

New Astronomical Reduction of Old Observations (the NAROO project)

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Abstract. The Gaia astrometric reference catalogue will provide star proper motions with an accuracy of one mas one century ago for stars of magnitude 14 or brighter. Our project is to re-reduce the old observations with the new catalogue allowing to have an astrometric accuracy only limited by the observational biases and not by reference stars. Then, we plan to get an accuracy of 50 mas where the old reductions were not better than 500 mas!

For our purpose, we will digitize old photographic plates with a sub-micrometric scanner. Tests were made using the UCAC catalogue showing that old photographic plates have an intrinsic accuracy of 30 to 60 mas.

Keywords. astrometry, photographic plates, photometry, spectrometry, solar system.

1. Introduction: the interest for old observations

Old observations are interesting for modelling transient events or periodic behaviors (observable through astrometry for dynamics or through photometry for variable objects). For that purpose, old data are used as published at the epoch they were made. However, the accuracy was not good since reference used for the reduction were not well-known. We propose to re-reduce these old observations with the Gaia reference star catalogue.

2. Solar system objects

First are the natural planetary satellites which are typical for our project. They are fast running objects so that many dynamical perturbations are easy to model provided that the sample of data is sufficiently large and sufficiently accurate. By increasing the astrometric accuracy of one order of magnitude, we will be able to quantify small effects such as the dissipation of energy due to tides in the natural satellite systems: internal structure and scenarios for the formation should be validated. We explain the thermal equilibrium of Io and the geysers on Enceladus by looking for an acceleration in the motion of the icy satellites. Concerning the Saturnian system, we look for old data helping to validate the scenarios of formation and evolution of the satellite system.

Second are the asteroids and comets. Digitizing and analyzing old Schmidt or astrographic plates may allow to make pre-discoveries of NEA/NEO or TNO. A large time

interval of data of high accuracy may help to model non-gravitational effects of asteroids and comets.

3. Spectrometry

It will be possible to digitize the large collection of variable stars spectra (Be stars). The data base BeSS, available at LESIA, provides a catalogue of all known (around 2000) Be stars and owns (around 130 000) available spectra of these objects. The study of the long-term spectroscopic variability of Be stars is very important to understand their sporadic ejection of matter. At the present time, the data start only in 1990 and the analysis of plates from 1950 to 1980 will enlarge the time series of data and will allow to detect a period in the ejections.

4. The first results

We had collaborations with laboratories owning sub-micrometric scanners and photographic plates (USNO-Washington DC, ROB-Bruxelles, Bucharest Astronomical Institute, QMUL-London, OCA-Nice). We made tests by scanning Galilean, Saturnian and Martian plates with ROB-DAMIAN digitizer (Robert *et al.* (2016).

Our results show that the accuracy reachable on old plates may be from 30 to 60 mas at a time where the accuracy of the data extracted from the same plates were from 200 to 500 mas! Using the proper motions of the final Gaia catalogue could improve our first results and completely renew the astrometric reduction.

5. The NAROO project

For our purpose, we are installing in Meudon observatory a sub-micrometric scanner the accuracy of which being chosen to guaranty the astrometric accuracy from the plates. We plan to start scanning old plates in 2018.

Our goal is now:

- making inventories of plate archives with objects, field, quality of plates, dates, and selecting plates to be analyzed
- choosing criteria and parameters for digitization and preparing reduction softwares taking into account the increase in accuracy
- making a specific database for files of digitized plates made available to the scientific community

6. Conclusion

The new reduction of old data started a few years ago. Unfortunately, the available catalogues such as UCAC did not allow to go back farther than the 1970's. At the present time, reducing older observations do not bring any improvement compared to the data published at the time they were made. The arrival of the final Gaia reference catalogue will completely renew the reduction of old data mainly for astrometry but also in the field of photometry and spectrometry.

Reference

- Robert, V., Pascu, D., Lainey, V., Arlot, J.-E., De Cuyper, J.-P., Dehant, V., & Thuillot, W. 2016, *Astron. Astrophys.*, 596, A37