Identification of asteroids and comets: update on methods and results

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Abstract. Starting from previous experiences in this field, we present an updated version of the software developed at Sormano Astronomical Observatory as a useful and practical method to identify asteroids and comets. In addition we report some information about the database.

Key words. Asteroids: orbit determination – Comets: orbit determination – Orbit identification

1. Introduction

The identification of the orbits of asteroids and comets is a field where it is still possible to try and improve existing methods for finding asteroids and comets which have been lost due to insufficient observation coverage, or to create new, more efficient algorithms for the same purpose (Marsden 1986; Milani 1999; Milani & Valsecchi 1999; Milani et al. 2000, 2001).

We are facing this problem since several years, and we have partially solved it with the implementation of software tools which were presented at the X Meeting of Planetology (Manca et al. 2011). On that occasion we were presenting a particularly effective method for managing and updating our internal database of orbital elements and observations of asteroids and comets, based on the observations published monthly by the Minor Planet Center.

These first positive results have provided the stimulus that has allowed us to make some improvements, especially in the most delicate part of the software, represented by search and selection algorithms. The programs performing these tasks are essentially two: IdaW for the comparison of orbital elements against an orbital catalog (or a section thereof, selected by the user, see Fig. 1), and Mappa2W for displaying trajectories of known objects in order to perform identifications based on their motions and position angles (see Fig. 2 and 3).

For a better understanding of the validity of the methods and tools used, we report as example the cases of asteroids 2010 TV150 (see Fig. 4) and 2010 MM32. These objects were discovered and observed by satellite WISE (Wide-Field Infrared Survey Explorer), launched by NASA in order to observe and carry out a survey in the infrared region. WISE satellite observed thousands of asteroids and comets, but for many of these objects the observational arc has been too short for finding a positive identification, also because sometimes the estimate of the absolute magnitude $H$ obtained by observing in the infrared is completely wrong. For this reason it has not been possible to identify with absolute certainty these two objects using the program IdaW for the comparison of the orbital elements. Moreover in the case
Fig. 1. Example of usage of program IdaW.

Fig. 2. Example of usage of program Mappa2W (input).

of 2010 MM32 (discovered by WISE on June 20, 2010) the short period of observation (two days) has not allowed to calculate an orbit sufficiently precise to be “linked” to other objects in the database; the identification problem has been worsened by the fact that the value of the absolute magnitude has been overestimated. In this case only a subsequent analysis, performed with program Mappa2W, has allowed us to find in the catalog a candidate
for the identification of the "short arc" of 2010 MM32. In other words the software Mappa2W, adequately improved through the use of search filters, pointed out the similarity of the two asteroids under consideration on the basis of the plot of their motions and position angles.

In situations such as those presented in this report, it is necessary to perform the comparison starting from the object having less accurate orbital elements, or even lacking completely orbital elements, and for which only observations are available. Using program Mappa2W we could identify many objects discovered by WISE satellite (and having an observation arc of only one day) with orbits of asteroids already observed in the past, even when no identifications had been found by the automated systems in use at the Minor Planet Center.
and divided according to their original groups:

- Comets 1
- PHAs 4
- NEAs 4
- MBAs 140
- Mars crossers 1
- Pallas 1
- Hungarias 5
- Trojans 5

The database in use, updated to December 12, 2012, is composed of:

- 83,300,874 observations of numbered asteroids
- 8,883,036 observations of asteroids with provisional designation
- 663,592 observations of comets
- 455,934 orbital elements of asteroids with provisional designation
- 3,534 orbital elements of comets

This database is updated monthly on the basis of data published by the Minor Planet Center, together with the catalog of observations of single-night objects lacking orbital elements. The rate of growth in the number of observations and orbital elements, due also to an increase of discoveries and redetections made by the large scale surveys, stresses the need for an improvement of the methods presented here. In addition there is a clear discrepancy in the number of observations available for the computation of the orbit of each object between numbered asteroids and asteroid with provisional designation (see Fig. 5, 6 and 7); this highlights the need for a continuous and accurate follow-up.

References

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