Solargraphy cans

Manual for building a solar can to observe the Sun.

Introduction

In this user manual, you will find all the necessary information to build a solar can, also known as a pinhole camera, and understand how it works. We invite you to read it carefully, as it is a simple but delicate experiment. The results of the experiment, conducted by numerous schools, families, and groups of people, will be showcased at the fourth edition of the **Astronomy Festival - The Universe in All Senses**, in Castellaro Lagusello (MN) on **June 7-8-9, 2024**.

The purpose of the experiment is to **observe the change in the Sun's motion** at intervals of weeks or months.

Operating instructions

Preparation & materials

This kit for building two solar cans contains:

- User manual
- Two photosensitive films FOMA Fomatone MG 131 - Natural Gloss 12.7x17.8 CM

For completing the experiment, you will also need:

- Two 40/50 cl cans for each solar can
- Can opener
- Pair of scissors
- Electrical tape
- 4 zip ties for each solar can
- A pin

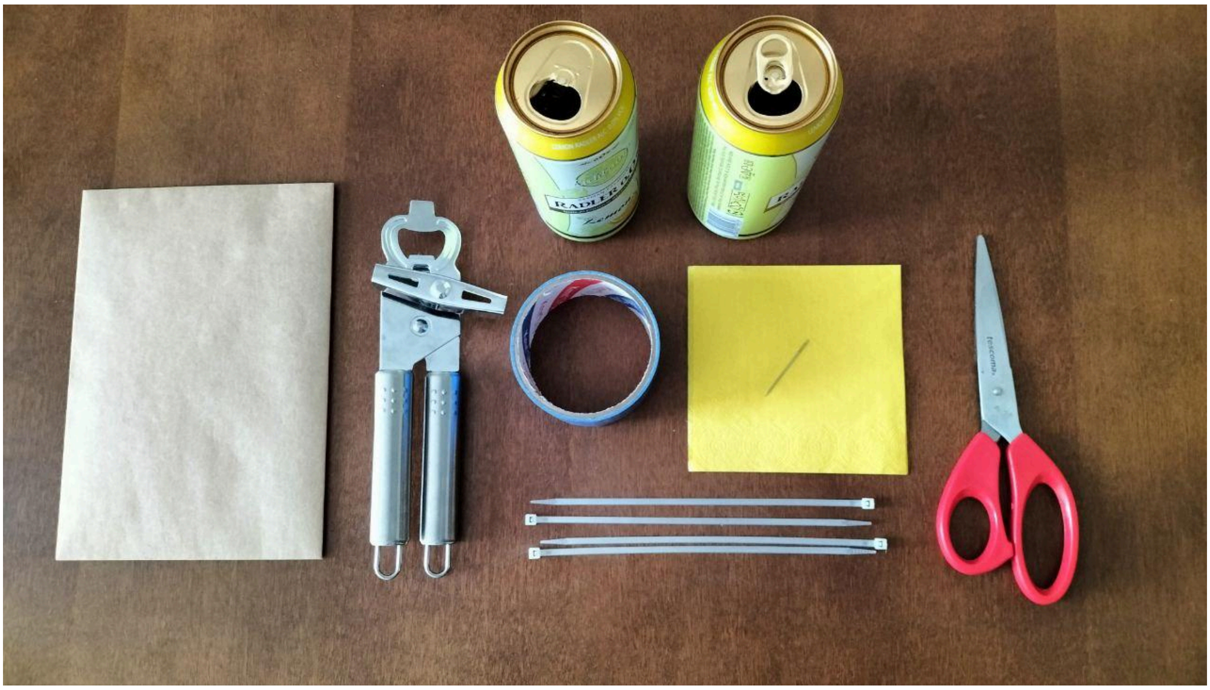


Fig. 1: Materials needed for creating the solar can. The brown envelope contains the photosensitive paper.

You can, of course, proceed to build as many solar cans as you like by obtaining additional photosensitive paper.

ATTENTION!

The treatment of aluminum cans can be dangerous, especially during the cutting process. We recommend wearing gardening gloves when performing this operation or seeking the assistance of an adult. Use only a can opener and a pair of scissors for these operations, avoiding knives, saws, or tools that would leave the can edge jagged and sharper than necessary.

Construction

1. First, open the cans as shown in figure 2.1. Remove the top cap of the first can using the can opener, and remove the bottom of the second can, leaving a few centimeters of the edge.
2. Once you have the two separate parts of the solar can, pierce the main can at the midpoint using a pin or nail (fig 2.2). Be careful to make the hole as small as possible; this will help obtain better images.
3. After making the hole, seal it with a piece of tape (fig. 2.3) or electrical tape. This will be the shutter of the solar can, to be removed only when it is in position.
4. For the next step, we recommend being in a dark or semi-dark environment. Take out the photosensitive paper and place it inside the main can so that the sensitive surface (shiny and yellowish) of the paper faces inward (fig 2.4), ensuring that the paper does not cover the entrance hole (fig. 2.5). If you wish, you can secure the photosensitive paper with a piece of tape to prevent it from moving.
5. At this point, simply close the solar can with the bottom of the second can (fig 3.1) and seal it with a wrap of electrical tape (fig. 3.2).

Fig. 2: Steps for the construction of the solar can.

Fig. 3: Closure, sealing, and external positioning of the solar can. The piece of tape above the hole should be removed once the can is fixed to the support.

Installation

The solar can should be positioned vertically (fig. 3.3) and oriented towards the south, meaning that the hole you made should point south. You can follow the instructions in the "*Finding the South*" section in the last part of this manual. We recommend using zip ties to secure the can.

IMPORTANT: Once installed, gently open the shutter of the solar can by removing the piece of tape that seals the entrance hole to light.

The solar can can remain in position for months; we suggest choosing an interval between 1 and 4 months during which the solar can should **not** be moved.

Scanning

Once the exposure time has elapsed, **close the hole of the solar can before moving it from its position**. You can then open the solar can, remembering to do so in a dark or semi-dark environment. At this point, please note the following information:

- **Start date of the observation**
- **End date of the observation**
- **Positioning address of the solar can**
- **Names of the experimenters**

The exposed film will show a color-inverted image. To proceed with image processing, we recommend using a flatbed scanner to digitize the image (select a resolution of at least 500 dpi, format .jpg or .png). Please send us the digitized file to the email provided at the bottom, attaching the above information. We can take care of inverting colors and axes of the image once we receive the digital file. For any issues, feel free to contact us! Figure 4 shows a particularly successful image.

Please send us the result of the experiment no later than 15/05/2024, and we invite you to come to the festival to see the final panel with all the solar traces!

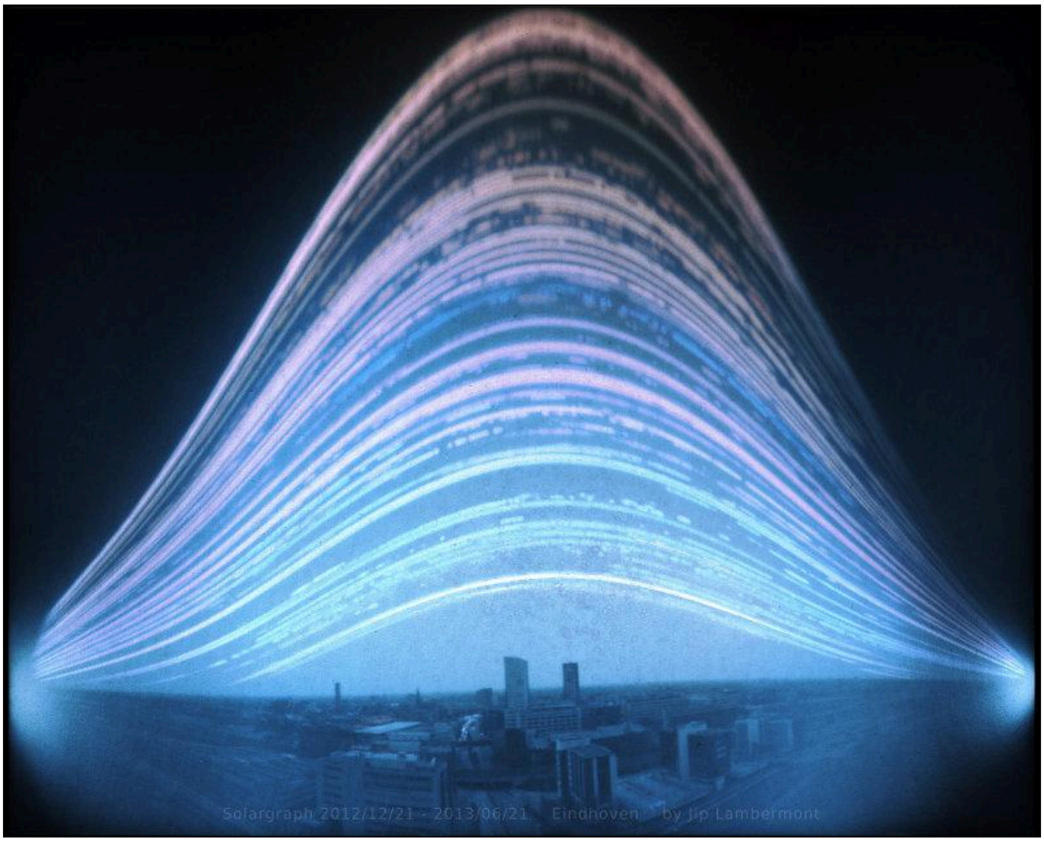


Fig. 4: Image produced with a solar can by xyzon

To delve deeper

Physical and chemical principles

The pinhole camera

The pinhole camera (from the Greek στενός stenós "narrow" and ὀπή opè "hole, opening") is the simplest possible optical system. It is a darkroom, which can be a box or a can, equipped with a hole that allows light to enter. It is an optical system that does not use lenses or mirrors and is based solely on the linear propagation of light. Each point of the framed object emits a light ray that passes through the small hole of the camera and is reflected on the image inside the camera. The image is thus inverted both vertically and horizontally, as shown in figure 5.

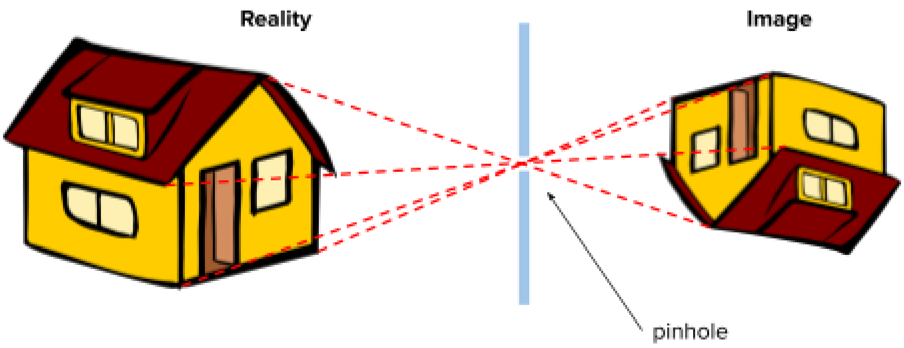


Fig. 4: Diagram of the image inversion through the pinhole. As can be seen, the image on the right is inverted both in the vertical and horizontal directions.

The peculiarities of this optical system are that the depth of field is almost infinite, meaning that all objects, regardless of their distance, are brought into focus in the same way, and the definition of the image depends on the size and shape of the hole. **The smaller and more regular the hole, the more defined the image will be.**

The photosensitive film

Sunlight, carrying energy, is capable of modifying the chemical composition of the photosensitive paper, leaving a trace on it. The trace is more evident the more light it receives. To increase the light and thus the visibility of the image, two methods can be used: enlarging the entrance hole or increasing the exposure time. As seen in the previous section, if the entrance hole is enlarged, the image would be blurred and less defined because the camera does not have a lens or lens system. Therefore, we must proceed with increasing exposure times. In the image in figure 6, the difference between different exposure times for a simple camera is shown.

Fig. 6: Difference in image brightness with changing exposure times. Short times correspond to darker images, long times to brighter images.

Of course, in modern cameras, there are many factors at play, such as the shutter aperture, sensor or film sensitivity, and so on. In this simple case, we can say that the image brightness is directly proportional to the exposure time.

As you will see once you have extracted the photosensitive paper from its envelope, the color of the paper is white/yellowish. The image produced at the end of the exposure will be in color inversion, and it will need to be digitally modified to see the actual colors. Colors are inverted because sunlight "burns" the chemical components of the paper, so what is in shadow remains white, what is illuminated becomes black, and so on.

The motion of the Sun

The motion of the Sun in the sky is actually an apparent motion, meaning it seems like the Sun is moving in the sky, but in reality, it is us on Earth rotating around our axis. As the seasons change, we observe that the Sun's motion repeats every day from East to West but with some differences. While in winter, the Sun rises in the southeast, reaches its lowest point in the south, and sets in the southwest, in summer, the Sun rises in the northeast, reaches its highest point in the south, and sets in the northwest.

This phenomenon causes longer days in summer as the Sun follows a longer path in the sky.

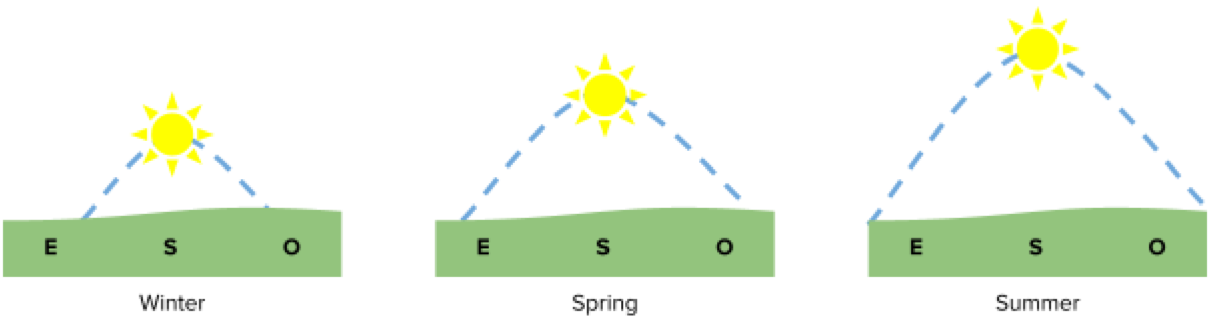


Fig. 7: Diagram of the solar trajectory as the seasons change. The observer has their back to the North, with the East to their left and the West to their right.

The nature of this phenomenon lies in the tilt of the Earth's axis. The Earth does not rotate around an axis perpendicular to the plane of its orbit but inclined at 23.27°. Since the axis maintains its inclination while the Earth revolves around the Sun (revolutionary motion), sometimes the northern hemisphere is tilted toward the Sun, i.e., in summer, and sometimes not, i.e., in winter. This leads to the alternation of seasons and the change in the apparent trajectory of the Sun in the sky.

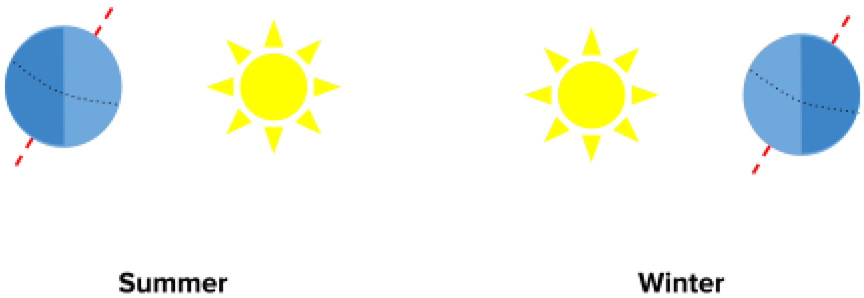


Fig. 8: Diagram of the orientation of the Earth's axis as the seasons change in the northern hemisphere; in the southern hemisphere, the seasons are reversed. The light part of the globe indicates the illuminated part, and the dashed line is the terrestrial equator.

Due to the tiny entrance hole, the solar can requires exposure times of months. This allows us to observe the change in the solar trajectory over time.

Finding the South

Orientation, the technique used to find the cardinal points, has always been considered essential for those who want to explore, travel, or observe the sky. Over the centuries, many techniques have been developed to find one of the cardinal points, from which the others can be deduced. Here, we provide some tips on how to orient your solar can to the South, assuming you are in the northern hemisphere! If you are in the southern hemisphere, under the equator, you need to orient the solar can to the North.

Following the Sun

The simplest method to find the South is to follow the Sun. Astronomers define the noon of a certain location as the moment when the Sun passes over the southern meridian, or more simply, the direction that the Sun points at noon is the south. Just wait until it's 12 o'clock and see where the Sun is: that's the south. Behind you will be the north, to the right the west, and to the left the east. For this experiment, high precision is not necessary; it is enough that the solar can is oriented toward the south. In the southern hemisphere, everything is reversed: the Sun culminates on the northern meridian, in which case at noon, you will have the sun to the north, facing south, the east to the right, and the west to the left.

Satellites and maps

Every smartphone is equipped with at least one navigation app like Google Maps or WAZE. Accessing these maps, the smartphone connects with satellites in orbit to determine our position and uses the phone's internal compass to understand which direction we are facing. The maps are usually oriented to the north; just turn around until the arrow indicating your position in the app points to the south.

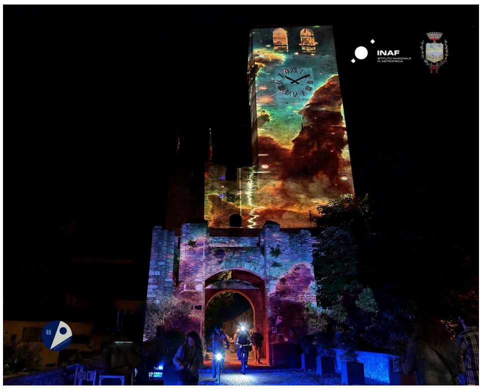
Compass

If you have a compass or if your smartphone has one built-in, you can use it to orient yourself. The compass has a magnetized metal needle free to move. The needle will try to position itself along the lines of the Earth's magnetic field that go from the north pole to the south pole. Since the needle indicates the north, just look in the opposite direction to find the south.

The Festival - The universe in all senses

The organization of the Festival includes exhibitions, interactive workshops, informative conferences, shows, sky observations, and projections, where people of all ages can have direct experiences. Also, this year, all activities will be multisensory, including not only visual elements but also tactile and auditory ones. In this way, everyone can have access to the knowledge of astronomy and discover new ways to explore the Universe. The Festival is an opportunity for everyone to be amazed by the fascinating beauty of the Universe.

We invite you to participate in the Festival on the days of June 7-8-9, 2024, in the village of Castellaro Lagusello (MN). During the Festival, the results of the solar cans collected in these months will be showcased.



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For further information and contacts, feel free to write to us:
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See you soon,
Andrea & Giovanni