WIDE-FIELD STELLAR STATISTICS FROM TAUTENBURG SCHMIDT PLATES

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1. Introduction

For a detailed investigation of the kinematics of our Galaxy we need accurate proper motions and photometric data of stars over a wide range of magnitudes. The proper motions have to be obtained with respect to an extragalactic, i.e. nonrotating reference system. The best way to determine absolute proper motions of a great number of stars for further statistical analysis is to use the enormous amount of information stored on photographic plates taken with large Schmidt telescopes within the last decades. Since automated measuring machines have become available it is no longer a problem to extract this information from a Schmidt plate. Large Schmidt plates cover a sky area of more than 30 square degrees with usually thousands of stars and hundreds of galaxies per square degree outside the galactic plane. With the Tautenburg Schmidt telescope (134/200/400) more than 8000 plates have been taken in selected Northern sky areas since it was mounted in 1960. A 24 cm x 24 cm Tautenburg plate covers a field of about 10 square degrees, and a 20 minute exposure of a B plate has a limiting magnitude of 19 to 21. In comparison to other large Schmidt telescopes the plate bending is reduced to a minimum due to the four metre focal length and the use of relatively small plates. Therefore irregular positional shifts of the emulsion caused by the rebending after the exposure are of less influence. The large focal length leads to a plate scale of 51 arcsec/mm providing a relatively high positional accuracy.

2. Astrometry

For Tautenburg plates measured with the automatic measuring machine MAMA in Paris or APM in Cambridge (cf. Schilbach & Scholz 1992), a positional accuracy of about 1 μm is typical over a wide range of magnitudes and becomes much worse at about one magnitude above the plate limit. Consequently, with two Tautenburg plate pairs and a 20 years base line a proper motion accuracy of about 3 mas/year can be achieved for the majority of stars. The plate reduction is carried out using the method of stepwise regression (Hirte et al. 1990) with a complete third-order polynomial as the starting model. Generally, an inclusion of higher terms does not improve the accuracy of final results significantly. Outside the galactic plane, proper motions can be obtained with respect to hundreds or even thousands of galaxies.

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3. Photometry

The internally calibrated APM magnitudes (Bunclark & Irwin 1983) measured on Tautenburg plates are linearly related to photoelectric ones, so that a zero-point calibration can be done with only a few photoelectric standards. For MAMA measurements, we fit the magnitudes and MAMA density fluxes of the standards. The relationship is non-linear. Therefore, a sufficient number of standards covering the whole range of magnitudes is necessary. No significant colour equations could be found on the Tautenburg plates analysed. An accuracy of photographic magnitudes of about 0.05 mag can be achieved for stars with $B < 18$ provided two plates of the same colour are used.

4. Potsdam Astrometric Programmes with the Tautenburg Schmidt Telescope

About 3,000 photographic plates were taken in Tautenburg before 1970. As the Tautenburg Schmidt was not designed for a sky survey and was predominantly used for a detailed study of selected areas, there are a few fields with more than 100 plates and 70 fields with at least 4 plates (Scholz & Hirte 1991). These observations present an important potential for different proper motion programmes. About 50 fields with at least two first epoch plates of good quality are included in Potsdam proper motion programmes. Independent of initial programmes, the results for bright stars ($B < 12$) are proposed to be included in the link of HIPPARCOS proper motions to an extragalactic reference frame (Dick et al. 1987).

- *Link of the HIPPARCOS catalogue to an extragalactic reference frame.* Absolute proper motions of HIPPARCOS stars obtained with Tautenburg plates will be used to link HIPPARCOS proper motions to an extragalactic reference frame. With approx. 600 link stars, the residual rotation of the HIPPARCOS system can be reduced to less than 1 mas/year. This provides nearly the same accuracy of the link as VLBI observations.
  For approx. 50 extragalactic radio sources, optical positions will be determined with Tautenburg plates taken during the last 5 years. Generally, the objects are very faint and, therefore, their optical positions can only be obtained with powerful telescopes. Positions are derived with respect to faint stars of the Hamburg programme reduced to the FK5 system.
- *Stellar kinematics of stars in the main galactic meridian.* Absolute proper motions and B, V magnitudes for stars up to 18 mag are obtained in 17 fields along the main galactic meridian (Schilbach 1988). Kinematic interpretation of data for approx. 100,000 stars in the direction of the Galactic North Pole, Centre and Anticentre is in progress (Kharchenko et al. 1993).
- *Kinematics of star clusters.* A catalogue of proper motions and photographic B, V, R magnitudes for 30,000 stars up to 18 mag in the region of Pleiades is in preparation (Schilbach et al. 1992). An accuracy of 2 mas/year and 0.05 mag has been estimated for the majority of stars in the survey. The data are used for the determination of the Pleiades membership and kinematic study in an approx. 16 square degree region centred near Alcyone. Mean absolute proper motions of the globular clusters M 3 and M 92 were derived with an accuracy of 0.6 mas/year. The data have been used for the determination of galactic orbits of the clusters (Scholz et al. 1993). Measurements of Palomar and Tautenburg Schmidt plates with seven other globulars have been completed.

References

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