Lick Northern Proper Motion Program: NPM1 Reference Galaxies

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Documentation for the Computer-Readable Version

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Abstract

The Lick Northern Proper Motion (NPM) program measured proper motions, positions, and photographic photometry for some 149,000 stars (NPM1 Catalog) covering the sky outside the Milky Way north of declination $-23°$. The NPM1 proper motions were measured with respect to an absolute reference frame defined by some 50,000 faint galaxies (mostly $16 < B < 18$). The rms position errors for the NPM1 reference galaxies average $\sim 0\farcs2$. The rms errors for the B magnitudes average ~ 0.25 mag.

1 Introduction and Source Reference

A copy of this document should accompany any further distribution of this file.

1.1 Introduction

The Lick Northern Proper Motion (NPM) program is a mammoth photographic survey of the northern sky, whose goal is to measure absolute proper motions on an inertial system defined by some 50,000 faint galaxies for some 300,000 stars over a blue apparent magnitude range from 8 to 18, covering the northern two-thirds of the sky. A full description of the NPM program is given by Klemola, Jones, and Hanson (1987).

The NPM survey is based on photographs taken with the Lick 51 cm (20 in) Carnegie double astrograph. There are 1,246 $6° \times 6°$ fields in the NPM survey (from $+90°$ to $-23°$). First-epoch photography began in 1947; second-epoch photography was completed in 1988. Measurements and reductions for proper motions, positions, and photometry in the sky outside the Milky Way began in 1975 and were completed in 1992.

The NPM program falls into two parts: Part I covers the 72% of the northern sky lying outside the Milky Way. Here, faint galaxies define the inertial reference frame for absolute proper motions. Part II covers the remaining 28% of the northern sky – the Milky Way.

Part I of the NPM program has now been completed (Klemola, Hanson, and Jones 1993). The resulting catalog *(NPM1 Catalog)* contains some 149,000 stars from measures in 899 of the 1,246 NPM fields. The 50,000 NPM1 reference galaxies comprise a separate list, for which positions and blue magnitudes are given here.

1.2 Source Reference

"Lick Northern Proper Motion Program. III: The NPM1 Catalog" 1993, Klemola, A.R., Hanson, R.B., and Jones, B.F., AJ (in preparation).

2 Structure and Content of the NPM1 Reference Galaxy List

2.1 File Structure

The *Lick NPM1 Reference Galaxy List* as distributed here is in a single fixed block file. It contains 50,517 records, each 46 bytes long. This list concatenates 114 NPM1 zones, each covering 1° of declination. The zones are ordered from North to South ($+89^\circ$ through $+00^\circ$, then -00° through -23°). For identification, each galaxy is assigned a running number within its zone, in right ascension order. Multiple measures from overlapping fields have been averaged to give one entry (one record) per galaxy.

This information is sufficient for a user to describe the indigenous characteristics of the machine-readable version of the Lick NPM1 Reference Galaxy List to a computer.

2.2 Content

The NPM1 reference galaxies were selected at the Lick Gaertner survey machine for the fundamental purpose of providing the absolute zero point of proper motion in each NPM1 field (Klemola, Jones, and Hanson 1987). The galaxies selected for measurement lie in the magnitude range $14 < B < 18$, with most in the fainter half of this range, i.e., $16 < B < 18$. Ideally, a reference galaxy should show little or no structure and have a small, generally round shape with a well-exposed core. In practice, to obtain an adequate number of galaxies, most NPM fields rely on a wider range of galaxy types, including many weak, patch-like objects. Typically, from 50 up to a limit of 100 galaxies were selected in each $6^\circ \times 6^\circ$ NPM1 field. Thus, the distribution on the sky of the NPM1 reference galaxies is as nearly uniform as possible.

The NPM1 galaxies were measured for astrometry and photometry in the same manner as the NPM1 stars. However, the galaxy data have two major differences from the stellar data in the *NPM1 Catalog.* First, the proper motions measured for the galaxies simply reflect measurement errors, and contain no information about the galaxies' actual motions, which are vanishingly small. Hence, proper motions are not given in the NPM1 Reference Galaxy List. Second, $B - V$ colors for the NPM1 galaxies are not given, since the NPM1 faint star color reductions (Klemola, Jones, and Hanson 1987) do not apply to galaxies.

Each galaxy's entry begins with its NPM1 "name," containing the NPM1 declination zone and the galaxy's running number within its zone (e.g., +89.0001). Any galaxy in the list can then be specified by prefixing "NPM1G" to the "name" (e.g., NPM1G+89.0001).

Positions are given for equinox B1950. Each galaxy's entry includes the blue magnitude ($\sim B$), the number of NPM fields measured, and discrepancy flags for position, proper motion, and photometry. (Even though proper motions are not listed here, the discrepancy flag has been retained as in the *NPM1 Catalog*, so that all cases with suspect astrometry are flagged.)

The rms errors of the NPM1 galaxy positions average about $0\farcs2$ in each coordinate for declinations

Bytes	Item	Format	Description
1- 8			NPM1 galaxy “name”
1	zsign	a1	Sign of declination for this zone (+ or −)
2- 3	npmzone	i2	Declination zone (degrees)
4- 8	znum	f5.4	Running number in this declination zone
9-21			Right ascension (B1950 Epoch and Equinox)
10-11	irah	i2	Hours
13-14	iram	i2	Minutes
16-17	iras	i2	Seconds (integer part)
18-21	rasec	f4.3	Seconds (fractional part)
22		1x	Blank
23-34			Declination (B1950 Epoch and Equinox)
23	dsign	a1	Sign of declination for this galaxy (+ or −)
24-25	idd	i2	Degrees
27-28	idm	i2	Arc minutes
30-31	ids	i2	Arc seconds (integer part)
32-34	dsec	f3.2	Arc seconds (fractional part)
35-40	bmag	f6.2	Photographic photometry (B magnitude)
41-42	nfields	i2	Number of NPM fields on which this galaxy was measured
43		1x	Blank
44-46			Discrepancy flags (see Table 2)
44	ips	i1	Position
45	ipm	i1	Proper motion
46	ibv	i1	Photometry

Table 1: Data Format for NPM1 Galaxy List

from 0° to +70°. North of +70° and south of the Equator, the positional errors approach $0''.3$. The rms errors for the NPM photographic photometry (B magnitudes) average about 0.25 mag.

Flags	Position	Proper Motion	Photometry
0	O.K.	O.K.	O.K.
1	R.A.	R.A.	B
2	Dec.	Dec.	$B - V$
3	Both	Both	Both
9	Error	Error	Error
Limits	$1.0''$	$3.0''$ cent^{-1}	1.0 mag

Table 2: NPM Discrepancy Flags (Galaxies)

2.3 File Format

Table 1 gives a byte-by-byte description of the contents of the data file.

Table 2 gives a description of the discrepancy flags for proper motion, position, and photometry. (NOTE: Error code [9] may appear in the NPM1 Reference Galaxy List as any serious errors are identified. These objects will be retained to preserve the numbering system. However, their data should not be used.)

3 Notes to the Catalog

As of September 1993 there are no Notes to the NPM1 Reference Galaxy List. Detailed documentation and an updated description of the NPM reductions and catalog preparation will be published separately (Klemola, Hanson, and Jones 1993).

4 Acknowledgments

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5 References

Klemola, A. R., Jones, B. F., and Hanson, R. B. 1987, AJ 94, 501
Klemola, A. R., Hanson, R. B., and Jones, B. F. 1993, AJ (in preparation)