Catalog Information and Recommendations

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1 Introduction

The following is a list of widely used or well known catalogs for astronomical data. It is intended to give users some basic information with regards to the content and usefulness of each. It is not intended as a substitute for journal articles or the catalog introductions.

2 Astrometric Data

FK5 Part I (Fifth Fundamental Catalog - The Basic Fundamental Stars):

Status: Effectively replaced by Hipparcos
This catalog contains the same 1,535 stars as its predecessor, the FK4, but with improved zero points, more internal consistency and smaller individual errors in the stars' positions and motions. This part of the FK5 defined the FK5, J2000.0 system. The average density, however, is only one star per 27 square degrees. The errors quoted in the catalog indicate that on the average the errors at 2000 should be near 0.05 second of arc; however, current observations indicate that the errors may be as great as 0.10 second of arc, especially in the Southern Hemisphere. Results also show that there are systematic errors of 0.10 and more in parts of the sky, especially south of -50 degrees.

FK5 Part II (Fifth Fundamental Catalog - The FK5 Extension):

Status: Effectively replaced by Hipparcos
This part of the FK5 was created for two reasons: First, in addition to the low density, Part I does not have a uniform distribution of stars. Second, the average magnitude in Part I is 4.8 and there are very few stars fainter than 6th magnitude. The USNO collaborated with the Astronomisches Rechen-Institut (Heidelberg) to produce this catalog of 3,117 stars. Thus, the complete FK5 catalog has an average density of one star every 8.9 degrees. Great care was taken to ensure an even distribution over the sky and in both magnitude (to 9th) and spectral type. The positions and motions were compiled differentially on FK4 and transformed to the FK5, J2000.0 system. These stars represent the FK5 system sufficiently well to be part of the FK5 catalog. They have an average accuracy of 0.15 second of arc at 2000.

IRS (International Reference Stars):

Status: Effectively replaced by Hipparcos
The IRS comprises a whole-sky catalog that, by international agreement, was the standard reference for reductions over limited areas. (Currently, the internationally agreed standard reference is the Hipparcos Catalog). The list was formed by combining the AGK3R in the north with the SRS in the south. The catalog was compiled at the USNO by combining 124 meridian circle catalogs and resulted in positions accurate to 0.22 second of arc for 36,027 stars (about one star every 1.1 square degrees), mostly in the 7th to 9th magnitude range. This extends the FK5 system to a much higher density. The positions and motions of 2,100 of the FK5 Extension stars come directly from the IRS. The catalog is available referred to both FK5, J2000.0 and to FK4, B1950.0.

ACRS (Astrographic Catalog Reference Stars)

Status: Effectively replaced by Tycho-2
For some time there has been a general need for a replacement to the Smithsonian Astrophysical Observatory Star Catalog (SAOC), and therefore the USNO compiled the Astrographic Catalog Reference Stars. This work was completed in 1991 and incorporated all suitable star catalogs available at the time. Some 1,700,000 star positions from 170 meridian circle and photographic catalogs were combined to produce 320,211 positions and proper motions. This gives an average density of 7.9 stars per square degree down to magnitude 10.5, and the average positional error is 0.23 second of arc at 2000. Like the IRS, the positions and motions are referred to both FK4, B1950 and to FK5, J2000.0.

The observational histories of some of the stars are not as good as others. Part I contains the stars with the better histories and generally more accurate positions and motions. Part II consists of stars with proper motions derived from only two positions or with high mean errors.

PPM (Positions and Proper Motions):

Status: Effectively replaced with Tycho-2
The PPM catalog was compiled at the Astronomisches Rechen Institut in Germany and contains approximately the same stars as the ACRS north of -2.5 degrees, but more south of there due to the inclusion of a recent southern observing program. The catalog has 181,731 stars (8.6 per square degree) in the northern portion and 197,179 (9.7 per square degree) in the southern, for an overall density of 9.2 stars per square degree. The positions and proper motions are given for FK5, J2000.0 only. The northern and southern parts of the PPM were compiled separately and, thus, there may be a discontinuity at the -2.5 degree line. The formal errors quoted in the catalog give an estimated accuracy of 0.30 second of arc at 2000 for the northern half and 0.16 second of arc for the southern. Since both the ACRS and the PPM are based on the IRS, it is recommended that, for now, the ACRS be used north of -2 degrees and that the PPM be used south of there.

HIPPARCOS:

Status: Recommended for use
This catalog contains 118,218 stars that were observed by the European Space Agency's Hipparcos Satellite, operational from late 1989 to 1993. It is complete to V=7.3. The positional accuracies of 1 to 3 mas at epoch 1991.25 are unsurpassed in the optical. Proper motion accuracies, of around 2 mas/yr, remain state of the art. By international agreement, the Hipparcos catalog is the standard reference catalog for optical astrometry, representing the ICRF in the optical wavelengths. However, in 1999 this agreement was amended to excluded approximately 18,000 stars having flags in column 59, the so-called "problem" and double stars. Hipparcos also contains broad band visual photometric data including variability information. For the brighter stars, this is in the 1 to 2 millimagnitude range. Two color photometry from the Tycho experiment (also flown on the Hipparcos satellite) is also published and is estimated to be good to better than 0.1 magnitudes. The catalog is extensively documented.

TYCHO-1:

Status: Replaced by Tycho-2
Caveats: Very poor proper motions
This one million star catalog contains positional and photometric data from the "star mapper" flown on the Hipparcos satellite. The positional accuracies are 30 to 50 mas at mean epoch of 1991.25. However, the proper motion errors are quite large, at 20-30 mas/yr, making conversions to other epochs not recommended. The ACT reference catalog, compiled using positions from Tycho-1 and the Astrographic Catalogue (see description below), improved the proper motions ten-fold. Tycho-1 also contains two-color photometry (blue and visual) for most of its stars.

ACT Reference Catalog:

Status: Effectively replaced with Tycho-2
The ACT Reference Catalog was compiled at USNO for the express goal of improving the Tycho-1 proper motions. To do this, data from the century-old Astrographic Catalogue was combined with the Tycho-1 positions to determine proper motions for 988,758 stars with about a 100 year base-line. Photometry from Tycho-1 is included, as are cross-references with Tycho-1 and Hipparcos.

TYCHO-2:

Status: Recommended for use
This catalog is the result of a joint collaboration between (primarily) the Copenhagen University Observatory (CUO) and the USNO. CUO re-analyzed the Tycho data from the Hipparcos satellite, which led to better positions for the Tycho-1 stars, as well as extending the number of stars from 1 million to 2.5 million. The USNO was responsible for computing the proper motions, which was done by combining over 140 astrometric catalogs. The result is a global reference catalog that is 99% complete to V=11.0 and 95% complete at V=11.5. Positional accuracies range from about 10 to 100 mas, depending on magnitude. Proper motion accuracies are from 1 to 3 mas. Two color photometry from the Tycho experiment is published, as well. This catalog, along with documentation, is available by contacting the USNO (seu@pyxis.usno.navy.mil).

AC (Astrographic Catalogue):

Status: Limited usefulness by itself due to early epoch
Caveats: Positional catalog only, no proper motions

The Astrographic Catalogue (AC) was an international program to photograph the entire sky and obtain positional measures on all stars 11.0 magnitude and brighter (although there are many stars in the AC as faint as 13.0). The average plate epoch is around 1905, with some observed as early as 1891 and a few as late as 1950. The positions derived from the AC have been combined with modern observations to compute proper motions. Specifically they have been combined with Tycho-1 to form the ACT Reference Catalog, Tycho-2 positions to form the Tycho-2 proper motions, and UCAC to form much of the UCAC1 catalog.

UCAC1 (USNO CCD Astrograph Catalog, 1st release)

Status: Recommended for use
Caveats: Contains most of S. Hemisphere, none of the N. Hemisphere
The UCAC1 is a preliminary catalog containing stars in most of the Southern Hemisphere in the V=8.0 to 16.0 magnitude range. Positions are based on recent observations taken at Cerro Tololo, Chile using the USNO 8-inch astrograph. Proper motions for stars brighter than about 12.5 were derived in the same way as the Tycho-2 were. Fainter stars utilized the positions in the USNO A2.0 for proper motion determination. Positional accuracies are 20 to 70 mas, dependent primarily on magnitude. Proper motion errors are 1 to 12 mas/yr, also magnitude dependent. Photometry is one color and should be used for identification purposes only. This catalog is available by contacting USNO (nz@pisces.usno.navy.mil).

GSC 1.2 (Guide Star Catalog version 1.2)

Status: Not recommended; use Tycho-2, UCAC1 or A2.0 instead
Caveats: No proper motions
The Hubble Guide Star Catalog version 1.2 contains positions for 19 million stars down to 16th magnitude, although it is not complete to this level. No proper motions exist. It is based on plate measures made at Space Telescope Science Institute in Baltimore. Positional errors at the plate epoch are estimated to be near 500 mas.

USNO A2.0

Status: Recommended for use
Caveats: No proper motions
USNO-A2.0 contains entries for 526,230,881 stars which were detected in the digitized images of three photographic sky surveys. For the entire northern sky and the southern sky down to declinations of -30, all the photographic plates were part of the original Palomar Optical Sky Survey (POSS-I). Photographs were taken on blue- and red-sensitive emulsions. Only those stars which were detected in both colors were included in the USNO-A2.0 catalog. The rest of the southern sky was covered by the Science Research Council (SRC)-J survey and the European Southern Observatory (ESO)-R survey. Again, only stars appearing in both colors were accepted for the final catalogue. USNO-A2.0 is contained on 10 CD-ROMs. A2.0 presents right ascension and declination (J2000, epoch of the mean of the blue and red plate) and the blue and red magnitude for each star. It is estimated that the positional error at plate epoch is near 250 mas. Note that no proper motions are given.

USNO SA2.0

Status: Recommended for use
Caveats: No proper motions
USNO-SA2.0 is a subset of USNO-A2.0 which is a lot easier to handle on a small computer because it contains only a tenth as many stars as the parent catalog (54,787,624 stars in all). The goal in creating this smaller catalog was to provide a spatially uniform distribution of stars in an intermediate range of magnitudes which would be useful as a "reference grid" for astrometric analysis.

3 INFRARED SOURCES

CPIRSS - (Catalog of Positions of Infrared Stellar Sources):

Status: Recommended for use
The CPIRSS is the result of combining NASA's Infrared Astronomy Satellite Point Source Catalog (IRAS) with the data of the catalogs in Section I. The description of the original CPIRSS, released January 1994, can be found in the Astronomical Journal 107 1 pg 280-286. Two upgrades have been made since the original release. In 1996, 4022 new sources were added, bringing the total to 37,700. In 2000, better astrometry was substituted. Of the 37,700 stars, all but 105 were found in either the Hipparcos or Tycho-2 catalogs. The astrometry for these are given, as well as the observed IRAS fluxes at 12, 25, 60 and 100 microns. Computed fluxes at 2.2 microns are given for the 18,000 stars that show no evidence of excess emission in the infrared.

2MASS - (Two Micron All Sky Survey):

Status: Recommended for use
Caveats: Does not yet cover entire sky; no proper motions
The 2MASS project aims to observe roughly 300 million stars and a few million galaxies in the near IR realm. The project is being managed by University of Massachusetts, and utilizes two telescopes, one in the Northern Hemisphere, one in the Southern. The data are being released in increments, two have been made available at this time. These cover roughly 45% of the sky. The positions are estimated to be good to about 200 mas. Expected catalog completion in 2002.

4 CATALOGS FORTHCOMING

The following is a short list of catalogs that should be available in the near future. Only educated guesses regarding the numbers of stars and accuracies can be made at this time.

UCAC final (USNO CCD Astrograph Catalog, final release)

Expected availability: 2004
The UCAC final will be the culmination of the UCAC project, described above. It is expected that 80 million stars from V 7.5 to 16.5 covering the entire sky will be included. Positions will be magnitude dependent and range from about 15 to 70 mas. Proper motions will be in the 1 to 5 mas/yr range.

USNO B

Expected availability: 2001
The USNO B will be the successor to the A2.0 catalog, described above. Primary difference is that the B will include proper motions and more stars.

GSC 2 (Guide Star Catalog 2

Expected availability: 2002
The GSC 2 will be the successor to the GSC 1.2 catalog. Primary difference is that the GSC 2.0 will contain vastly more stars than the 1.2 version (upwards to 500,000,000) and contain proper motions.

5 DOUBLE STARS

WDS (The Washington Double Star Catalog):

Status: Recommended for use
The Washington Double Star Catalog maintained by the USNO is the official database of double and multiple star data for the International Astronomical Union. The WDS Catalog contains positions (ICRS), discoverer designations, epochs, position angles, separations, magnitudes, spectral types, proper motions, and, when available, Durchmusterung numbers and Notes for the components of 83,293 systems based on 546,648 means. The present WDS is a major revision of the 1984.0 and 1996.0 versions. More precise Hipparcos and Tycho magnitudes have been included where available, as have MK spectral types. A major observing effort at the USNO has increased the number of systems with accurate interferometric data, and has also reexamined many unconfirmed or long-neglected systems. The WDS Notes have been extensively revised to include information on orbital motion and multiplicity (including astrometric, photometric, and spectroscopic), variability, composite spectra, etc. Stars with Durchmusterung numbers have been individually compared with the SIMBAD database. Since new data are continually being added to the database, the WDS is updated on a nightly basis. Upon request, data from the catalog are supplied to users world-wide (bdm@draco.usno.navy.mil).

Fifth Orbit Catalog:

Status: Recommended for use
The data available here include all published orbital elements for systems whose orbits have been determined. Also included are ephemerides that span the next five years. The catalog is continually maintained on the World Wide Web. All orbits are graded on a numerical scale; plots of each orbit with all available astrometric data also allow the user to judge a given orbit's quality. Where sufficient measurements have been made, orbits have been determined for those stars that show orbital motion. These orbital determinations are periodically published in leading astronomical journals. In addition, special requests for ephemerides of orbit stars can be met by the USNO.

6 MAGNITUDES AND SPECTRAL TYPES

HD (Henry Draper Catalogue):

The Henry Draper Catalogue with 225,300 entries was completed in 1924 and for many years has been the standard source for magnitudes and spectral types. However, more recent photometric data and spectral classification (which now often includes luminosity class) are available for many stars. This is especially true for stars brighter than 8th magnitude. Hipparcos and Tycho-2 provide 2-color photometry for most of their stars, which may be sufficient for many users. However, the best spectral classifications are not collected into a single source and are, therefore, not conveniently obtained. The star catalogs listed above give magnitudes, and some give spectral types though many of these data originally come from the HD.

7 PARALLAXES

Hipparcos:

Status: Recommended for use
One of the primary goals of the Hipparcos mission was to measure accurate parallaxes for the stars it observed. The mission was successful, and the Hipparcos parallaxes are among the most accurate found. See above description for the catalog.

General Catalogue of Trigonometric Stellar Parallaxes, 4th Edition

Status: Recommended for non-Hipparcos stars
The General Catalogue of Trigonometric Stellar Parallaxes has been prepared at the Yale University Observatory. This completely revised and enlarged two-volume edition contains 15,994 parallaxes for 8,112 stars published before the end of 1995. In this Fourth Edition, 1,722 (27%) new stars have been added to those contained in the previous edition by Jenkins (1963). The mode of the parallax accuracy for the newly added stars (0.004" s.e .) is considerably better than in the previous editions (about 0.016"). Approximately half of the newly added stars are fainter than the Hipparcos Astrometric Satellite's magnitude limit of 13.0. Copies of the Catalogue are available from the Yale University Observatory.

8 VARIABLE STARS

Hipparcos and Tycho-2:

Status: Recommended for use
Both Hipparcos and Tycho-2 include photometry. These are among the best available and can be utilized. However, the mission lasted only a few years, so long-term and irregular variables require special attention. See GCVS below.

GCVS (The General Catalog of Variable Stars):

Status: Recommended for long-period and irregular variables, and non-Hipparcos stars
The GCVS was the long time standard source for these objects. However, the Hipparcos photometry superseded the accuracies that can easily be attained from the ground. However, since Hipparcos was only operational for three years, the data on the long-period and irregular variables found in the GCVS may prove more reliable. The GCVS gives star identifications and rough coordinates as well as maximum and minimum magnitudes for most stars listed. A period and epoch are given in some cases, but many of these values are derived from old sources and cannot be reliably extrapolated to the present. For currently accurate data a literature search is generally required. The notes section lists other data such as B-V colors for various parts of the light curve where these quantities have been determined.

9 WCCD (WASHINGTON COMPREHENSIVE CATALOG DATABASE):

Status: Internal to USNO
Most of the data discussed above have been combined in the Washington Comprehensive Catalog Database. For each of the 2.5 million stars in the database, the best available data on position, proper motion, parallax, magnitude, variability, spectral type, and multiple components are given. Work is underway to provide fluxes at standard photometric bands. This may require making new observations when the data for certain stars are found to be inadequate for a particular requirement. The catalog will evolve continuously as new results from observational programs are received, thus ensuring that the WCC will contain the best possible values for each of the parameters at any given time. The stars are extensively cross-referenced. Data from this database are made available through requests made to the USNO (seu@pyxis.usno.navy.mil).