PPM: A TOOL FOR ASTRONOMERS

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ABSTRACT. The new catalogue of Positions and Proper Motions ("PPM") was compiled to replace the AGK3 and SAO catalogues as an astrometric reference on the northern celestial hemisphere. It provides more than 180 000 reference stars, is on the system of FK5 (J2000.0) and has a higher accuracy than the two older catalogues.
Some properties of PPM and its High-Precision Subset are presented.

1. INTRODUCTION

PPM gives positions and proper motions of 181731 stars north of -2.5 degrees declination. Its main purpose is to provide a convenient, dense and accurate net of astrometric reference stars on the northern celestial hemisphere. This net is designed to represent as closely as possible the new IAU (1976) coordinate system on the sky, as defined by the FK5 catalogue. In other words, it is a representation of the FK5 system at higher star densities and fainter magnitudes.

Two older catalogues of similar character have served the same purpose in the past decades: AGK3 and the SAO Catalogue. There are three major reasons to replace these now:

1) SAOC and AGK3 are representations of the now obsolete FK4 system of positions and proper motions. Astronomers should have a direct access to the FK5 system.

2) The accuracy of positions and proper motions in AGK3 and SAOC is no longer satisfactory. Astronomers should have a more accurate tool. Over more than a century astrometrists have accumulated a vast treasure of measured star positions. The power of present-day computers makes it easy to analyse and combine this amount of data.

3) Proper motions in AGK3 and SAOC were derived from only two separate source positions per star. This lack of redundancy lead to a large number of coarse errors in those catalogues. With more than two measurements per star such errors can be largely avoided. In this way astronomers now get a more reliable astrometric tool.

PPM is available on magnetic tape from the astronomical data centers CDS at Strasbourg, France and NSSDC at Greenbelt, Maryland - or from the authors. A printed version is aimed at.

J. H. Lieske and V. K. Abalakin (eds.), Inertial Coordinate System on the Sky, 465–467.

2. PROPERTIES OF PPM

The table below shows a summary of the accuracy budget of PPM. Each line of the table gives the following data for the particular set of stars indicated: The number of stars in the set, the average number of source positions per star, the average of the mean epochs (for right ascension and declination), the average of the mean errors of proper motion (for right ascension and declination) and the average of the mean errors of position at epoch 1990 (again for right ascension and declination). Units are seconds of arc and seconds of arc per century, respectively. At the bottom of the table the corresponding values for AGK3 and SAOC are given for comparison.

Table 1: Accuracy budget of PPM

set of stars	No. stars	No. obs.	mean epochs		mean err. prop. mot.		mean err. pos. 1990	
PPM, all stars	181731	6.2	1931.5	1930.7	0.43	0.42	0.27	0.27
PPM, HPS stars	31841	7.8	1950.3	1948.0	0.24	0.25	0.12	0.12
PPM, FK5 stars	1365	---	1954.2	1945.2	0.08	0.10	0.04	0.05
AGK3	181581	2.0	1945	1945	0.95	0.95	0.45	0.45
SAOC, north	133000	2.0	1930	1930	1.5	1.5	0.9	0.9

Three subsets of PPM are shown in the table: The first line refers to the entire catalogue, the third line to the FK5 stars and the second line to the High-Precision Subset (HPS) of PPM. This subset is defined as the set of PPM stars for which either Carlsberg Meridian Catalogue or AGK3R observations are available. Its superior precision in present-day positions is mainly due to the work done at the Carlsberg Automatic Meridian Circle. Applications of PPM demanding utmost accuracy rather than high star density should use HPS stars only.

Note that (on average) more than 6 measured positions were used per star. This redundancy allowed to discover (and eliminate) a large number of coarse errors in the source catalogues. The positions and proper motions given in PPM should be highly reliable, therefore.

3. PRESENTATION OF DATA IN PPM

The physical units used and the arrangement of stars are the same as in the printed SAOC. The stars are arranged in belts of 10 degrees width. In addition to the positions and proper motions and their respective mean errors PPM gives the following data for each star: Spectral type and magnitude (both copied from AGK3), SAOC number, HD number, AGK3 number, DM number and a set of flags. The astrometric data are given for equator and equinox J2000.0, on the system of FK5. The flags indicate double stars, members of the HPS, peculiar object designations and some uncertain astrometric data, for instance.

As PPM presently does not cover the southern celestial hemisphere the PPM magnetic tape contains also a J2000.0 (FK5) version of the southern portion of SAOC. In addition all data given for J2000.0 are repeated for equator and equinox B1950.0 on the system of FK4.

Discussion

WARREN: Prof. Jaschek (*see editorial remark below*) used his usual insight when he made the comments that you cited. We recently performed statistics on archived catalogs disseminated from the data centers and we found that the two most frequently requested catalogs are the SAOC and the Bright Star Catalogue. The SAO is often used for applications such as spacecraft tracking and guidance and for general reference because it includes the whole sky; however, it is well known that the SAO catalog has its real problems in the south. The PPM is a valuable piece of work and will help the situation, but clearly there is a lot to do yet because such a catalog must cover the whole sky in order to be useful for many present-day applications.

EDITOR'S NOTE: The remark by Jaschek is contained in *Mapping the Sky*, Proceedings IAU Symposium 133 (S. Débarbat *et al.* eds.) page 381: *"Now it is unnecessary to ask your opinion about SAO, because there seems to exist a certain consensus that it is not the best catalogue which could have conceivably been constructed. But the general use made of it shows that for non-astrometrists it is the catalog "par excellence." I think this underlines very clearly the needs of the non-specialist for astrometric data, and it tells also that the astrometric community has not been very active in responding to these needs. If astrometrists feel that one could do better than SAO, then DO IT—but please do not tell that one has to wait until HIPPARCOS is reduced, or give some other date from here in twenty years. Users wish to have data NOW."*

BASTIAN: I fully agree. It is clear that a southern-hemisphere equivalent has to be provided as quickly as possible. We shall do this within about a year. The improvement in the south will indeed be much larger, simply because the SAOC has such an utterly low accuracy in the south.

CORBIN: (1) You have over 400,000 AC positions in your list. Are they of different stars? You have only 182,000 in your catalog.

(2) What zones do you cover with your AC data?

(3) How do you determine the mean errors of your proper motions? From propagation of errors?

BASTIAN: (1) The Astrographic Catalogue was designed to be a two-fold coverage of the sky. In fact it is even 2.5-fold. So we have 2.5 independent positions for each star.

(2) We used all AC zones from –2° to +90° declination. We were lucky to find punched cards with the necessary data on them in the Strasbourg and Hamburg observatories. At Strasbourg we found *all* AC data complete from –2° to +32° on 6 tons of punched cards. Luckily we did not need to read all of these cards, because most of the data had already been read onto a tape. You had this tape in your possession and kindly gave it to us. At Hamburg we found punched cards from +32° to the pole. But these did not contain *all* AC data for these zones. Dieckvoss 20 years ago had selected only the data for the AGK3 stars from the printed AC volumes. These data were kindly given to us by Drs de Vegt and Steinbach.

(3) Yes, error propagation using separately determined weights for each catalogue. The weights were determined in different ways for different catalogues.