

11.3.2: Proper Motions of the Comparison Stars

Corrections for the proper motions of the comparison stars should certainly be made if possible.

Until a quarter of a century or so ago, a typical stellar catalogue used by asteroid observers was the *Smithsonian Astrophysical Stellar Catalog* containing the positions and proper motions of about a quarter of a million stars down to about magnitude 9. This catalogue gives the position (right ascension and declination referred to the equinox and equator of B1950.0) of each star at the time of the original epoch when the photograph on which the catalogue was based, and also the position of each star corrected for proper motion to the epoch 1950.0, as well as the proper motion of each star. Thus for the star SAO013800 the position (referred to the equinox and equator of B1950.0) at the original epoch is given as

$$\alpha_{1950.0} = 08^{\text{h}} 14^{\text{m}} 40^{\text{s}}.390 \quad \delta_{1950.0} = +65^{\circ} 09' 18''.87 \quad (11.3.2.1)$$

and the proper motion is given as

$$\mu_{\alpha} = -0^{\text{s}}.0058 \quad \mu_{\delta} = -0''.085 \text{ per year} \quad (11.3.2.2)$$

The epoch of the original source is not immediately readable from the catalogue, but can be deduced from information therein. In any case the catalogue gives the position (referred to the equinox and equator of B1950.0) corrected for proper motion to the epoch 1950.0:

$$\alpha_{1950.0} = 08^{\text{h}} 14^{\text{m}} 40^{\text{s}}.274 \quad \delta_{1950.0} = +65^{\circ} 09' 17''.16 \quad (11.3.2.3)$$

Now, suppose that you had taken a photograph in 1980. At that time we were still referring positions to the equinox and equator of B1950.0 (today we use J2000.0), but you would have to correct the position for proper motion to 1980; that is, you need to apply the proper motion for the 30 years since 1950. The position, then, in 1980, referred to the equinox and equator of B1950.0) was

$$\alpha_{1950.0} = 08^{\text{h}} 14^{\text{m}} 40^{\text{s}}.100 \quad \delta_{1950.0} = +65^{\circ} 09' 09''.61 \quad (11.3.2.4)$$

and this is the position of the star that should be used in determining the plate constants.

One problem with this was that the proper motions were not equally reliable for all the stars (although the catalogue does list the formal standard errors in the proper motions), and there are a few stars in which the proper motion is even given with the wrong sign! In such cases, correcting for proper motion obviously does more harm than good. However, the stars with the “worst” proper motions are generally also those with the smallest proper motions; it can probably be assumed that the stars with significant proper motions also have proper motions that are well determined.

The situation changed in the 1990s with the widespread introduction of CCDs and the publication of the *Guide Star Catalog* containing positions of about half a billion stars down to about magnitude 21. With modern instrumentation one would never normally consider using comparison stars anything like as bright as magnitude 9 (the faint limit of the SAO Catalog). You now have the opportunity of choosing many more comparison stars, and faint ones, whose positions can be much more precisely measured than bright stars. Also, the *Guide Star Catalog* gives positions referred to the equinox and equator of J2000.0 which is the present-day norm for reporting astrometric positions. A difficulty is, however, that the GSC positions were obtained at only one epoch, so that proper motions are not available for the GSC stars, and hence proper motions cannot be applied. The standard response to this drawback is that, since faint stars (magnitude 16 and fainter) can be used, proper motions are negligible. Further, the epoch at which the GSC positions were obtained is recent, so again the proper motion correction is negligible. One always had certain qualms about accepting this assurance, since the apparent magnitude of a star depends not only on its distance but also on its absolute luminosity. Stars are known to have an enormous range in luminosity, and it is probable that stars of low luminosity stars are the commonest stars in the Galaxy, and consequently many of the apparently faint stars in the GSC may also be intrinsically faint stars that are nearby and may have appreciable proper motions. Furthermore, as time marches inexorably on, the epoch of the GSC becomes less and less “recent” and one cannot go on indefinitely declaring that proper motion corrections are negligible.

Today, however, the catalogue favoured for astrometric observations of asteroids is the USNU-B Catalog. (USNO = United States Naval Observatory.) This has positions and proper motions for more than a billion objects, so there is no longer any excuse for not applying proper motion corrections to the comparison stars.

This page titled [11.3.2: Proper Motions of the Comparison Stars](#) is shared under a [CC BY-NC 4.0](#) license and was authored, remixed, and/or curated by [Jeremy Tatum](#) via [source content](#) that was edited to the style and standards of the LibreTexts platform.