Appendix 29

The Tychos – Our Geoaxial Binary System

15 October 2019, 11:02 am[1]

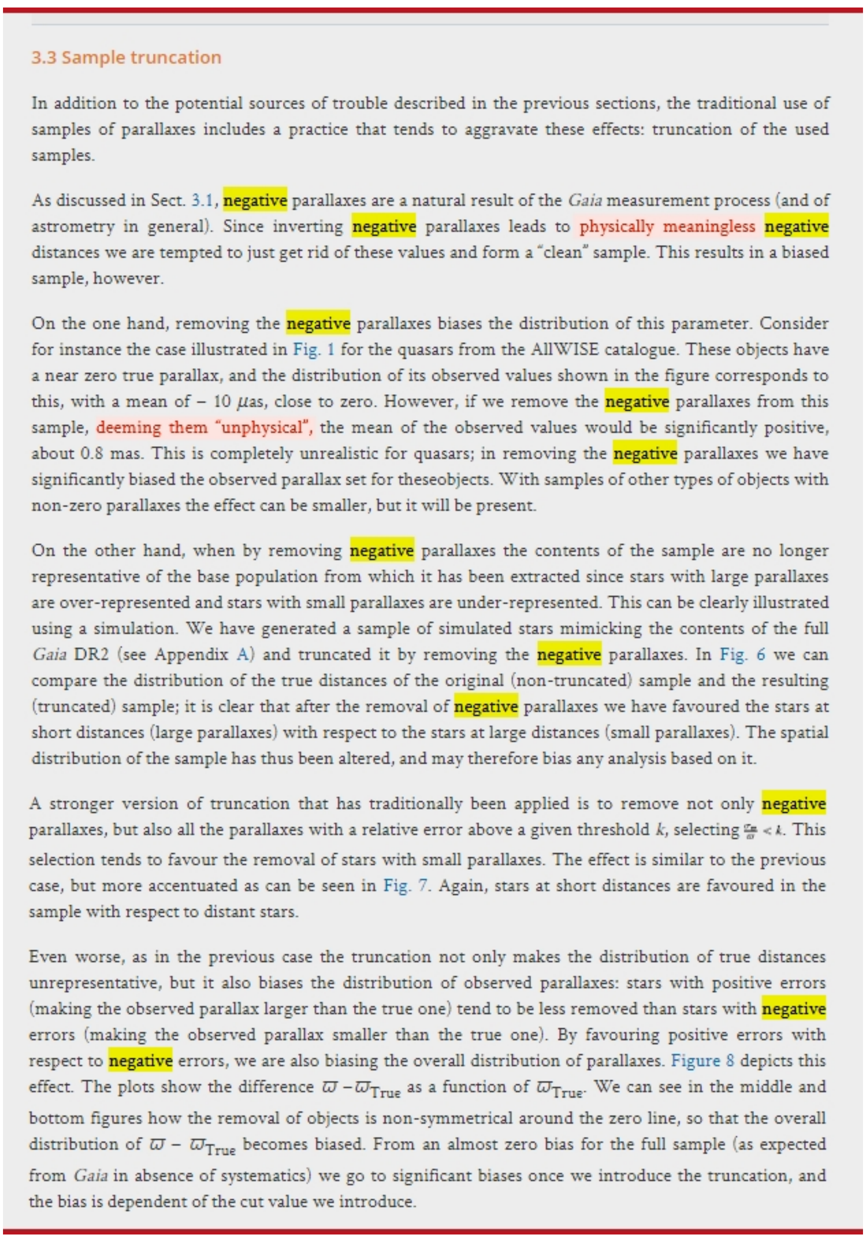
ESA's "explanations" for the observed negative and zero parallaxes

A Swedish veteran astronomer, Paul, who has been vigorously "attacking" the Tychos model through e-mail group discussions over the past year or so, has agreed that within the Copernican model negative parallaxes are obviously unphysical and simply cannot exist. Paul is aware that ESA's largest stellar parallax catalogue (named "Tycho") displays 25% negative parallaxes, 50% zero parallaxes and 25% positive parallaxes, but he believes such parallaxes are nothing but observational errors caused by a series of problems that plagued ESA's "Hipparcos satellite" back in the 1990s. According to Paul, ESA's latest "Gaia satellite" has now solved these problems. Well, this does not seem to be the case: the ongoing Gaia data collection keeps yielding negative stellar parallaxes.

Let us first take a look at a few introductory statements from a tutorial paper[2] released in April 2018 under the title "GAIA Data release 2":

> *"Introduction*
> *The Gaia Data Release 2 (Gaia DR2; Gaia Collaboration 2018) provides precise positions, proper motions, and parallaxes for an unprecedented number of objects (more than 1.3 billion).*
>
> *Critical review of the traditional use of parallaxes*
> *We start this section by briefly describing how parallaxes are measured and how the presence of measurement noise leads to the occurrence of zero and negative observed parallaxes.*
>
> *Using Gaia astrometric data: how to proceed?*
> *The fundamental quantity sought when measuring a stellar parallax is the distance to the star in question. However, as discussed in the previous sections the quantity of interest has a non-linear relation to the measurement, r = 1/ϖTrue, and is constrained to be positive, while the measured parallax can be zero or even negative."*

Below is a screenshot from the above paper showing a section on sample truncation. It starts by stating that negative parallaxes are a natural result of the Gaia measurement process (!) and proceeds to "explain" why negative parallaxes, in spite of being "meaningless" and "unphysical", should basically be retained—not "truncated"—so as to prevent introducing bias into the analysis of any given sample of the Gaia stellar parallax data.



3.3 Sample truncation

In addition to the potential sources of trouble described in the previous sections, the traditional use of samples of parallaxes includes a practice that tends to aggravate these effects: truncation of the used samples.

As discussed in Sect. 3.1, negative parallaxes are a natural result of the *Gaia* measurement process (and of astrometry in general). Since inverting negative parallaxes leads to physically meaningless negative distances we are tempted to just get rid of these values and form a "clean" sample. This results in a biased sample, however.

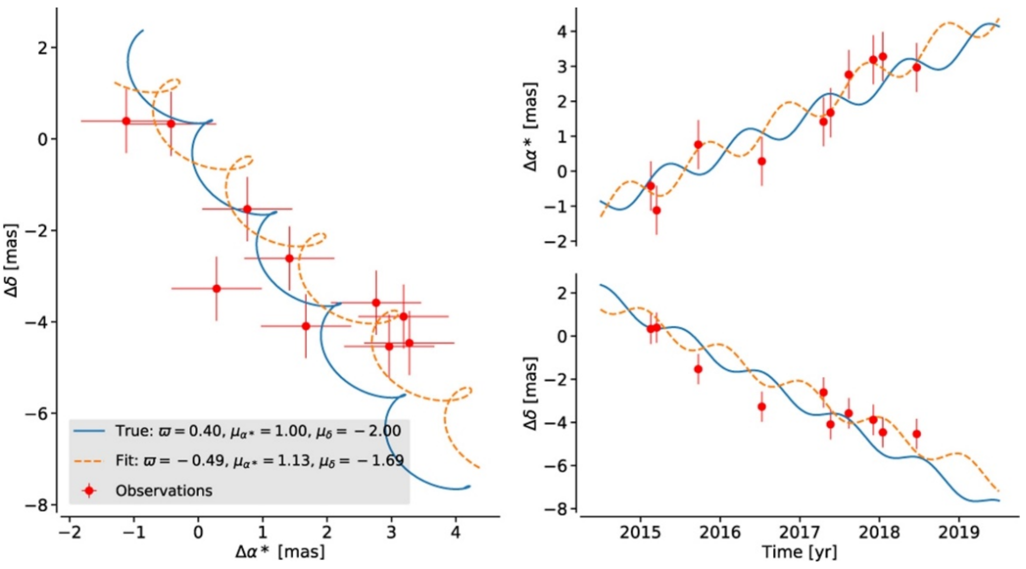
On the one hand, removing the negative parallaxes biases the distribution of this parameter. Consider for instance the case illustrated in Fig. 1 for the quasars from the AllWISE catalogue. These objects have a near zero true parallax, and the distribution of its observed values shown in the figure corresponds to this, with a mean of – 10 μas, close to zero. However, if we remove the negative parallaxes from this sample, deeming them "unphysical", the mean of the observed values would be significantly positive, about 0.8 mas. This is completely unrealistic for quasars; in removing the negative parallaxes we have significantly biased the observed parallax set for theseobjects. With samples of other types of objects with non-zero parallaxes the effect can be smaller, but it will be present.

On the other hand, when by removing negative parallaxes the contents of the sample are no longer representative of the base population from which it has been extracted since stars with large parallaxes are over-represented and stars with small parallaxes are under-represented. This can be clearly illustrated using a simulation. We have generated a sample of simulated stars mimicking the contents of the full *Gaia* DR2 (see Appendix A) and truncated it by removing the negative parallaxes. In Fig. 6 we can compare the distribution of the true distances of the original (non-truncated) sample and the resulting (truncated) sample; it is clear that after the removal of negative parallaxes we have favoured the stars at short distances (large parallaxes) with respect to the stars at large distances (small parallaxes). The spatial distribution of the sample has thus been altered, and may therefore bias any analysis based on it.

A stronger version of truncation that has traditionally been applied is to remove not only negative parallaxes, but also all the parallaxes with a relative error above a given threshold k, selecting $\frac{\sigma_\varpi}{\varpi} < k$. This selection tends to favour the removal of stars with small parallaxes. The effect is similar to the previous case, but more accentuated as can be seen in Fig. 7. Again, stars at short distances are favoured in the sample with respect to distant stars.

Even worse, as in the previous case the truncation not only makes the distribution of true distances unrepresentative, but it also biases the distribution of observed parallaxes: stars with positive errors (making the observed parallax larger than the true one) tend to be less removed than stars with negative errors (making the observed parallax smaller than the true one). By favouring positive errors with respect to negative errors, we are also biasing the overall distribution of parallaxes. Figure 8 depicts this effect. The plots show the difference $\varpi - \varpi_{True}$ as a function of ϖ_{True}. We can see in the middle and bottom figures how the removal of objects is non-symmetrical around the zero line, so that the overall distribution of $\varpi - \varpi_{True}$ becomes biased. From an almost zero bias for the full sample (as expected from *Gaia* in absence of systematics) we go to significant biases once we introduce the truncation, and the bias is dependent of the cut value we introduce.

The paper even contains a diagram with an "example of a negative parallax arising from the astrometric data processing":



[1] https://cluesforum.info/viewtopic.php?p=2412871#p2412871
[2] https://www.aanda.org/articles/aa/full_html/2018/08/aa32964-18/aa32964-18.html

The caption of the above diagram runs as follows:

> *"Example of a negative parallax arising from the astrometric data processing. Solid blue lines, true path of the object; red dots, the individual measurements of the source position on the sky; dashed orange lines, the source path according to the least-squares astrometric solution, which here features a negative parallax. Left: path on the sky showing the effect of proper motion (linear trend) and parallax (loops). Right: right ascension and declination of the source as a function of time. In the fitted solution the negative parallax effect is equivalent to a yearly motion of the star in the opposite direction of the true parallactic motion (which gives a phase-shift of π in the sinusoidal curves in the right panels). The error bars indicate a measurement uncertainty of 0.7 mas, the uncertainties on $\Delta\alpha^*$ and $\Delta\delta$ are assumed to be uncorrelated."*

In conclusion—and much to some people's chagrin—negative stellar parallax measurements are here to stay.
