

# Present status of the "Carte du Ciel" and "Astrographic Catalogue" glass plates of the Real Instituto y Observatorio de la Armada

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## Abstract

The Real Instituto y Observatorio de la Armada of Spain (ROA) was one of the 18 observatories that have collaborated in the observations and computes to elaborate the "Carte du Ciel" and the "Astrographic Catalogue". The ROA observe the zone from  $-3^\circ$  to  $-9^\circ$  in declination. At present the complete collections of plates are stored in the ROA library in moderately good conditions. A few years ago a digitization of all the plates was carried out using a commercial flatbed scanner machine every plate was scanned in to positions rotated  $90^\circ$  in order to be able to remove the systematic errors introduced by the movements of the reading head of the scanner machine.

In this talk we present the status of the collections and the possibility to get copies of the plates in FIT format requesting them to the ROA.

**Keywords:** Carte du Ciel, Astrographic Catalogue, digitization of astronomical plates

## 1 Introduction

In 1887 the admiral Mouchez director of the Paris Observatory organized the International Congress Astrophotographic. Fifty six astronomer of all the world participated in the meeting and agree to proceed to take photographic plates of the whole celestial sphere thrice, two to produce the "Carte du Ciel" with a limit magnitude of about 14.0 and another to produce the "Astrographic Catalogue" reaching until magnitude 11.0. 18 observatories spread over the world agree to divide the celestial sphere in declination zones and observe one zone each. These observatories were from north to south: Greenwich, Roma, Catania, Helsingfors, Potsdam, Oxford, Paris, Bordeaux, Toulouse, Argel, San Fernando, Tacubaya, Santiago, Cordoba, Perth, The Cape, Sidney and Melbourne [2]. The main object of the project of the "Carte du Ciel" was to get a photographic map of the whole celestial sphere with similar telescopes using glass plates with a scale of 1 arcmin/mm. Each plate covers  $2^\circ \times 2^\circ$  of sky and its centre was separate 1 of the centre of the 4 plates surrounding it. In this way each sky region was photographed twice.

In order to get a correct identification of the stars and reject spurious spot, the plates with centre in odd declinations degree has three 30 minutes exposures with a small separation of 7" in order to get a equilateral triangle with the three exposures, the plates with centre in even declinations only have one exposure de 1hour getting a limit magnitude of 14.5 magnitude.

The plates for the "Astrographic Catalogue" were observed in a similar way to those of the "Carte du Ciel" but with exposures of 6 minutes for those with centre in even declination degree and three exposures of 6, 3 minutes and 20 seconds forming also a equilateral triangle for those plates with centre in odd declinations. The limit magnitude for the 6 minutes exposures was 11. To make easier to measure the coordinates of the stars photocentre a grid of lines separates 5mm (5") was superimposed to the plates before to reveal them [1].

Once revealed the "Carte du Ciel" plates were enlarged to double size in a cliche and then copper printing plates were elaborated to produce the pictures of the "Cartes du Ciel"

San Fernando Observatory observed the zone of declination -3 to -9. A total of 1260 plates for every catalogue were exposed since 1892 to 1930. Between 1921 and 1929 were published the six volumes of the "Catálogo Astrofotográfico de San Fernando" with more than 400000 star positions.

## 2 Present status of the San Fernando sets of plates

At present the two set of plates are stored in the library of the observatory inside metal boxes. Each box contains 24 plates and are stored in wood cabinet with good air circulation in a north salon of the main building provided with a dehumidifier machine, so there are not big seasonal

temperature changes or high humidity in the salon.

Also in the library are stored the six volumes of the "San Fernando Astrophotographic Catalogue" and sets of the printed version of the all the zones of the "Carte du Ciel" pictures.

Also stored in wood boxes the ROA preserve the copper printing plates used to print the "Carte du Ciel" catalogue of the San Fernando zone.

### 3 Digitization of the San Fernando sets of plates

During the years 2003 and 2004 the two sets of glass plates were digitized using a commercial scanner AGFA type DuoScan F40. This scanner has an optical resolution of 1200 x 2400 dpi, a dynamical range of 3.0 in density and a digital resolution of 16 bits. The reading head uses a trilinear CCD array of 10000 elements. The main performance of this scanner is its built-in scanning bed for transparencies which permit that the images captured from it are scanned directly, not through a glass plate as used for opaque materials. We use the maximum resolution of the scanner which give a scale of 0".60 per pixel and an area of 13000 x 13000 pixels that cover 2°.3x2°.3 a little more of the 2°x2° area of the plate.

Each plate was scanned twice, identified as A and B, with a rotation of 90 between both positions, in order to be available to remove the effect of the non uniform motion of the system drive of the scanner reading head and a systematic effect in the linear CCD array, this effect is more or less regular but the motion of the drive is variable from one scan to another. The two images of every glass plate are recorded in standard FITS format in a CDRom.

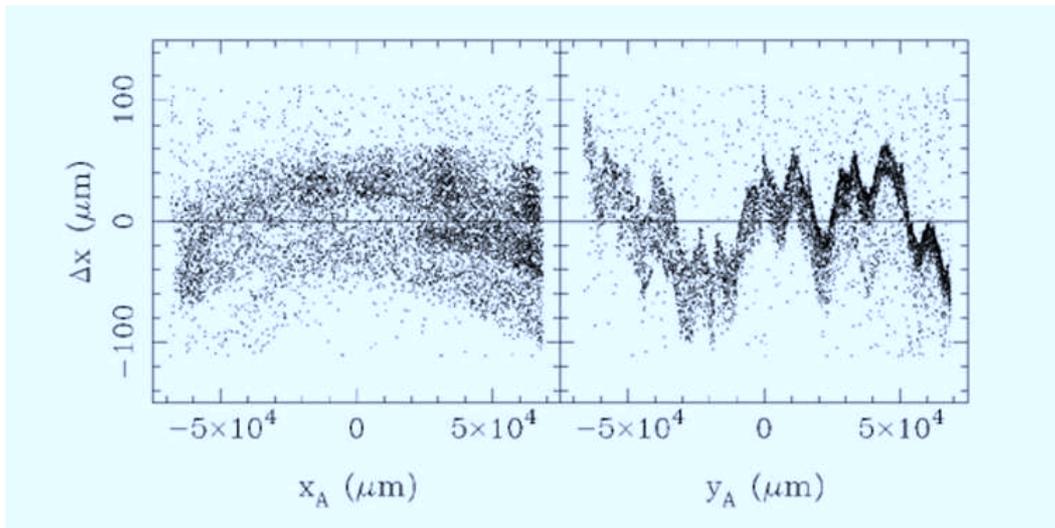


Figure 1: Typical systematic effects of the linear CCD (X) and the drive (Y) of the AGFA scanner (Figure by courtesy of Vicente et al.).

Dr. Vicente [4] in her doctoral thesis and two articles [3], [5] shows that with the software, developed by her, it is possible to get a precision in the measures of the photocentre positions of 3 μm equivalent to 0".20. This precision is similar to that of other measuring machines in digitizing this kind of old plates. The software is based in comparisons of the stars coordinates measured in the two 90° rotated positions of each plate and also in the four overlapping plates and its corresponding rotated.

### 4 Conclusions

The ROA preserves the two set of 1260 glass plates corresponding to the "Carte du Ciel" and "Astrophotographic Catalogue" in a moderately good conditions having in account that the plates were

exposed more than a century ago.

Also the ROA preserves the copies of the pictures in scale 2:1 of all the zones of the "Carte du Ciel" and the copper printing plates of the San Fernando zone.

In 2003 all the glass plates of the both sets have been scanned twice with a commercial flatbed scanner in positions rotated  $90^\circ$ . The two scans of each plate have been recorded in format FITS in one CDrom. From these CDroms using the convenient software it is possible measure the positions of the stars with a precision of approximately  $0''.2$ .

It is possible to get from the ROA copies of the CDroms on request.

At present the ROA projects to copy the two sets of 1260 FITS images in one USB disk of 2 terabytes in order to preserve them in a more modern and quick accessible format.

## References

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