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Data Retrieval Software for the USNO-A Catalog: Another Member of the -DARES Family

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Abstract. The recently released USNO-A V1.0 catalog contains astrometric and photometric information for 488,006,860 objects, and is widely used by the astronomical community for all sorts of applications. However, accessing the actual catalog data is not quite straightforward, due to the huge size of the catalog and a somewhat complicated internal format. To facilitate data retrieval, we have created U-DARES, a user-friendly program that lets one look directly at the data in the USNO-A catalog, either as a graphical sky map, a plot, or a simple text table.

Like GUIDARES (Malkov & Smirnov 1994), its predecessor for the Guide Star Catalog, U-DARES can read a sampling of USNO-A data for a given sky region, store this sampling in a text file, and display a graphical map of the sampled region either in projected celestial coordinates (perfect for finder charts) or in the Aitoff projection. It supports rectangular and circular regions defined by coordinates in the equatorial, ecliptic (any equinox), galactic or supergalactic systems. Other features include magnitude cut-offs and specification of the shape of the area.

1. USNO-A V1.0

USNO-A, version 1.0 (Monet 1996) is a catalog of 488,006,860 sources whose positions can be used for astrometric references. These sources were detected by the Precision Measuring Machine (PMM) built and operated by the U. S. Naval Observatory Flagstaff Station during the scanning and processing of the Palomar Observatory Sky Survey I (POSS-I) O and E plates, the UK Science Research Council SRC-J survey plates, and the European Southern Observatory ESO-R survey plates. The PMM detects and processes at and beyond the nominal limiting magnitude of these surveys, but the large number of spurious detections requires that a filter be used to eliminate as many as possible. The inclusion requirement for USNO-A was that there be spatially coincident detections (within a 2 arcsecond radius aperture) on the blue and red survey plate. For field centers of -30 degrees and above, data come from POSS-I plates, while data from field centers of -35 and below come from SRC-J and ESO-R plates.

USNO-A contains right ascension and south polar distance in the system of J2000 at the epoch of the survey blue plate for each object, and lists an estimate of the blue and red magnitude. For POSS-I sources, the photometric system is the photographic system defined by the O and E emulsions and filters, while southern sources are measured in the photometric system defined by the IIIa-J and IIIa-F emulsions. It is believed that the typical astrometric error is about 0.25 arcseconds and that the typical photometric error is about 0.25 magnitudes. To avoid the necessity of consulting many catalogs, objects brighter than 11th magnitude that appear in the Guide Star Catalog (GSC) and that were not detected by the PMM were inserted. USNO-A covers the entire sky, and goes as deep as O=21, E=20, J=22, and F=21 for objects with appropriate colors. The limiting magnitude is brighter for objects with extreme colors, and follows from the requirement for a detection on both the blue and red survey plate. Although it covers the entire sky, there are holes in the catalog in the vicinity of bright stars, regions of nebulosity, crowded fields, etc.

The USNO-A is widely used by the astronomical community for many different applications, such as:

- statistical studies of sky regions. The extremely large size and scope of the data set opens up research possibilities that were previously impossible.
- searches for candidate optical counterparts of astronomical objects found at other wavelengths.
- mapping of object vicinities (in particular, finder charts for variable stars).

The catalog's distribution format (a set of ten CD-ROMs) requires minimum hardware and is well suited for all sorts of conditions, especially observations.

Unfortunately, the actual data in the catalog are not easily accessible. It is in the form of binary files, and the coordinates are given in one standard system (J2000.0). Thus, even generation of a simple finder chart is no trivial undertaking.

2. U-DARES

To help PC users solve the problem of data retrieval, we have created the USNO-A Catalog Data Retrieval Software, or U-DARES. This is a user-friendly program which lets one easily produce text samplings of the catalog and sky maps in Aitoff or celestial projections.

U-DARES requires a PC with DOS or Windows and a CD-ROM drive. It will work without a CD-ROM if the necessary USNO-A files are copied onto the hard disk.

The main function of U-DARES is to produce an ASCII table of object entries from a specified region, and a graphical sky map of the region. It can handle rectangular and circular regions in four different coordinate systems.

2.1. User Interface

To the user, U-DARES looks like an intuitive and self-explanatory menu that is used to enter the following information:

- The logical drive where the USNO files are located.
- The coordinate system in which the region is specified: equatorial, ecliptic, galactic or supergalactic. For equatorial and ecliptic coordinates, the equinox may also be set (the default is 2000).
- The shape of the region: rectangular or circular.
- Magnitude limits for the objects to be retrieved.

- The actual coordinates of the region (minimal and maximal or central and radius).

The software performs a lot of error control along the way. Illegal values of coordinates are impossible to enter, the command to start retrieval is unavailable until all the necessary data have been specified, inverted coordinates are implicitly swapped if necessary, etc.

2.2. Data Retrieval

During retrieval, the evolution of the process is shown on the screen. In addition, a sky map in the celestial or Aitoff projection is simultaneously plotted. Internally, U-DARES performs the following steps:

- Convert the region coordinates to the standard USNO-A system.
- Determine which USNO-A files overlap the user's region.
- Scan the USNO-A files for objects that fall within the user's region, convert the objects' coordinates back into the user's system.

If errors occur, or if the CD-ROM must be changed, U-DARES notifies the user via a message box with standard "Abort, Retry, Ignore" or "Continue, Cancel" options.

2.3. Output and Sky Maps

For every region, U-DARES creates an output file. This is an ASCII table with the following data for each object:

- position and magnitudes (blue and red).
- magnitude quality flag
- field ID
- indication on a correlated GSC entry

A U-DARES SkyMap can be produced both during retrieval and afterwards, by reading the sampling file. A coordinate grid with labels is displayed, and objects are plotted over it as circles. The radius of the circles is proportional to the magnitude. In the Aitoff projection, all objects are plotted as dots (this projection is intended for relatively large sky areas).

U-DARES automatically selects the highest resolution available and takes into account the screen aspect ratio, so that square regions look truly square at any resolution.

2.4. Distribution

To avoid the hassle of separate "Read Me" files, all the documentation has been built into the executable module. By selecting an option form the U-DARES menu, the user can produce a documentation file whenever he needs. Therefore, the whole package is distributed as a single file. U-DARES is a public domain product, available by FTP from

`ftp.inasan.rssi.ru/pub/UDARES`

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