THE LICK NORTHERN PROPER MOTION PROGRAM

A.R. KLEMOLA, R.B. HANSON AND B.F. JONES
UCO/Lick Observatory
University of California, Santa Cruz, CA 95064 USA

1. Introduction

The Lick Northern Proper Motion (NPM) Program will provide absolute proper motions (referred to faint galaxies), equatorial coordinates, and two-color photographic photometry for some 300,000 stars with $8 < B < 18$ covering the 70% of the sky north of declination $-23°$. Part 1 of the NPM program (NPM1), recently completed, covers the 72% of the northern sky (899 of 1,246 fields) outside the Milky Way. Two catalogs result from NPM1: The NPM1 Catalog (Klemola *et al.* 1993a, Hanson 1993a) contains 149,000 stars. The NPM1 Reference Galaxy List (Klemola *et al.* 1993b, Hanson 1993b) contains 50,000 faint galaxies. Klemola *et al.* (1987, 1994, 1995) describe the NPM program. Hanson *et al.* (1994) describe the NPM1 Catalogs.

In the present paper we give an overview of the stellar content of the NPM1 Catalog, describe current and future applications of the NPM data, and outline plans for the Part 2 of the NPM program (NPM2) – the Milky Way sky.

2. Content of the NPM1 Catalog

The NPM1 Catalog is arranged in one-degree zones of declination, from $+89°$ to $-23°$. Each star is assigned a running number within its zone, in right ascension order. Multiple measures from overlapping fields have been averaged to give one entry per star. Where available, the AGK3 (north of $-2°$) or SAO (south of $-2°$) number is given.

The NPM1 Catalog contains three general categories of stars (Table 1). Large samples of anonymous stars, in two magnitude ranges ($10 < B < 13$ and $14 < B < 17$) were selected for use in the astrometric reductions and for statistical studies of solar motion and galactic rotation. Samples of stars

TABLE 1. Major Components in NPM1 Catalog

Component	Number*	Comment
Anonymous Stars	93,935	Mag. 12 & 16
Positional Reference	23,242	AGK3 & SAO
Special Stars	34,717	Various classes
Stars (total)	148,940	NPM1 Catalog

*Numbers exceed total due to duplicate entries.

from the AGK3 and SAO catalogs were used for astrometric and photometric reductions. These catalog stars will also be useful for galactic and astrometric studies. Finally, many stars of astrophysical interest, selected by Klemola from the astronomical literature and complied in the Lick *Input Catalog of Special Stars*, were measured for the NPM1 Catalog. Counts of some of the more numerous classes are given in Table 2. Certain stellar classes form the basis of studies in progress, or planned, at Lick and elsewhere. Some such studies are noted in the next section.

To enhance the utility of the NPM1 Catalog, Klemola has assembled a file giving some 42,000 cross-identifications between the NPM1 Catalog and the original source identifications for each of the 35,000 Special Stars. This *NPM1 Cross-Identifications File* will be deposited with the data centers in 1994, allowing users to select all stars of a given type from the NPM1 Catalog, as well as locating individual stars of interest.

TABLE 2. Some Classes of Special Stars in NPM1 Catalog

Class	Number	Class	Number
FBO/FBS	4805	Variables (all)	3020
White Dwarf	1405	RR Lyr	1059
Dearborn (gKM)	1846	Semi-Regular	453
Horizontal-Branch	995	Eclipsing	537
UV-Excess	309	Mira	357
Subdwarf	191	Irregular (L)	297
Metal-Deficient	169	UV Cet	131
Carbon & S	158	Irregular (I)	43

3. Applications of the NPM1 Catalog

Several immediate applications of the NPM1 absolute proper motions are already underway at Lick and in collaborations with other institutions.

Hanson (1987, 1989) used faint anonymous stars from a partial version of the NPM1 catalog, then about 60% complete, to study the solar motion and galactic rotation. These studies now continue with the full NPM1 Catalog, including the brighter anonymous and catalog stars. The catalog stars will also be used to redetermine the corrections to the constants of precession.

The NPM1 Catalog contains over 1000 RR Lyrae stars, whose proper motions will be valuable for statistical studies. Layden *et al.* (1994) have combined the NPM1 data for 200 RR Lyraes with new metal abundances and radial velocities in a major new statistical parallax luminosity calibration.

The NPM1 Catalog contains over 5000 halo population candidate stars of several types. Reduced proper motion diagrams are being used to isolate sub-samples (e.g. ∼1000 field horizontal-branch stars) for galactic studies and further observations.

Another important application of the NPM1 results is to help link the Hipparcos proper motions with the extragalactic reference frame. The NPM1 Catalog has nearly 13,000 stars in the Hipparcos Input Catalogue. Intercomparison will give a major check of the Hipparcos proper motion frame.

4. Steps Toward the NPM2 Catalog (Milky Way)

Part 2 of the NPM program (NPM2) will cover the remaining 28% of the sky north of −23°, the Milky Way zone (347 NPM fields). Here the lack of galaxies requires an alternative means of defining the proper motion reference frame. We intend to use the Hipparcos results to supply the final correction from relative to absolute proper motions for NPM2.

Plate surveys and measurements for NPM2 will begin in 1995, using the Hipparcos Input Catalogue to select reference stars. In addition, large samples of stars will be taken from the Tycho program. We expect NPM2 will take 3–5 years to complete. As in NPM1, data reductions will proceed in step with the measurements, except that the proper motion zero-point reductions will await the availability of the final Hipparcos results at the end of 1996.

The total number of stars in NPM2 will roughly equal the 150,000 in NPM1. The the number of stars *per field* will be much higher. The Lick *Input Catalog of Special Stars* will be updated and expanded to include more fully the many classes of stars which are concentrated towards the

Galactic plane, or toward the Galactic center. Hence NPM2 will contain a much higher fraction of Special Stars than NPM1.

5. Acknowledgements

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