MEASUREMENT OF THE ABSOLUTE PROPER MOTIONS OF THE MAGELLANIC CLOUDS[1]

H.-J. TUCHOLKE, M. HIESGEN
Astronomisches Institut der Universität Münster
Wilhelm-Klemm-Strasse 10
D-4400 Münster
F.R. Germany

ABSTRACT. Currently, we are measuring the absolute proper motions of the Magellanic Clouds relative to background galaxies, using plates taken with the ESO Schmidt Telescope. In spite of the small epoch difference of about 15 years, an accuracy of 0.5-1.0 milliarcsecs (mas) may be achieved using large numbers of stars and galaxies. Measurement and reduction procedures are presented; a preliminary solution for the absolute proper motion of the LMC from the measurements of three plates gives a result similar to the independent study of Jones *et al.* (1989).

1. Introduction

Lin and Lynden-Bell (1982) predicted the proper motion of the LMC to be 2.0 mas or 1.5 mas due east, for a galactic model with or without a massive halo, respectively. The tangential velocity of the LMC may be inferred from the rotation of the kinematic versus photometric line of nodes, if the direction of motion is assumed. Meatheringham *et al.* (1988) found v_{LMC} = 275±65 km s^{-1} corresponding to a proper motion of 1.2±0.3 mas, assuming that the direction of motion is parallel to the Magellanic Stream with a position angle of 110°. Direct astrometric measurements of the tangential motion of the MCs are now being pursued by several groups. Jones *et al.* (1989) reported a preliminary proper motion of the LMC relative to galaxies of about 1 mas, which agrees better with the kinematic results than with the models. This paper presents an approach to measuring the absolute proper motion of the Magellanic Clouds relative to background galaxies using Schmidt plates of small epoch differences, but large number of stars and galaxies.

2. Observational material

The plate material consists of ESO Schmidt plates (scale 67".52/mm). Quick Blue Survey (QBS) plates with limiting magnitude $20^m.5$ serve as first-epoch plates; two second-epoch plates per field were taken in 1988-89 for each of the seven fields in the LMC and the five fields in the SMC. The expected accuracy of individual proper motions is modest due to the short epoch difference of about 15 years, while the mean proper motion of the LMC should be defined much better due to the large number of LMC stars available; the accuracy of the absolute proper motion is dictated by the much smaller nuamber of reference galaxies.

---

[1] Based on plates taken with the Schmidt Telescope at European Southern Observatory, La Silla, Chile

R. Haynes and D. Milne (eds.), The Magellanic Clouds, 491–492.

3. Measurements and reduction

All plates are digitized with the PDS 2020 GM^{plus} microdensitometer at the Astronomical Institute of Münster University. Image frames for all objects exceeding a predefined threshold above the local background are stored on-line (Horstmann 1988). Up to now, the plates for two LMC fields have been measured; here, we report on the preliminary reduction of the ESO/SRC atlas field no. 57, due east of the LMC bar.

On the average, 6×10^5 objects were found per plate. After computation of image centres, radii and internal magnitudes, an automatic classifier, developed for fields at high galactic latitude (Horstmann 1988), separated the objects into stars and galaxies. Typically, $\leq 5\%$ of the objects were classified as galaxies.

The galaxies found in the previous step are used to compute the plate-to-plate transformations; thus the resulting proper motions will be absolute. Taff *et al.* (1990) warned against the use of global transformation models for Schmidt plates. Since we must avoid all sources of systematic errors, which would propagate to large proper motion errors due to the short epoch difference, we follow the suggestion of Taff*et al.* to divide the plates artificially into subplates and to compute the plate-to-plate transformations for independent, non-overlapping subplates. By this method, local irregularities, occurring randomly on Schmidt plates, may be corrected. A drawback of this approach is the reduced number of transformation galaxies per subplate, increasing the error of the absolute proper motion. Another critical point of the current analysis is the automatic classification of galaxies, which was trained in a non-crowded field. For the preliminary reduction only visually classified galaxies were used.

4. Results

With a division into 24 subplates, and 498 galaxies used for the plate-to-plate transformation , the absolute proper motion of the LMC is

$$\mu_\alpha \cos\delta = +0.91 \pm 2.34 \text{ mas}$$
$$\mu_\delta = -0.23 \pm 2.77 \text{ mas.}$$

The proper motion is similar to the one found by Jones *et al.* (1989) and compatible with the kinematic results, but smaller than the predictions by Lin and Lynden-Bell (1982). The errors result from the transformation *rms* error divided by the epoch difference and by the square root of the mean number of transformation galaxies per subplate. In the future, we will adapt the automatic galaxy classification to crowded fields in order to reduce the errors of the reference system. Proper motions from overlapping plates will be compared to check their accuracies.

5. References

Horstmann, H. (1988), *Large-Scale Structures in the Universe, Observational and Analytical Methods*, W.C. Seitter *et al.* (eds.) (Springer-Verlag: Berlin) p.111.
Jones, B.F., Klemola, A.R., Lin, D.N.C. (1989), *Bull. Amer. Astron. Soc.* **21**, 1107.
Lin, D.N.C., Lynden-Bell, D. (1982), *M.N.R.A.S.* **198**, 707.
Meatheringham, S.J., Dopita, M.A., Ford, H.C., Webster, B.L. (1988), *Astrophys. J.* **327**, 651.
Taff, L.G., Lattanzi, M.G., Bucciarelli, B. (1990), *Astrophys. J.* **358**, 359.