THE UPPSALA ASTEROID DATA BASE

P. MAGNUSSON, C.-I. LAGERKVIST, M. DAHLGREN, A. ERIKSON

Astronomiska observatoriet, Box 515, S-751 20 Uppsala, Sweden
E-mail Per.Magnusson@astro.uu.se.

M.A. BARUCCI

Observatoire de Paris-Meudon, F-92195 Meudon, France

I. BELSKAYA

Astronomical Observatory, Sumskaya Str. 35, Kharkov 310022, Ukraine

M.T. CAPRIA

Istituto di Astrofisica Spaziale, CNR, Viale dell'Università 11, I-00185 Rome, Italy

Abstract. A collection of data and results of asteroid photometry and related observations has been made available by anonymous ftp. It contains all published asteroid lightcurve photometry, a table of reliable rotation periods, and a collection of all asteroid spin vector determinations. Here we describe the database in some detail.

1. Introduction

Data sets made in the course of extensive asteroid research at Uppsala Astronomical Observatory and in collaboration with other institutes are made available to the asteroid community. They are divided into three parts described in the following sections. Access is freely available by anonymous ftp.

2. Asteroid Photometric Catalogue Data Base

The Asteroid Photometric Catalogue was first published in printed form by Lagerkvist *et al.* (1987). Two subsequent updates are now available (Lagerkvist *et al.*, 1989, 1992) and a third one is in preparation. These volumes contain illustrations of all published asteroid lightcurves, replotted in standard formats. In addition, extensive reference lists, aspect data, and details of the observations are included.

We now make available the digital data used in the production of these printed volumes. Software for easy digestion of the data is also supplied.

A. Milani et al. (eds.), Asteroids, Comets, Meteors 1993, 471–476.

2. 1. CONTENTS OF THE PHOTOMETRIC PART

The database currently contains all asteroid lightcurve photometry published up to and including the year 1992.

This part of the database consists of :

- Documentation;
- A table of references to all original publications; these currently number in eccess of 300;
- A table with recomputed aspect data for all observing nights.
- The lightcurves with detailed information (more than 4000 lightcurves);
- Fortran subroutines for reading and converting the digital lightcurves.

We discuss the last three items in more detail in the following subsections.

2. 2. ASPECT DATA

In order to establish aspect data of uniform accuracy and reliability we recompute all the observing geometries instead of relying on the aspect data published by the observers. This is achieved using the integrator Radau (Everhart 1985) applied to a 9-planet Solar System. The actual aspect values are computed with the Jet Propulsion Laboratory software EPHJPL. In addition to the five standard aspect parameters appearing in the printed volumes full high-accuracy information on the relative 3-body geometry Sun-asteroid-Earth for individual data points in the lightcurves can be extracted from the database.

2. 3. LIGHTCURVES

The data on the individual lightcurves contain a general header containing the following information :

- Asteroid number and name;
- Reference to the original publication;
- Acquisition (usually original data from the observer or a digitization from the publication)*;
- Aspect data (see discussion above);
- Observatory name and geographic coordinates*;
- Telescope aperture and name*;
- Detector type*;
- Specification of the photometric system (*e.g.*, Johnson UBV);
- Applied corrections, *e.g.* light time correction and magnitude reduction;

- Zero points and units for the time and magnitude data;
- Composite formation (in order to minimize the model-dependence of the data, we try to avoid composite lightcurves as discussed in Sec. 2.6).

The items marked with an asterisk (*) are applicable to current insertions into the database — old data may still lack some of this information.

This header information is followed by a table containing for each integration typically the time and the measured magnitude with an error estimate, if available. The general philosophy is to keep this tabulation as close as possible to that supplied by the observer (digitally, or in a diagram) and to use the header as a specification of how to interpret this table. The advantage is that the database contents can easily be checked against the original data. The draw-back is that the resulting data have a complicated inhomogenous format, which is difficult to read automatically without a lot of programming effort. The software described in the next section is the remedy to this problem.

2. 4. SOFTWARE AND FORMATS

Fortran software running on Sun and Vax machines are supplied with the data. In particular, subroutines for reading the data in the "human-friendly", but complicated, format described in the previous subsection (called the *atlas* format) is available. Users may convert these subroutines to fit as "front-ends" to their own application software. Alternatively, these subroutines are part of a self-contained program (also supplied) which reads data given in the atlas format and converts it into a more "machine-friendly" format called *homo*. The resulting homogeneous data files are easy to use as input to user-made software.

2. 5. SIZE

The current size of the photometric part of the database is about 5 MByte (1-2 MByte will be added in the third update). It can be compressed to less than 2 MByte. The size of the data for individual asteroids range from less than 1 kByte up to 150 kByte. The corresponding storage requirements for the non-resident homogeneous format *homo* (see Sec. ??) is about twice those given above.

2. 6. UPDATING AND OBSERVER INPUT

The photometric part of the database is updated every second year. Continuous updating is under consideration.

We depend very much on collaboration from observers submitting a copy of their lightcurves in digital form. This ensures that the data will be available for future researchers in an easily accessible form at full accuracy. We strongly encourage observers to send their observations to us as soon as it has been accepted for publication somewhere. From experience, we know that later attempts to recreate the data from multiple versions on backup tapes *etc.* is time consuming and error prone. On request, we can keep data in a confidential queue and not include it in the public domain database until they appear in the literature.

In order to minimize the model-dependency of the database, we prefer to receive observations which have not been composited or transformed to standard solar phase angles. We therefore urge observers who publish data as composites or transformed beyond standard instrumental and atmospheric corrections to store one copy for the database containing observed magnitudes and times of observation.

3. Asteroid Rotation Periods

The rotation periods and lightcurve amplitudes in this part have been determined from the photometric part. For asteroids with reliable spin vectors the periods are taken from the spin vector part. The contents are :

- The rotation periods.
- The lightcurve amplitudes and the corresponding ecliptic longitudes.
- A reliability code.

For further information please contact Claes-Ingvar Lagerkvist at Internet address `Classe@astro.uu.se`

4. Asteroid Spin Vector Determinations

All published asteroid spin vector determinations are collected. Supplementary information on shape models and albedo variegation is also included, but only when part of a spin vector determination.

This part of the database consists of :

- A documentation file describing the database in detail;
- A file containing more than 100 references to the original papers containing the spin vector determinations;
- The main tabulation of results contains information on the types of data used, all spin vector directions (including symmetric solutions, basis for rejection of solutions, and constraints on the spin axis), sidereal rotation periods, shape modeling, and information on albedo variegation.

An earlier version of the collection was published by Magnusson (1989). The current version has 50% more determinations. In addition, the format has been improved to more clearly separate solutions that differ in sense of rotation.

For an introduction to the various techniques commonly used for asteroid spin vector determinations see Magnusson *et al.* (1989).

4. 1. SYNTHESIS OF INDEPENDENT RESULTS

For some asteroids a large number of independent solutions have been published. This is of interest to researchers studying the spin vector determination problem. Other readers may want a quick answer to the question : Is the spin vector for asteroid NN known and reliable enough for use in applications? For their benefit

Ia *synthesis* of our knowledge of the spin vector is included for some asteroids. We estimate that these synthesis results have a high reliability and an accuracy in the spin vector direction of 10° or less. They were obtained by taking averages of the most recent independent results, with weights based on the method used and the amount and type of the input data. This procedure is necessarily somewhat subjective, and can't replace a careful evaluation of the original results.

4. 2. SIZE AND FORMATS

The main tabulation is available as TEX files, a PostScript file, and in ascii (footnotes are missing in the ascii version). The supplementary reference list and documentation is available in ascii only.

The TEX files and the ascii version each take up less than 100 kBytes. The PostScript file currently requires about 150 kBytes (14 pages).

4. 3. UPDATING

This part is updated continuously. Comments, suggestions for improvements and references to new asteroid spin vector determinations will be appreciated (contact the first author).

5. Access to the Data Base

Access to the database is available by anonymous ftp. If you are connected to the Internet you type :

```
ftp ftp.astro.uu.se
```

When prompted for the username, give `anonymous`. Identify yourself when prompted for a password. Proceed to the `pub/Asteroids` directory. The three parts described above reside in the sub-directories `Photometry`, `RotationPeriods`, `SpinVectors`. Each of these directories contains a file `README` giving further instructions.

Readers without access to ftp may request by email from the first author the contents in `RotationPeriods` and `SpinVectors`. Due to its size, we can only send small sub-sets of the photometric database. In special cases, the entire database can be supplied on diskettes. The printed volumes of the Asteroid Photometric Catalogue showing all lightcurves in graphical form (Lagerkvist *et al.* (1987, 1989, 1992) can be ordered from C.-I. Lagerkvist.

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