cases, with a small systematic offset: $\Delta\alpha = +0\overset{s}{.}11$, $\Delta\delta = -0\overset{''}{.}6$ (UCAC4 − Aladin). This offset is presumed to be due to small errors in matching the DSS2 images to the ICRS reference frame, so the interactively recorded measurements were corrected accordingly. After applying this correction, a second pass was made against UCAC4 with a 2″-radius window to get final positions. The results are listed in the Table 1, which is the main data product of this paper. Figure 1 (left-hand panel) shows that the positional differences between corrected interactive measurements and UCAC4 are Normally distributed, and are less than one arc-second in the great majority of cases.

3. Discussion

The co-ordinates reported here are intended to establish precise positions for the objects marked by BE74 on their finder charts, independently of other investigations (largely to avoid any danger of propagating existing misidentifications). BE74 state that these charts, rather than their published co-ordinates, best define their targets, although a potential source of error is that they may not always have matched the emission-line star from their objective-prism plates with the correct object on the Hodge & Wright Atlas (cf., e.g., BE74 602; Table 2). Furthermore, in a number of cases multiple bright sources are present on DSS2 images (and sometimes on the Hodge & Wright atlas) within the BE74 identification circle; Table 2 discusses most of these instances.

Of course, in addition to ambiguities and possible errors in the original materials, there is certainly also the potential for misidentifications and mismeasurements in the present work. Cross-checking the adopted positions against BE74's co-ordinates initially disclosed six faulty results requiring correction in the former (all believed to be due to failures to "copy" a correct position before "pasting"), suggesting a residual error rate from this source of better than 1%.

Agreement between the finally adopted positions and BE74's original co-ordinates is generally satisfactory, with matches to within 1–2′ (Fig. 1, right-hand panel), although some discrepancies remain (cf. Table 2). The current co-ordinates have also been cross-matched to Skiff's astrometry for HDE, Sk, and LHα120-S sources, within a 5″ radius around the interactively recorded positions (Table 3, on-line). Where matches are found, the positional differences are almost all sub-arcsecond (essentially, the differences between UCAC2 and UCAC4 results), giving confidence in the assigned correspondences. In the few cases where larger offsets occured, DSS2 imagery was re-examined; invariably, the differences were found to arise because the BE74 object is not a single point source.

Finally, it is perhaps worth concluding with an explicit comment that, while the positions reported here are precise, they may not necessarily always be accurate, for the reasons just set out. At the least, for critical cases the results in Table 1 should be considered in conjunction with the notes on individual sources given in Table 2.

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