

TURNING BESANÇON OBSERVATORY ON-LINE FACILITIES INTO THE VO - GALACTIC MODEL SIMULATION, BINARY STAR, AND TNO DATABASES

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Abstract. We present the recent and forthcoming evolutions of the modelling tools (model of the Galaxy) and databases (double star database, TNO orbital database, photometric database for Kuiper-Belt Objects and Centaurs) developed at Observatoire de Besançon, as well as the on-going implementation of Virtual Observatory standards in these services.

1 Galactic Model of Stellar Population Synthesis

The model, developed since the '80s, aims at producing realistic simulations of the stellar content in a given direction of observations, based on a formation scenario and a population synthesis model of the Galaxy. A web interface has been provided since 1996 (www.obs-besancon.fr/model) which allows the user to perform its own simulations. In 2003 a new version was released (Robin et al. 2003) which extends the simulations towards the near infrared and gives largely improved simulations including in the bulge region. The simulator aims at providing the user with the stellar content of a region of the sky, including intrinsic parameters of the stars (absolute magnitude, effective temperature, gravity, metallicity, age) converted to observables, like photometry in different photometric systems (Johnson-Cousins, Megacam ugriz system), stellar motions (proper motions, radial velocity), distance, extinction on the line of sight. The simulation is done using selection bias defined by the user (selections on spectral type, luminosity class, age, population, intervals of magnitude and colours). These selections are applied after proper errors are computed for each observables (photometry, proper motions, radial velocity). Errors are also defined by the user as gaussians with standard deviation depending on the magnitude of the star. The simulator outputs either catalogues of simulated stars (which should statistically conform to what is expected in an observational catalogue), or tables showing the distribution of parameters chosen by the user (magnitude, colours, etc.) A new version of the model will be soon available which includes: (i) simulations in Megacam-Wircam combined photometric systems, (ii) simulations in SDSS photometric system, (iii) new extinction model for the galactic plane (from Marshall et al. 2006), (iv) user access from remote programs, (v) sending of the results on standard output, (vi) output in VOTable format.

2 Besançon Double and Multiple Star Database

A database merging all categories of double and multiple stars (bdb.obs-besancon.fr) has been developed since 1995. After initial incorporation of the large catalogues of binary stars and setting up of query mode based on various stellar identifiers, recent developments focus on: (i) ingestion of non-numerical data, such as CCD images obtained with different photometric filters (ii) data query based on selection of stellar systems from their intrinsic data, which vary as a function of the binarity type; visual binaries can be selected using a combination of up to 4 parameters: magnitude of the main component, angular separation, difference of magnitude and spectral type of components; eclipsing binaries can be selected against the period of the luminosity variation, the magnitude at the maximum of luminosity, the spectral type and photometric classification types (EA, Eb or EW) and Kopal's (detached, semi-detached or contact); stellar systems can also be selected from their sky coordinates. The database is presently being reimplemented under the free PostgreSQL DBMS. It aims at: (i) upgrading the data query modes, easing the implementation of some VO standards such as the VO

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query language ADQL, (ii) ease the process of the foreseen setup of a mirror of the database at the Institute of Astronomy of the Russian Academy of Sciences (INASAN). A collaborative work has been recently started with INASAN about UCDs for binary stars; based on the review of available catalogues, it aims in particular at determining missing UCDs in the present IVOA vocabulary, which are useful to characterize binary star data.

3 Dynamics of small bodies of the Outer Solar System

Data base: This project provides the first and unique bias-controlled database of orbital elements of small bodies of the Outer Solar System. It contains all the objects discovered in the framework of CFHTLS-VW. Apart from astrometric measurements, the database will contain the circumstances of the discovery and the efficiency of the discovery. We will also add the log of follow-up attempts of these objects, whether successful or not and why. When the astrometrical data allow it, orbital elements, ephemeris and a dynamical classification will also be provided. Besides this purely descriptive part, the database can also provide predictions of positions for a set of selected objects. This second step makes our database an operational tool for follow-up observations and also for comparisons with the Minor Planet Center database for search in archives. The database of astrometric data is already available on line at URL www.obs-besancon.fr/TN0db. It contains all the data concerning objects discovered during the first 2 years of CFHTLS-VW, as well as data from the pre-survey.

Simulator: This service will allow to test formation and evolution models of the Outer Solar System. Theoreticians will be able to propose a model of the Kuiper belt and compare the objects which would be observed in such a model to real objects detected by the CFHTLS-VW. At present, the simulation program is written and works correctly. A key element of the simulator is the knowledge of the whole set of survey observations and the efficiency of the discovery of each field as a function of the magnitude of the object and of its rate of motion on the sky background. This efficiency function has been determined for the whole set of CFHTLS observations in 2003. This service should be made available on line during year 2007.

4 Photometric database for Kuiper belt objects and Centaurs

This database aims at centralizing all photometric observations of Kuiper-belt objects and Centaurs. It must allow to get these data in a standardized way, directly usable by a computer, with user chosen parameters (apparent/absolute magnitudes, MJD corrected or not from the light travel time, phase angles, ...). These data are presently scattered across a large number of publications (sometimes not even published in detail) and in a large variety of formats which makes their use difficult. The PHP/MySQL database has been freely accessible on line (www.obs-besancon.fr/bdp) since August 2005. As of June 22, 2006, it contains 2493 photometric data for a total of 33 different objects. The database offers the possibility to obtain these data under different formats. After experimenting with the possibility for users to directly import their own data (under the control of a moderator), experience has shown this to be impractical. Hence the current version of the database has a simple HTML page giving the coordinates of its manager to send the data by electronic mail. By the end of year 2007, it is foreseen: (i) to set up a more sophisticated interface allowing to choose data, not only for a given object but for a whole range of objects corresponding to certain criteria (apparent magnitude, ...), (ii) to enter a great number of data in the database, by reviewing all published articles and possibly contacting the authors (work already started). In the longer term, three other improvements are planned: (i) "direct" analysis tools (periodogramme, graphical visualisation, ...), (ii) output of the data in VOTable format, (iii) interconnection with IMCCE's databases providing ephemeris for these objects.

A more detailed presentation of the present paper, including figures, can be found at:
www.obs-besancon.fr/vo/sf2a2006

References

- Robin, A. C., Reylé, C., Derrière, S., & Picaud S. 2003, *A&A*, 409, 523
Marshall, D. J. et al. 2006, *A&A*, 453, 635