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THE NAROO DIGITIZATION CENTER

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Abstract. The New Astrometric Reduction of Old Observations NAROO center is built at Paris Observatory, Meudon, and is dedicated to the measurement of astro-photographic plates and the analysis of old observations. The NAROO digitizer consists of a granite based Newport-Microcontrol open frame air-bearing XY positioning table, a scientific sCMOS camera, and a telecentric optical system. The plate holder assembly is suited for mounting glass plates up to 350-mm square. The machine positioning stability is better than 15 nm, its repeatability is better than 40 nm. With real photographic plate data, we are able to produce measurements with an accuracy better than 65 nm.

The renewed interest about photographic plates concerns the expansion of the database of transient objects evolving in time, since digitization now makes it possible to measure images with a high level of accuracy and to identify all the available objects. The information extracted from such materials can be of an astrometric, photometric, and spectroscopic nature, when not purely imaging, with consequences in planetology, near-Earth asteroid risk assessment, astrophysical phenomena, and general relativity, to mention but a few.

We will present first research possibilities for Solar photographic plates to be digitized and analyzed. We will also give details for the researchers to use our facilities and digitize their collection by answering our Call for Proposals.

Keywords: instrumentation: high angular resolution, techniques: image processing, digitization, photograhic plate

1 Introduction

The renewed interest about photographic plates concerns the expansion of the database of transient objects evolving in time, since digitization now makes it possible to measure images with a high level of accuracy and to identify all the available objects. The information extracted from such materials can be of an astrometric, photometric, and spectroscopic nature, when not purely imaging, with consequences in planetology, near-Earth asteroid risk assessment, astrophysical phenomena, and general relativity, to mention but a few.

Studying the dynamics of Solar System bodies, in particular, requires astrometric observations sampled over a long time span to quantify the long period terms which may help to analyze the evolution of the motion. Searching for old data is obviously useful for this purpose, and since we have demonstrated that a precise digitization and a new astrometric reduction of old photographic plates could provide very accurate positions (Robert et al. 2011, 2015, 2016), researchers involved in various scientific topics began to (re-)consider such materials. As a consequence, the Paris Observatory decided to acquire such an instrument and to build a scientific community for its exploitation, creating the New Astrometric Reduction of Old Observations NAROO program.

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2 Solar activities

The Paris Observatory owns about 100,000 photographic plates of the Sun, mostly observed in Hα, Ca II K center line wavelength, and continuum (near Ca II K line). These observations were made from 1870 to 1999 with photographic plates, while new observations are still being realized today using digital recording, with a recent update in 2018 (Malherbe & Dalmasse 2019).

Using the NAROO machine with older photographic plates of the Sun will allow us to tackle the problem of morphology and topology of various Solar features. The overall accuracy of the NAROO machine is ideal to measure the best possible location of the contours of filaments. Obviously, this will not be done for all filaments in all observations, but it will be possible to digitize the boundaries of filaments involved in strong flares to deduce the behavior of the magnetic field leading to them. This work can be achieved quite easily as we can benefit from filament detections (Fuller et al. 2005) and time tracking (Bonnin et al. 2013) to identify the photographic plates and digitize them in the collection.

Another application of the NAROO program deals with the exact determination of the boundaries of active regions (AR). First, we could analyze digitizations to determine the place between two opposite polarities, called the neutral line, where filaments can appear. Then, it will allow us to accurately study the extension of an AR and its evolution in time, which gives clues to the strength of the underlying magnetic field. Lastly, and probably the most prospective scientific application, is the fact that it will help us to precisely determine, at various altitudes, the shape of the ARs, giving 3D information on the magnetic field extension and evolution.

3 Call for Proposals

The value of a new analysis of old photographic plates has been demonstrated, and the community is beginning to worry about the use and preservation of such materials for science. As recommended by the resolution B3 of the XXX IAU General Assembly in 2018, the preservation, digitization, and scientific exploration of the plates must be realized. Plate collections of the Paris Observatory and other French and international institutions are being digitized to provide data spanning more than one century for our works. Corresponding results will be presented in upcoming papers. Digitized raw data will also be available for the community.

The NAROO machine is available for researchers to digitize their own collections for scientific purposes, since digitization time is reserved for external users. A call for proposals is being issued every six months via our project website `https://omekas.obspm.fr/s/naroo-project/`.

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