Revista de la Societat Catalana de Química, núm. 16 (2017), p. 38-44
Filial de l'Institut d'Estudis Catalans

ISSN: 2013-9853 DOI: 10.2436/20.2003.01.84
http://revistes.iec.cat/index.php/RSCQ

Solargraphy
Solarigrafia

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Abstract: Pinhole photography is lensless photography. A tiny hole replaces the lens and the light passes through it forming an image in the camera. Solargraphy is a specialised form of pinhole photography. It consists of applying long exposure times, from one or more days up to months or even years, thereby recording sun trails and other objects. Hence, the light strikes the photosensitive material placed inside the camera, both directly from the sun or by reflection from other elements.

Keywords: Photography, pinhole, pinhole photography, solargraphy.

Resum: La fotografia estenopeica és fotografia sense lents. Un petit forat substitueix la lent i la llum hi passa a través i produeix una imatge a la càmera. La solarigrafia és una forma especialitzada de fotografia estenopeica que consisteix en l'aplicació de temps d'exposició llargs, a partir d'un o més dies fins a mesos o fins i tot anys, i enregistra les traces del sol i altres objectes. Així, la llum incideix sobre el material fotosensible col·locat dins de la càmera de manera directa pel sol o per la reflexió d'altres elements.

Paraules clau: Fotografia, estenop, fotografia estenopeica, solarigrafia.

Introduction

In 2007, during the International Year of Science I received a number of emails from FECYT about workshops in Spain and one of them included a "Do It Yourself" pinhole camera cut-out model. [1] I did not get around to building one at that point, but the idea stayed firmly in my brain and two years later I discovered the Worldwide Pinhole Photography Day. The activities included a couple of workshops to be held in a community centre in Barcelona. The pinhole workshop was fully booked, so I ended up in a solargraphy workshop in which I discovered a different way of taking long exposure pinhole shots. I became hooked!

Pinhole photography and solargraphy

The workshop consisted of two parts: the first dealt with the basic principles of pinhole photography; the second addressed solargraphy in particular. In the first part, the main differences between pinhole and lens photography were clearly explained. This was a major discovery for me. The usual concepts of framing, composition, exposure time, depth of field, etc., expanded their limits and made me realise how to play with all of them together in perfect synchronization to achieve the best results. It might seem ridiculous but something similar happened to me when, as a college student, I suddenly discovered the abstractions hidden in the mathematics theorems and their meaning. You may compare it with a spotlight in the precise instant when it focuses on the artist of a show or with the magnificent explosion of fireworks. In summary, it changed my way of looking at and thinking of photography.

Regarding solargraphy, one of the main things I learned was the fact that, when exposed for a very long time using a pinhole camera (for instance, when recording solargraphs) photosensitive black & white paper was able to produce a colour image without the need for the developing process (figure 1).

The main characteristic of a pinhole camera (figure 2), also known as *camera obscura*, is its lack of any lens. It works based on the fact that light travels in straight lines producing

Figure 1. Picos de Europa. Solargraph recorded at El Pinu (Piloña, Asturias) from 4 August 2013 to 8 February 2014.

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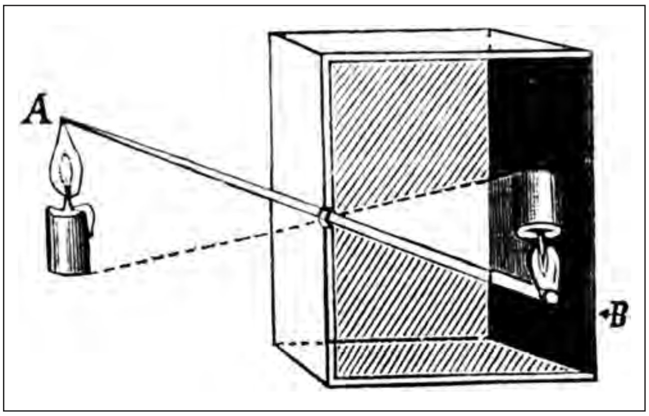

FIGURE 2. Basic design of a pinhole camera.

an image that appears upside down and laterally inverted inside the camera. When the shutter is opened, light shines through to imprint an image on photographic paper or film placed at the back of the camera.

Pinhole photography makes you think before making a picture. It is also important to study the peculiarities of each camera in order to get used to it. That is the most rewarding way of making photographs.

Usually you know the characteristics of a pinhole camera, like the *f*-number and the format of the light sensitive material being either paper or film. However, pinhole cameras do not have a built-in photometre to automatically measure light conditions or a viewfinder to help you when framing your photographs. This means that you need to make some calculations for the exposure time and carefully point your camera to frame what you are willing to get in your photograph. Also, the shutter is a bit different from those found usually in lens cameras. Thus, with a pinhole camera you need to get used to it, learn about its specific features like geometry, angle of vision, distortion (if any), etc., and take into account that the framing has a high chance of failing. Once you are "familiar" with your camera, you can guess beforehand how your photograph will be, and even then sometimes you may be pleasantly surprised with the outcome (figures 3 and 4).

Solargraphy is a specialised form of long exposure pinhole photography and it was established in November 2000 when Paweł Kula, Sławomir Decyk and Diego López Calvín launched the Solaris Project "involving the participation of artists, photographers and all other individuals interested in the photography, pinhole cameras and the movement of astral bodies.

FIGURE 3. Strong winds. Solargraph recorded at Sagrada Família (Barcelona) from 17 February 2013 to 21 June 2013.

The project was conceived as to allow the participation of anyone interested no matter how far he/she was from the original creators of the project". [2]

Solargraphy records the sun trails as a consequence of its apparent movement in relation to the earth (known as the "ecliptic"). The image is created using home-made pinhole cameras (usually tin cans, 35 mm film canisters, PVC pipe,

FIGURE 4. Library windows. Solargraph recorded inside Can Manyer Library (Vilassar de Dalt) from 14 June 2014 to 25 November 2014.

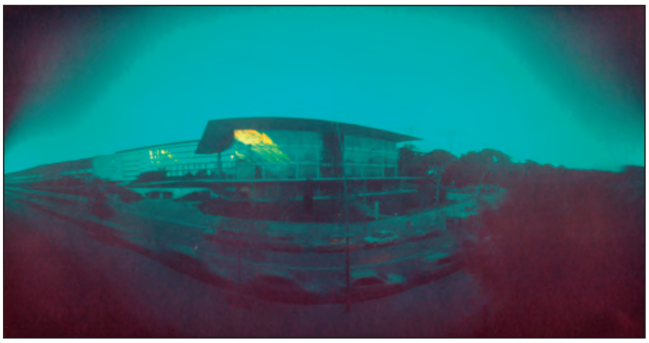

Figure 5. *Touched by the sun!* Solargraph recorded at Nexus II building (Barcelona) from 4 November 2014 to 21 December 2014.

etc.) loaded with photosensitive paper and secured to a specific point for a period of time.

It consists of applying long exposure times, from one or more days up to months or even years. During these extremely long exposures, the photosensitive material placed inside the camera records changes in the tonality of the emulsion as the light strikes it, both directly from the sun or by its reflection on other elements (figure 5).

Initially white or yellowish, depending on the paper used, it gradually becomes an observable image without the need for any chemical treatment whatsoever (development and/or fixing). The image looks like a geometrically inverted negative (i.e., upside down and reversed from left to right), presenting different colour tonalities only visible in red or faint light to prevent blurring.

You can use any kind of photographic paper, both colour or black & white paper. I only use black & white and these types are my favourites: Ilford MGIV RC DELUXE Pearl [MG4RC44M], Ilford Ilfospeed RC DELUXE 3 [ISRC344M] and

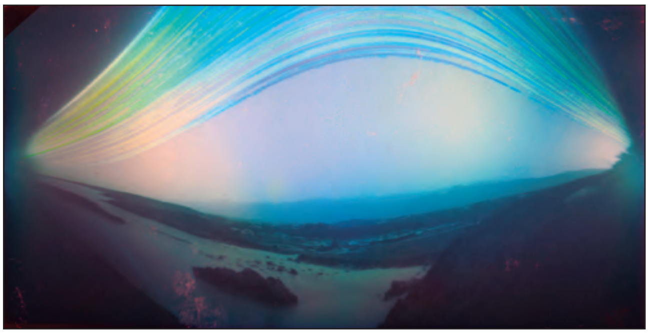

Figure 6. Borizu beach (Asturias). Solargraph recorded from 6 April 2014 to 10 October 2014 (with the help of Delfín Heredia).

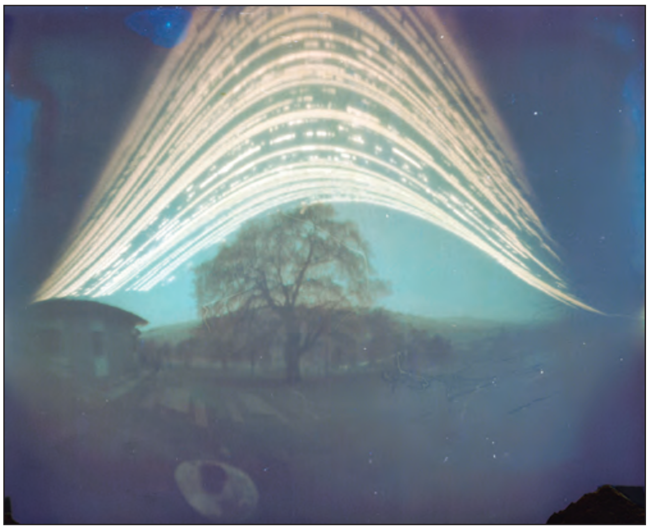

Figure 7. Centennial oak tree in Ayardes (Asturias). Solargraph recorded from 20 January 2016 to 9 July 2016.

Foma FOMATONE MG Classic warm tone. The differences in the paper are illustrated by different colouring, contrast or tone. These variations are an interesting topic open to investigation by the photographer. Other variables that can affect the final results are weather conditions, humidity, temperature, etc. (figures 6, 7 and 8).

Figure 8. Carrer de Milans (Barcelona). Solargraph recorded from 19 August 2015 to 22 June 2016.

Framing is the most difficult step. Only personal experience will give you an idea of what you can expect in front of the cameras. Typically you would place the cameras pointing south, to be better able to catch the sun trails, but you can also play with reflections on buildings, for example.

Once the exposure is complete and the cameras have been collected, I normally open them in a room with dim light to scan the image. You do not need to develop or fix the image, simply digitise it using a scanner to obtain a digital file and process it as you would with any other photograph. The scanner will need to perform a single pass over the image without stopping to avoid lines due to the scanner light. This has to do with computer memory, software and the resolution of the scan (figure 9).

In my opinion, the most interesting part of this process is that, when removing the paper from the can in a subdued light, the image is already observable. That means that the silver halides present in the gelatine emulsion of the paper react with the light photons yielding some silver complex salts of different tonalities which can be seen in dim light conditions, scanned to a digital file and post-processed using adequate software (figure 10).

This was something difficult to rationalise for a chemist like myself. It was only after I had read some old photographic texts that I realised that different silver halides or mixtures of them, coated on paper or glass in different conditions, showed characteristic behaviour in diverse light sources. [3]

a)

b)

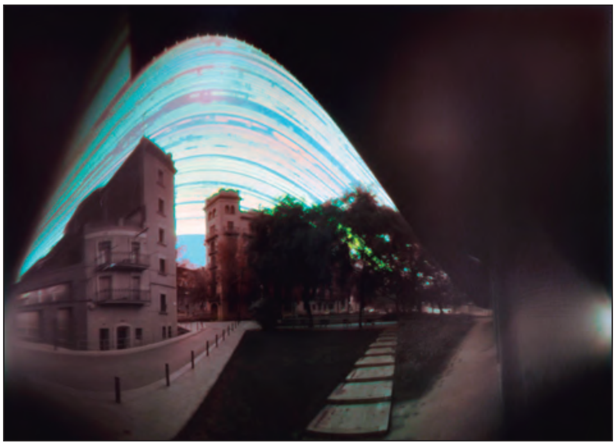

FIGURE 9. *a)* A solargraph under red light before scanning (photograph by Iker Moran). *b)* The same solargraph after processing. Recorded at Plaça del Dr. Pere Franquesa (Barcelona) from 4 July 2014 to 2 December 2015.

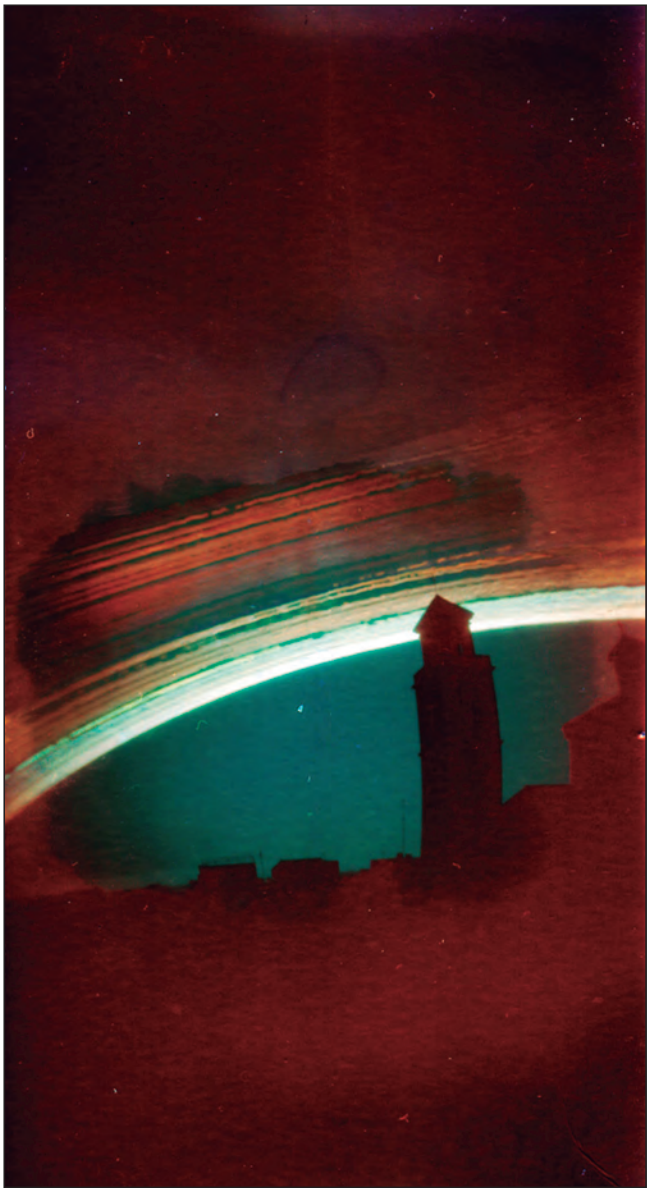

FIGURE 10. Church tower. Solargraph recorded at Vilassar de Dalt from 24 September 2014 to 18 January 2015.

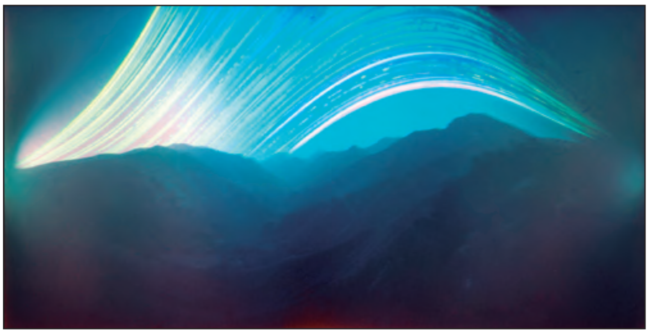

FIGURE 11. Ríu Infiernu valley (Asturias). Solargraph recorded from 16 June 2013 to 11 February 2014.

Moreover, the gelatine, which is a partially denatured protein, i.e., an organic chemical compound containing some mineral salts and water, may also have some effect.

A plausible explanation for the observed colours could be the formation of silver nanoparticles in solargraphy conditions, i.e., long exposure to ultraviolet and visible light of silver salts emulsified in gelatine. Although this is merely speculative, it is known that silver nanoparticles can be obtained by UV radiation of silver salt solutions, emulsions or colloidal media. [4]

FIGURE 12. *Window of enlightenment.* Solargraph recorded inside Can Manyer Library (Vilassar de Dalt) from 14 June 2014 to 25 November 2014.

Another important feature of the picture is that it has brown, ochre, reddish hues. In other words, it has colour (instead of black as elemental silver). The quick scan (in RGB mode) and the inversion of the negative to positive make the colours of the solar traces and the surrounding areas evident. Can you imagine the feeling of seeing a photo on black & white photographic paper and getting a colour image? It is spectacular! (figures 11, 12 and 13).

So, if you chemically develop the image as a regular copy in the photographic lab, you will get a full black sheet of paper unless you use a highly diluted developer. In this case, you lose the colour information and, at least for me, it makes no sense. Another possibility is to fix the image, also with diluted fixer, but in this case you lose some information as you are eliminating part of the silver salts present in the gelatine. Re-

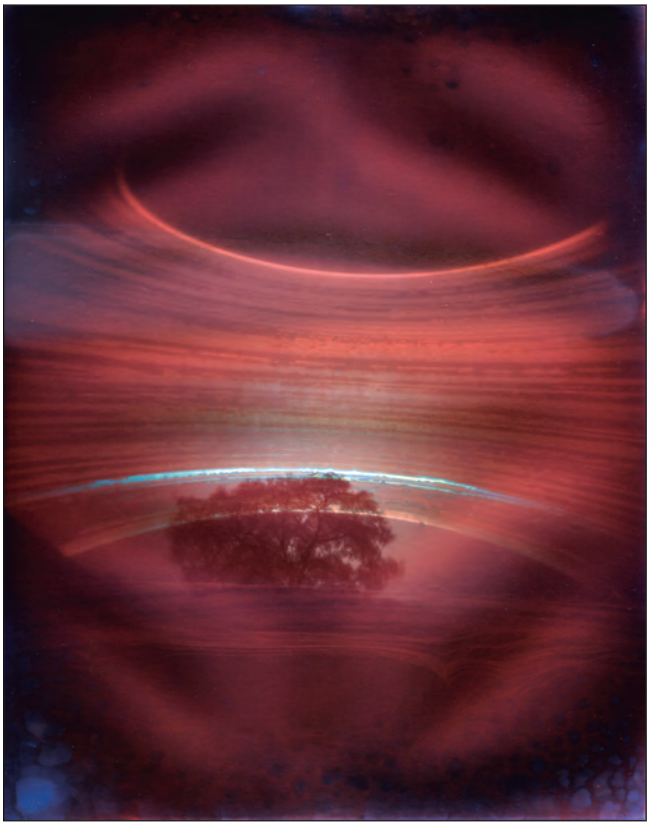

FIGURE 13. *De revolutionibus.* Solargraph recorded in Ayardes (Asturias) from 15 June 2013 to 7 February 2014.

member that the fixer removes all the remaining silver cations of the gelatine after the developer has reduced the excited ones (those that were struck by light photons) to elemental black metallic silver.

A recurring question some people ask me is how many cameras I have and how I know where they are and when I placed them. As you can imagine, considering the exposure times needed to make a solargraph, a way to make a certain number of them is to plant a lot of cameras wherever you go with the aim of returning or asking a friend to collect them for you. Thus, a database file allows me to keep track of the cans scattered around my house and those of my friends, on various rooftops and even in the mountains. I may have more than 30 cameras active at any given time, although it is true that some are lost, disappear or simply do not deliver the expected result.

Conclusions

Solargraphy is a mixed technique between science and art, chemistry and digital elements. The camera is the least important component and, at the same time, the process is almost more important than the result. A suggestive combination which, without being suitable for all audiences, does generate expectation. You just need a can, photosensitive paper and a lot of patience. The rest is a matter of the sun.

For further information on pinhole or solargraphy check out the links in reference. [5]

Notes and references

[1] The model was based on another one known as Dirkon, published in 1979 in the Czechoslovakian journal *An ABC of Young Technicians and Natural Scientists*. This model is available at <http://www.pinhole.cz/en/pinholecameras/dirkon_01.html> [Retrieved: April 16th, 2017].
[2] Unfortunately, The Solaris Project 2000-2002 website is no longer active: <http://free.art.pl/solaris/solaris/Solaris.html> [Retrieved: April 16th, 2017].
[3] See, for example: Eder, J. M. *The chemical effect of the spectrum* [on line]. New York: Scovill, 1884. <https://archive.org/details/chemicaleffects00edergoog> [Retrieved: April 16th, 2017].
[4] See for example: *a*) Zhang, X.-F.; Liu, Z.-G.; Shen, W.; Gurunathan, S. "Silver nanoparticles: synthesis, characterization, properties, applications, and therapeutic approaches". *Int. J. Mol. Sci.* 17 (2016), 1534-1572. DOI:10.3390/ijms17091534. *b*) Evanoff, D. D.; Chumanov, G. "Synthesis and optical properties of silver nanoparticles and arrays". *Chemphyschem* 6 (2005), 1221-1231. DOI:10.1002/cphc.200500113. *c*) Cozzoli, P. D.; Comparelli, R.; Fanizza, E.; Curri, M. L.; Agostiano, A.; Laub, D. "Photocatalytic synthesis of silver nanoparticles stabilized by TiO2 nanorods: a semiconductor/metal nanocomposite in homogeneous nonpolar solution". *J. Am. Chem. Soc.* 126 (2004), 3868-3879. DOI:10.1021/ja0395846. *d*) Mallick, K.; Witcomb, M. J.; Scurrell, M. S. "Polymer stabilized silver nanoparticles: a photochemical synthesis route". *J. Mat. Sci.* 39 (2004), 4459-4463. DOI:10.1023/b:jmsc.0000034138.80116.50.
[5] At the following link you have a computer software item for preparing all the calculations associated with a pinhole camera: <http://www.pinhole.cz/en/pinholedesigner> [Retrieved: April 16th, 2017].
A couple of sun motion simulator software items can be found at <http://astro.unl.edu/classaction/animations/coordsmotion/sunmotions.html> and <http://photoephemeris.com> [Retrieved: April 16th, 2017].
This is the website of Diego López Calvín, to whom I am grateful for sharing his knowledge about solargraphy: <http://www.solarigrafia.com> [Retrieved: April 16th, 2017].
And last, but not least, you can see my own work on my blog: *jesusjoglar.net*.

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Jesús Joglar holds a Ph.D. in Chemistry from the University of Oviedo. Photography – and in particular pinhole photography – is one of his passions. A large body of his photographic practice is devoted to solargraphy, a specialised lensless form of photography that produces exciting images and offers new perspectives on the world around us.