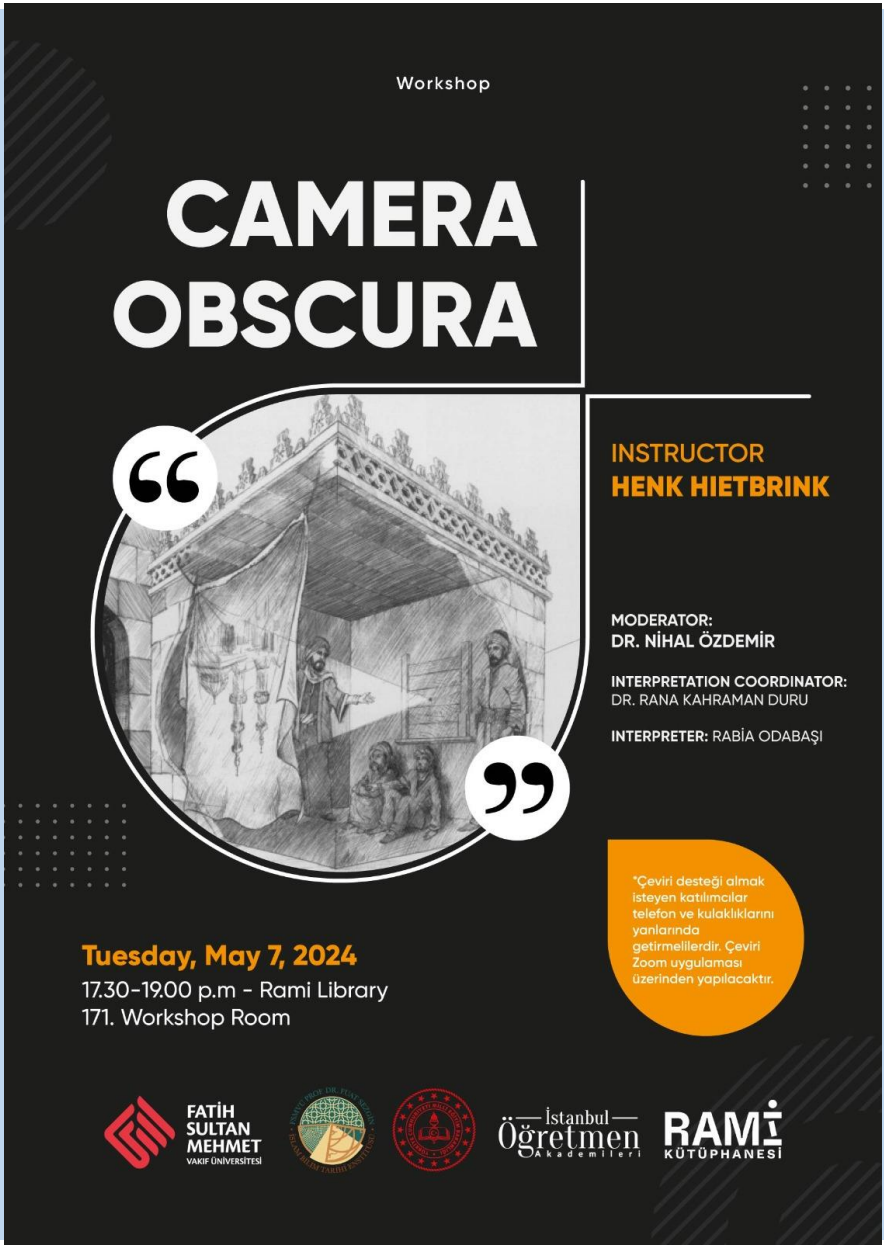
Rami Library

Workshop

On the shape of the eclipse

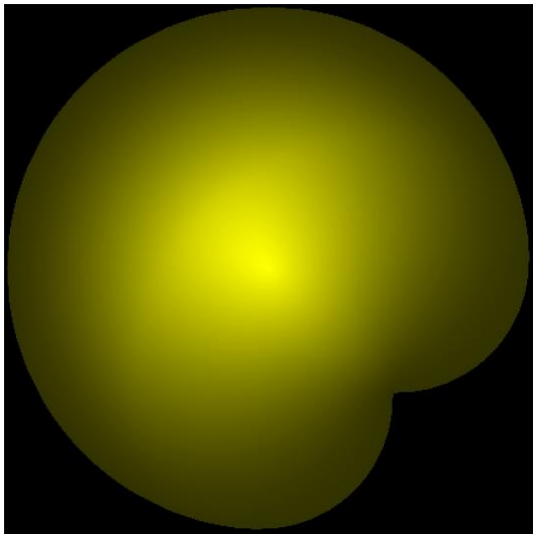


Ibn al-Haytham wonders the shape of the crescent moon

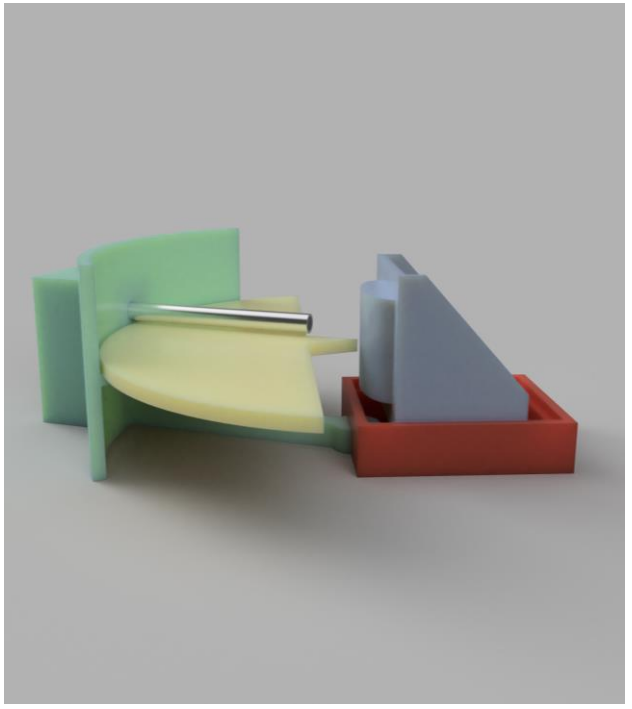
- **Why don’t we see a crescent moon in a camera obscura?**

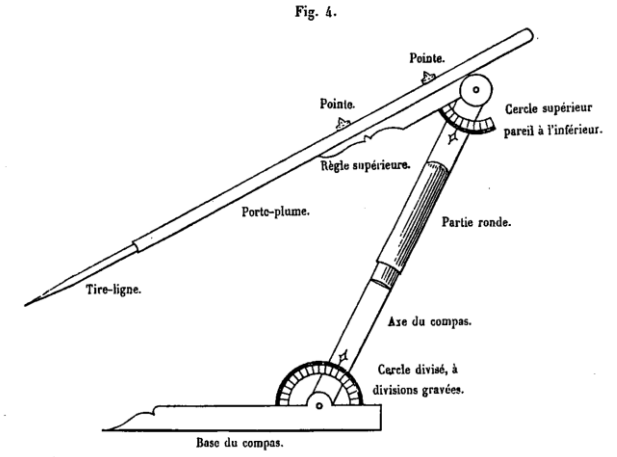
- **When the aperture is small, moonlight is too faint, we can not see the shape.**

- **When we enlarge the aperture, we see almost a full disc.**



Instruments from the Istanbul Museum of the History of Science and Technology in Islam





Why we do workshops

- **Intense learning**
  - Brain
  - Hands, Muscles
- **Learn by doing**
- **Use mathematics and astronomy to learn about**
  - Experiments
  - Develop a critical stance
  - Fact checking

Popular education on Dutch television

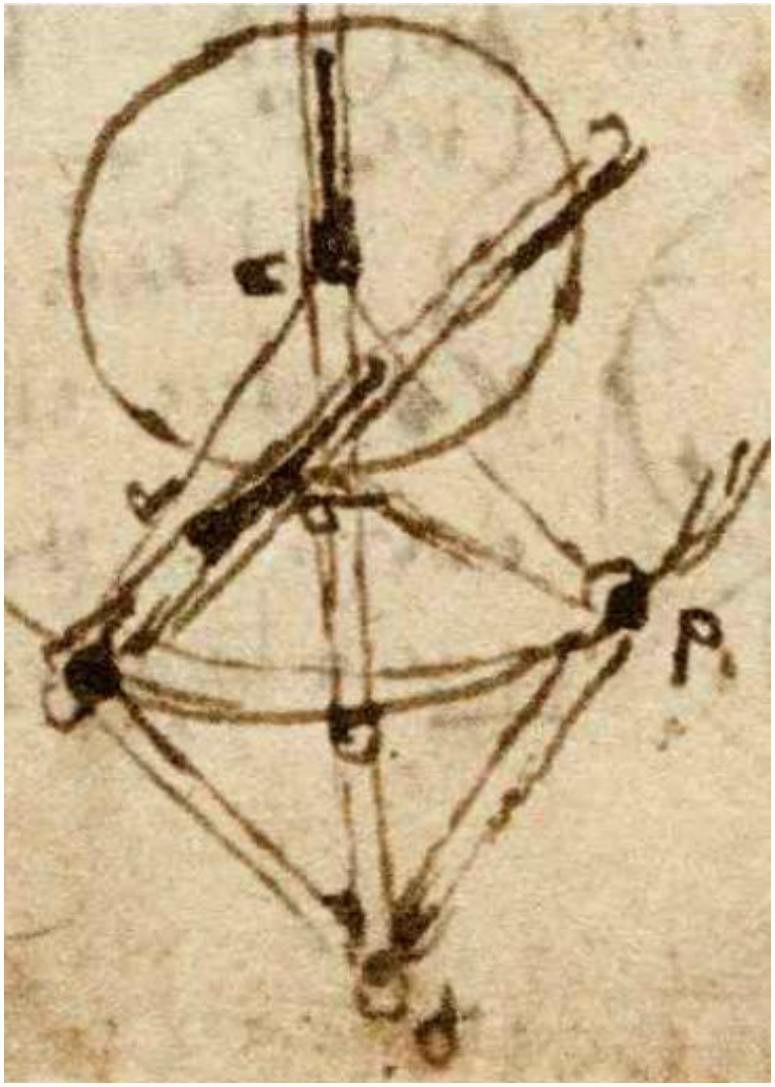
https://www.youtube.com/watch?v=YHeY8KYxbJ0

- There is no reason to remember Newton for sitting under a tree.
- Newton was too busy to sit relaxed under a tree.
- Newton is not important for finding the one and only formula.
- He is famous for eliminating all other options

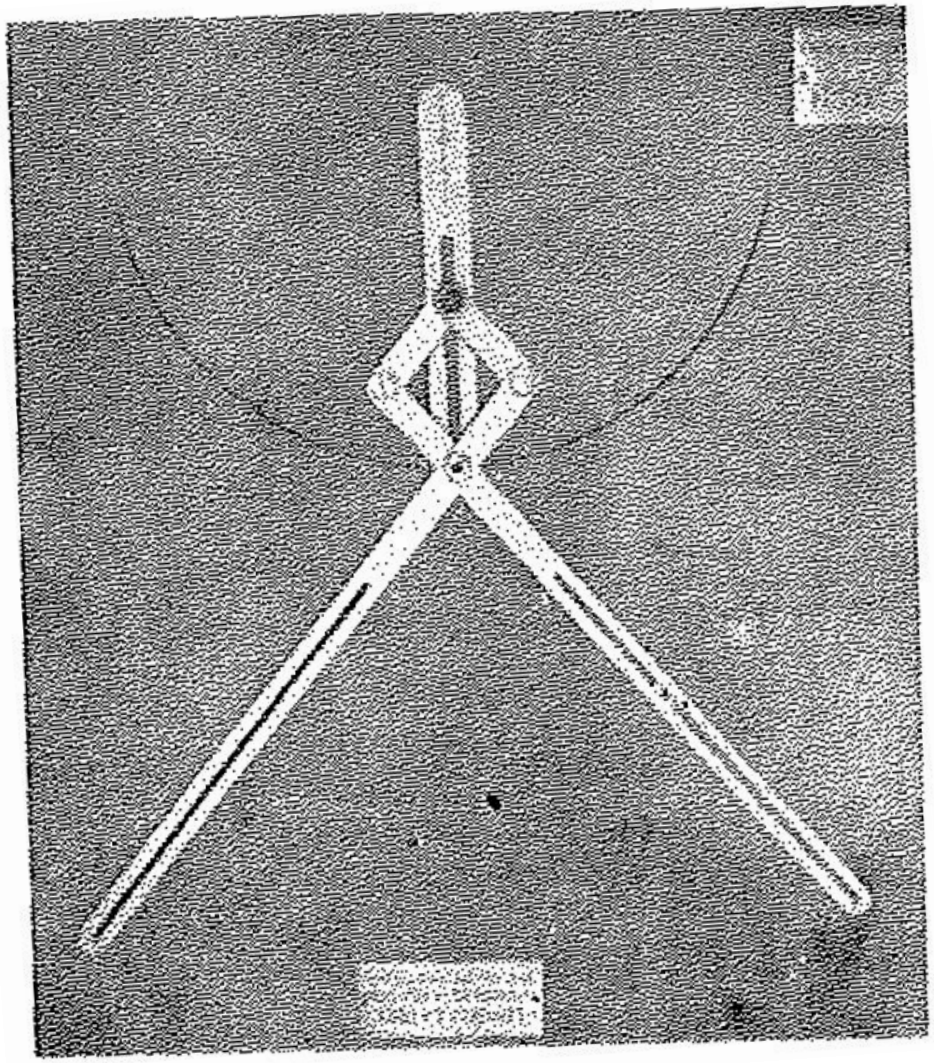
- https://www.youtube.com/watch?v=YHeY8KYxbJ0

2019 workshop
Leonardo da Vinci ⇔ Marcolongo

Geometry is a Kite

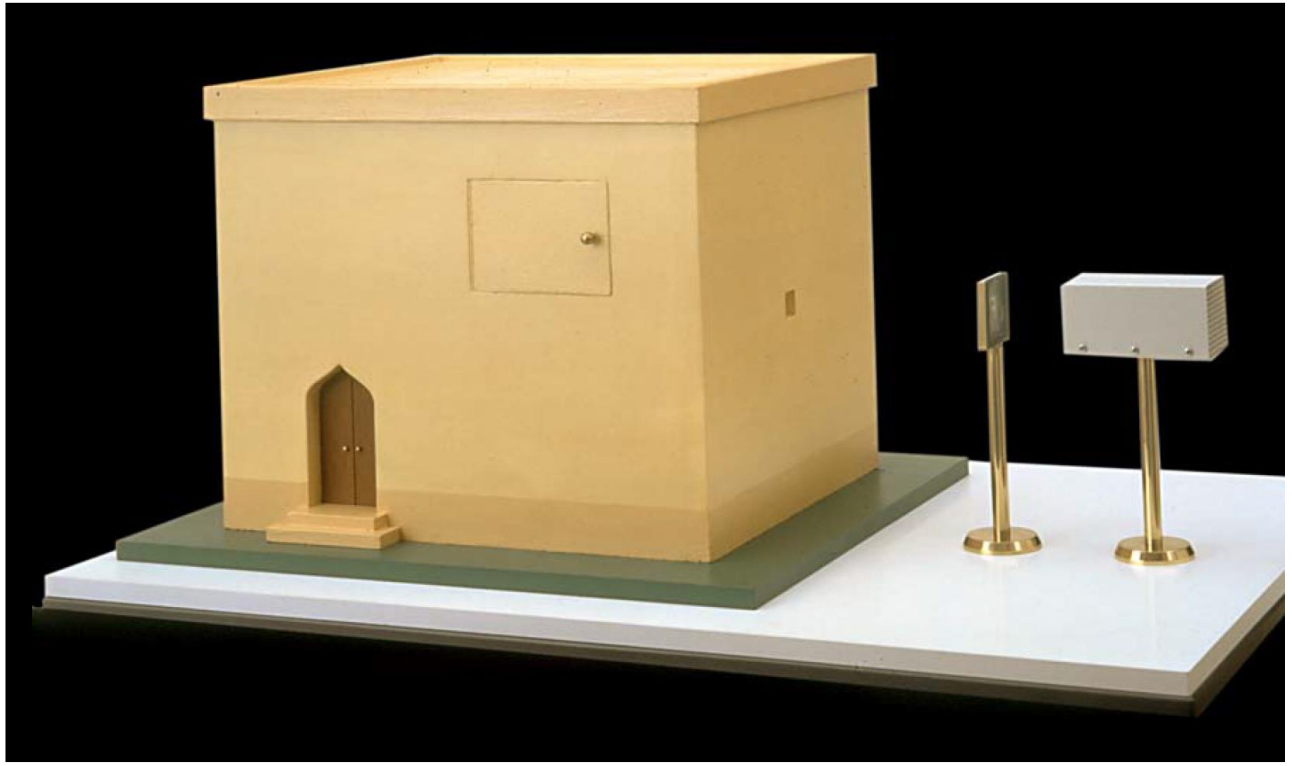


… is a Rhombus



2021 lecture: Camera obscura (or not)
http://www.fransvanschooten.nl/alhacen_uk.htm

It looks like a camera obscure, but …



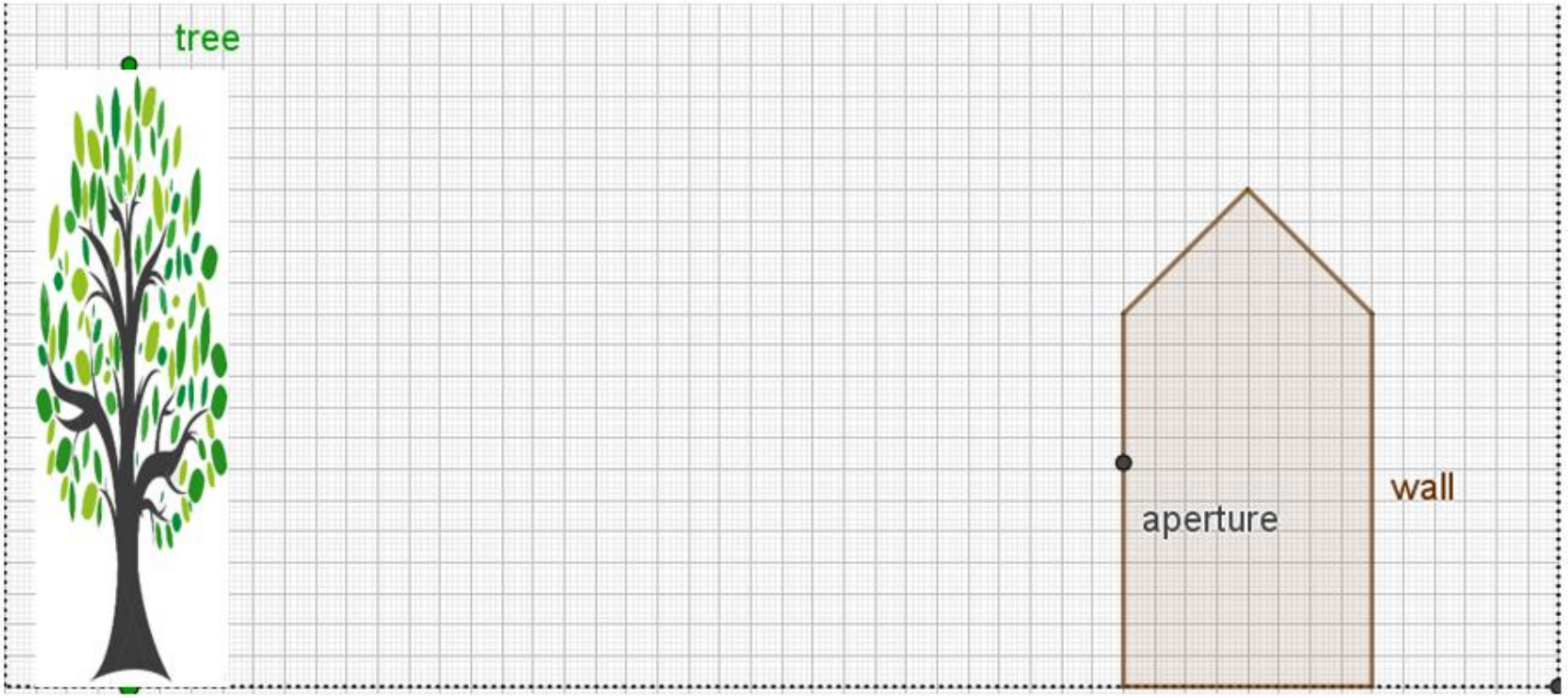
Shape of the image of the F

In the museum, a letter F is lit by a huge halogen light bulb at a near distance. The animation and the video explain the shape of the image of the F on the wall.

- Powerpoint
- Text
- Workshop
- Exercises

Exercise 1:

In a dark house, there is only one small hole (aperture).
The width of the house is 4 meters.
The diameter of the aperture is only 3 mm.
Light flows through that hole into the room.
Outline the image of the tree on the inside wall of that house.

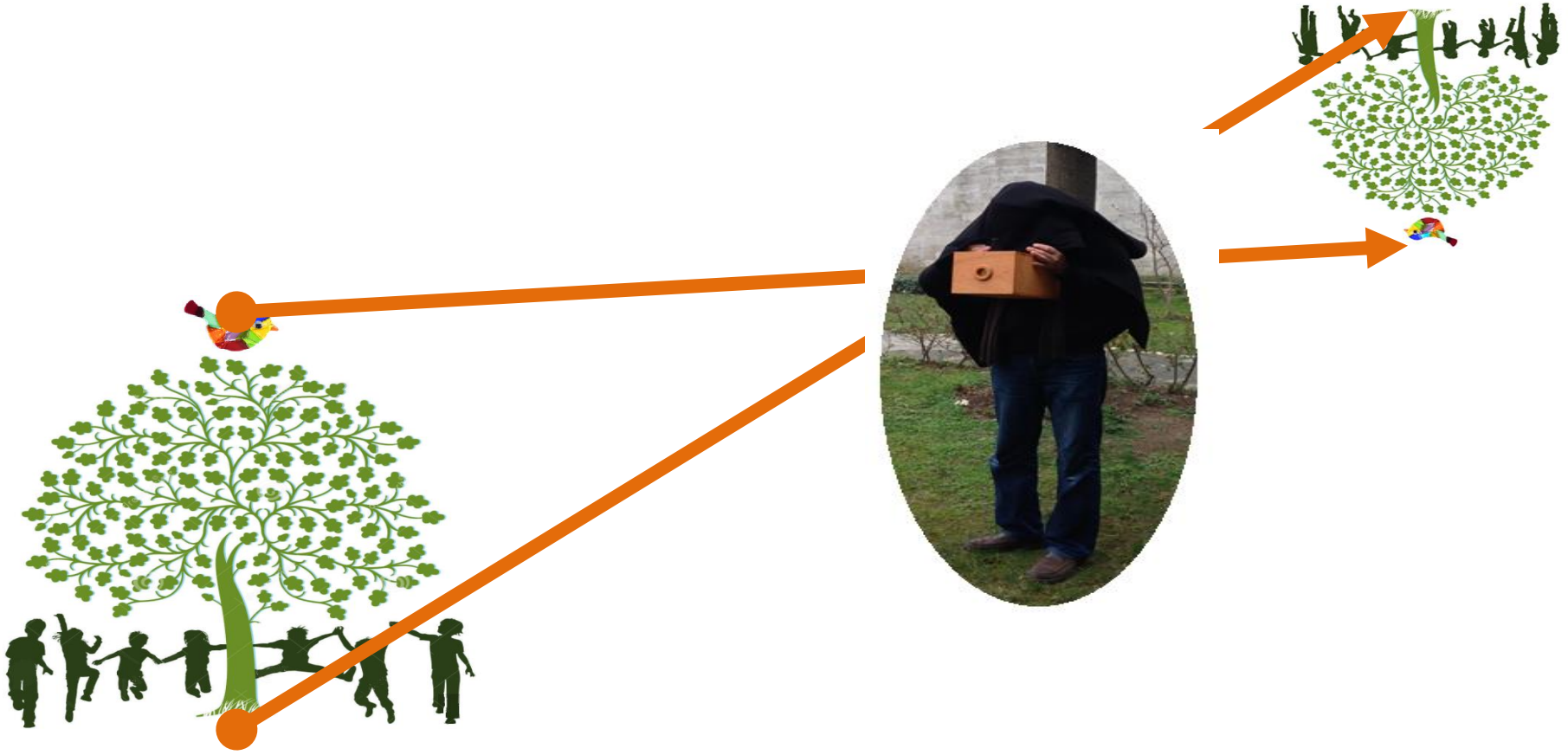


This camera obscura works !
Yücel Aşıkoğlu

Indirect Light

Answer to exercise 1:

The magnification factor equals the ratio between the distance to the tree and the distance to the rear wall.



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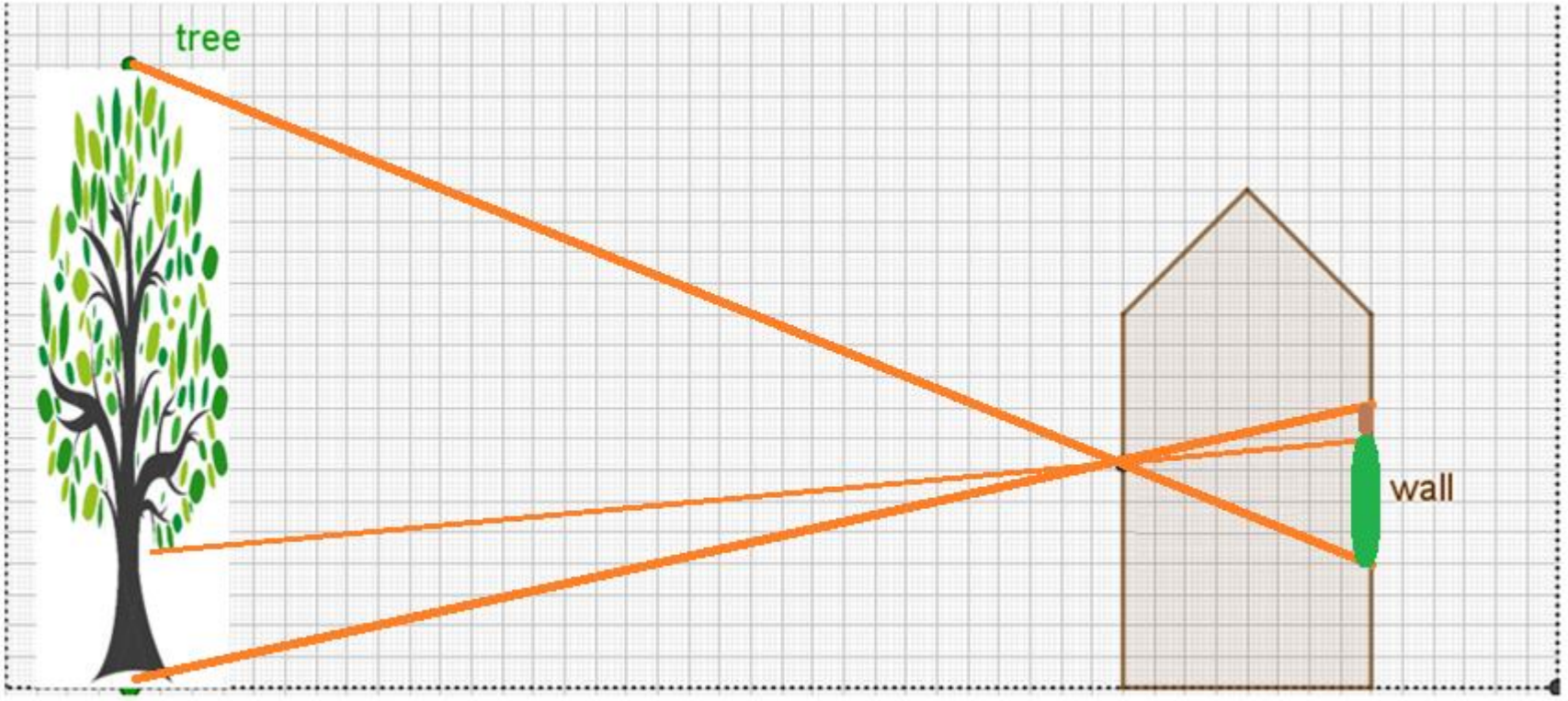


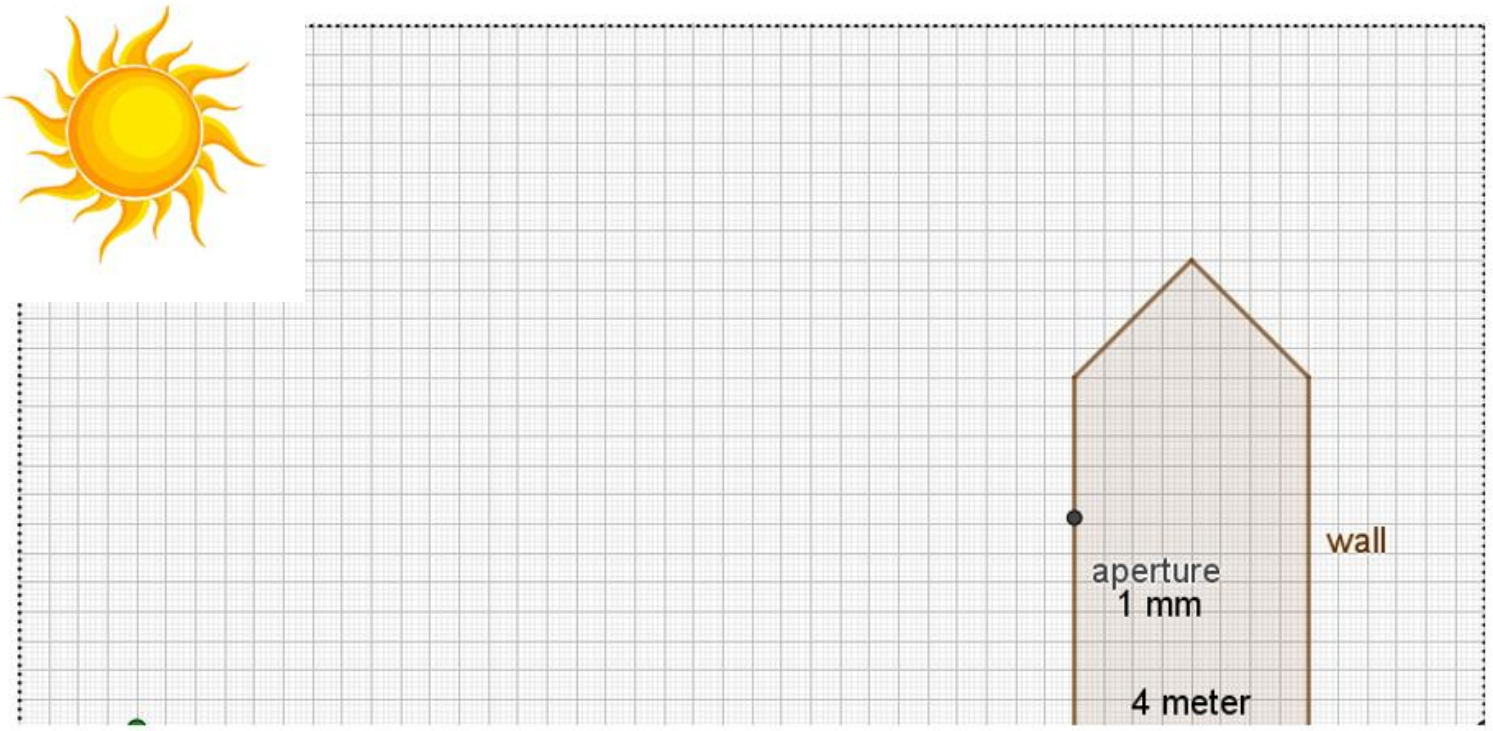
Exercise 2

Draw the image of the sun on the inside wall.

The small aperture is only 1 mm.

The width of the house is 4 meters.

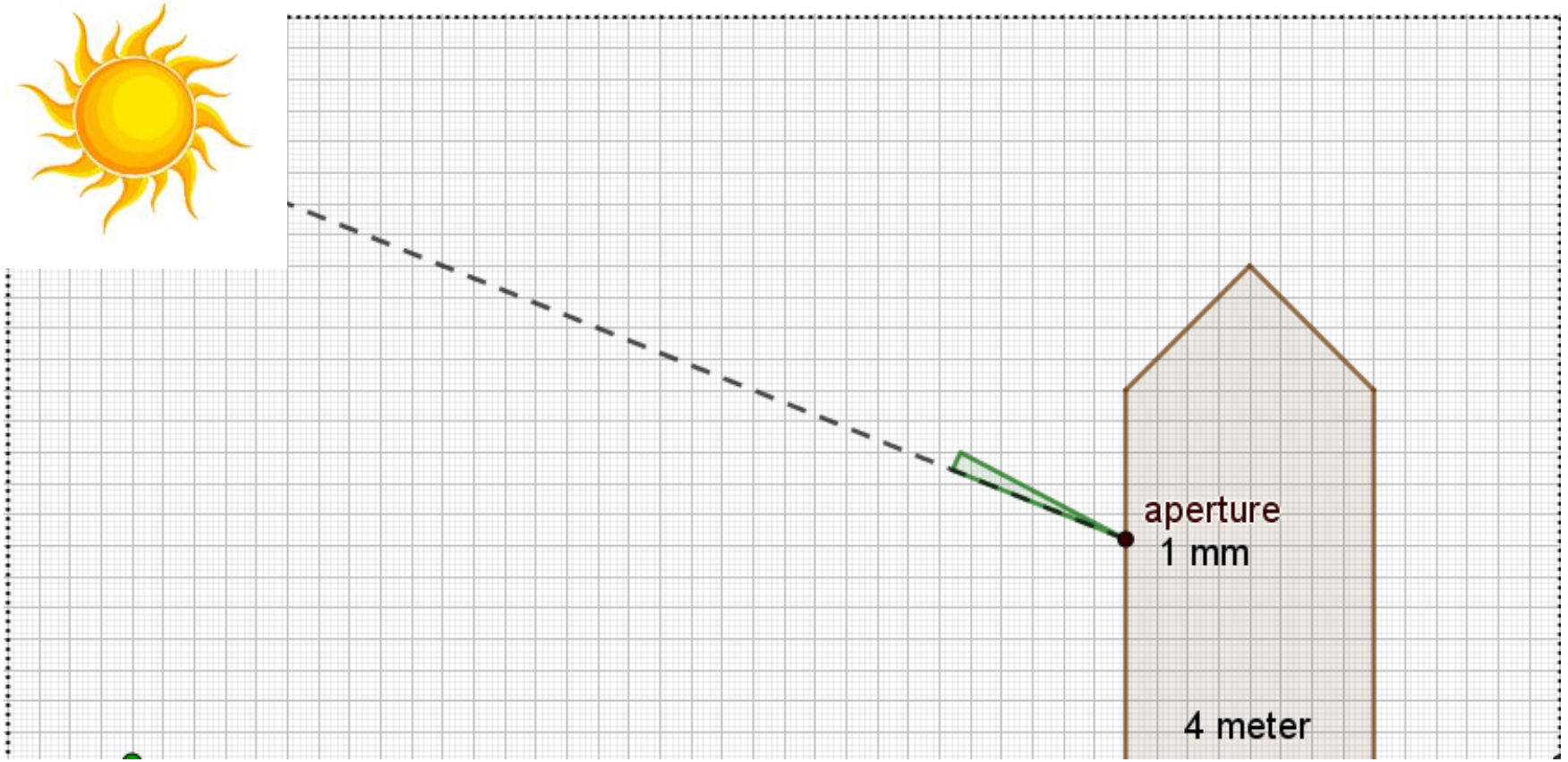
Estimate the diameter of that image.



Exercise 3

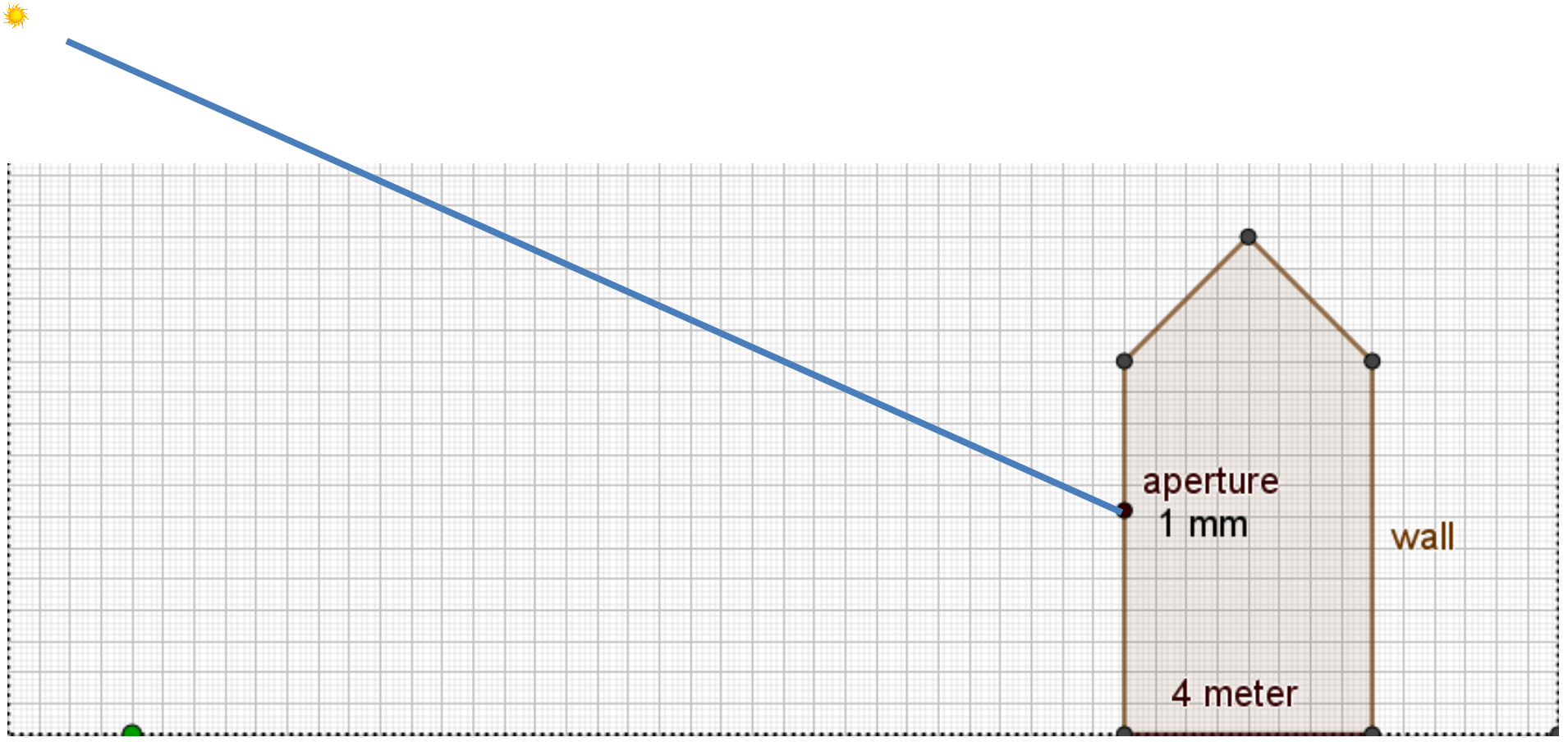
Draw the sun in the upperleft corner on a scale of 1 to 100. The width of the house is 4 meters.

Express the size of the sun in degrees



Answer to Exercise 3

The angular diameter of the sun is 0,5°.



Answer to Exercise 2
Calculate the radius with trigonometry

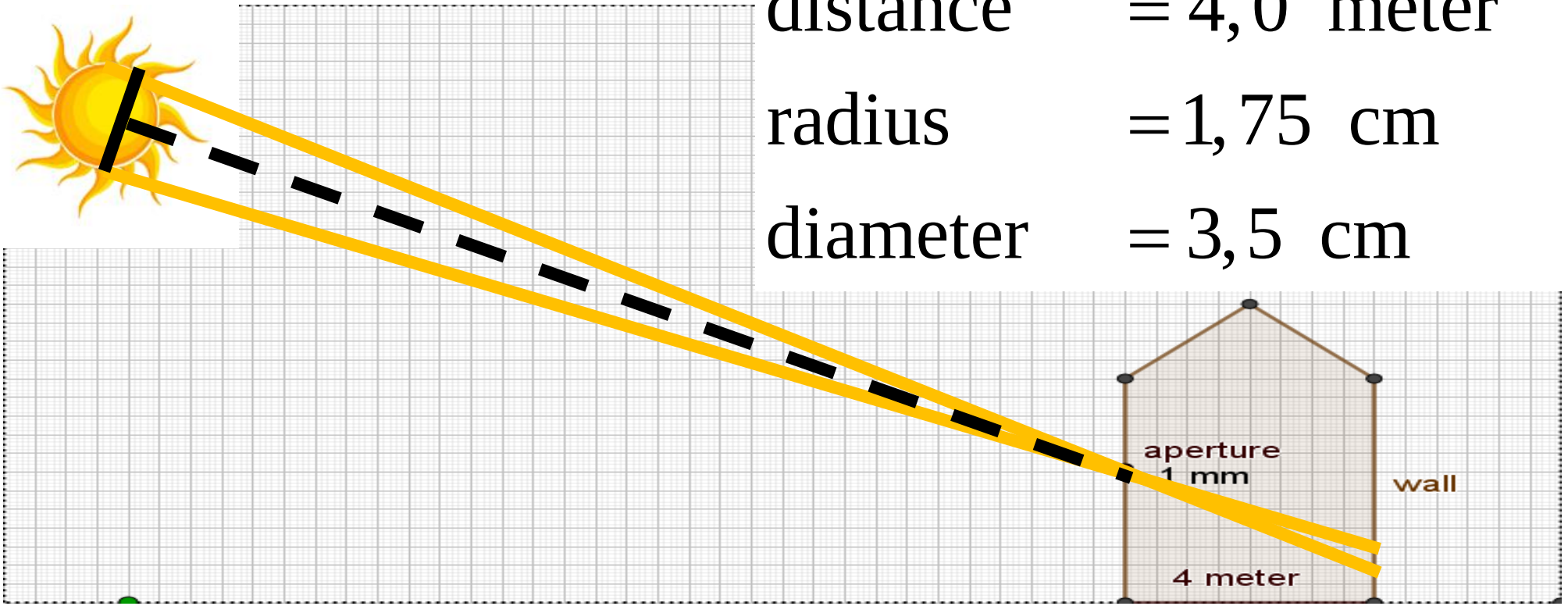
The angular diameter of the sun is 0,5°

$$\frac{\text{radius}}{\text{distance}} = \tan\left(\tfrac{1}{2}\cdot 0{,}5°\right)$$

$$\text{distance} = 4{,}0 \text{ meter}$$

$$\text{radius} = 1{,}75 \text{ cm}$$

$$\text{diameter} = 3{,}5 \text{ cm}$$



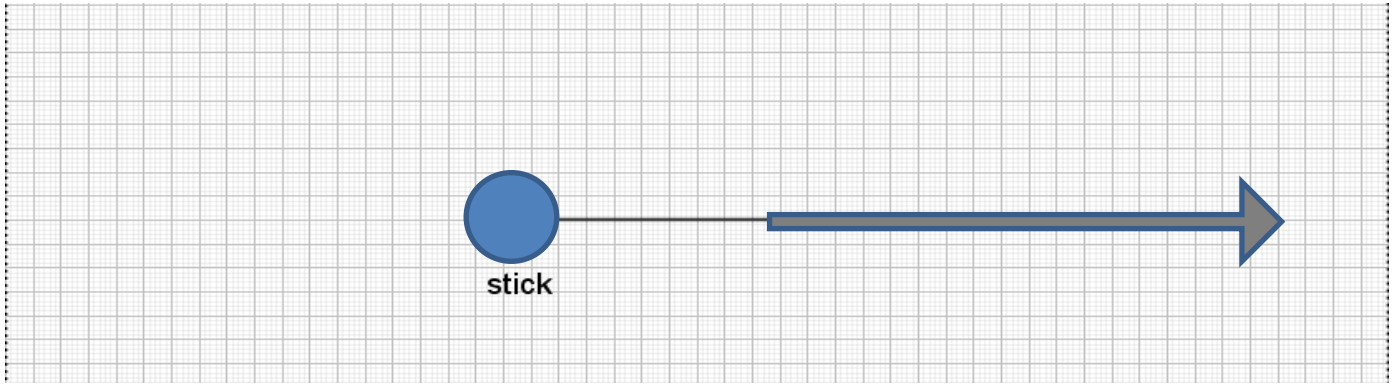
Measures of a cone with a top angle of 0,5°

Length (in meters)	Diameter (in cm)
1	0,9
2	1,7
4	3,5
10	8,7

Exercise 4

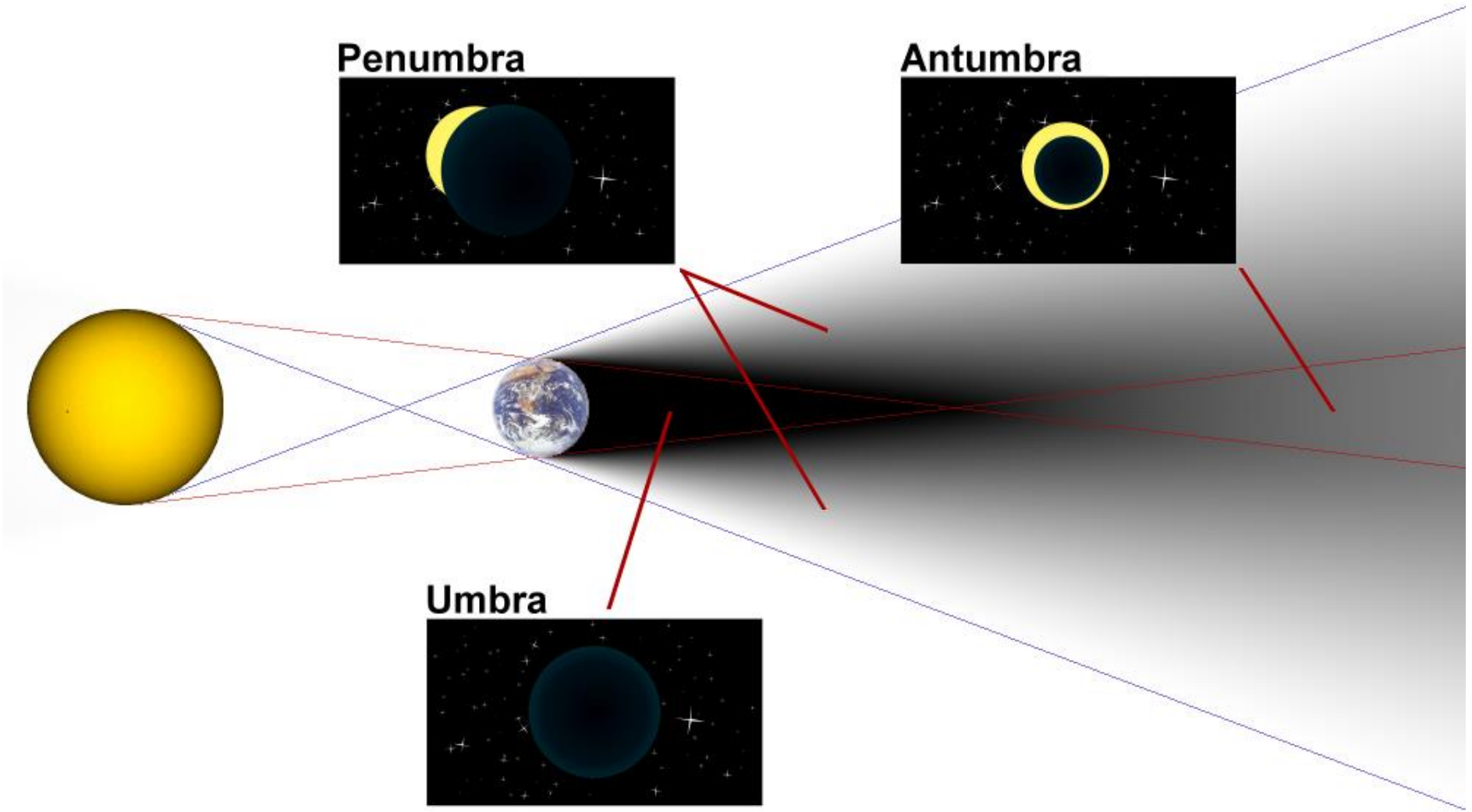
Construct the full shadow (umbra) and the semi-shadow (penumbra) of a 2 cm diameter stick at sunrise.

- **You might need more than one table.**
- **Estimate the length of the full shadow.**
- **Use rope, tape, and a paper ruler.**
- **Advice is to work precisely**



What is happening to the tip of the shadow of a long stick? It seems blurred. Why?

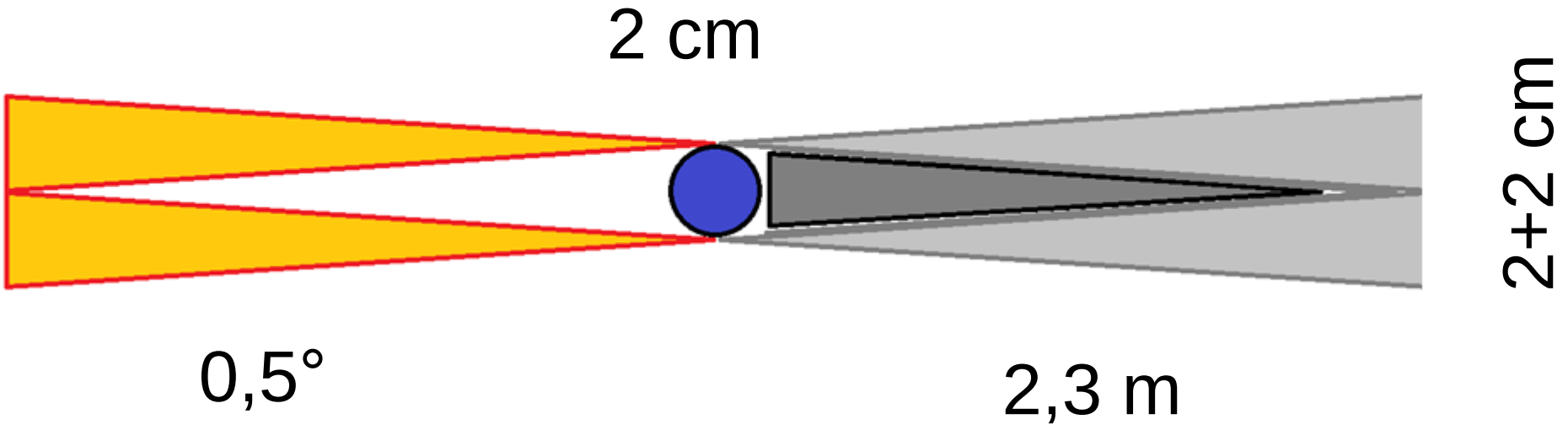
Full shadow and semi-shadow
Umbra and penumbra



https://en.wikipedia.org/wiki/Shadow

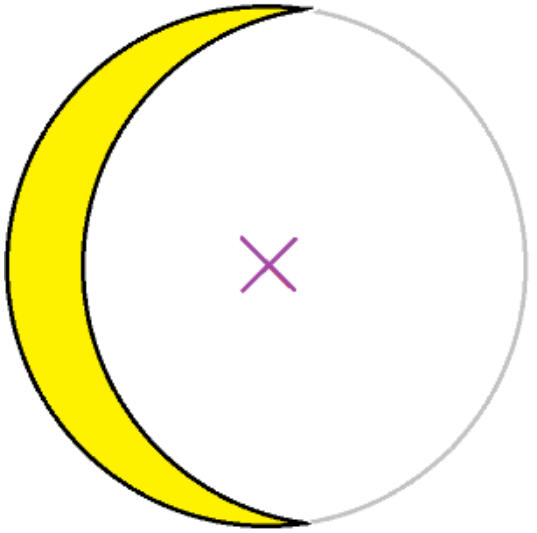
Answer to Exercise 4

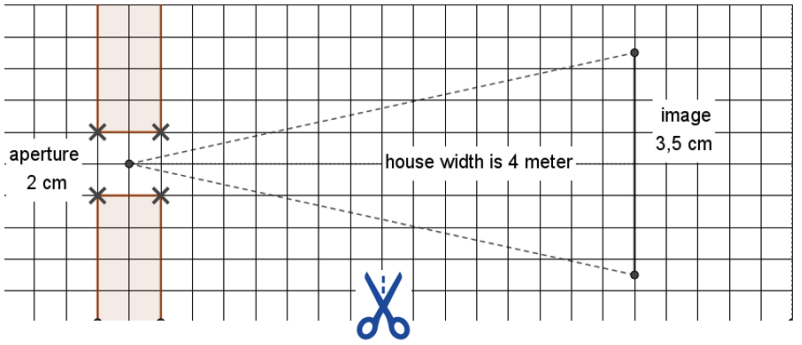
Construct the full shadow (umbra) and the semi-shadow (penumbra) of a 2 cm diameter stick at sunrise.



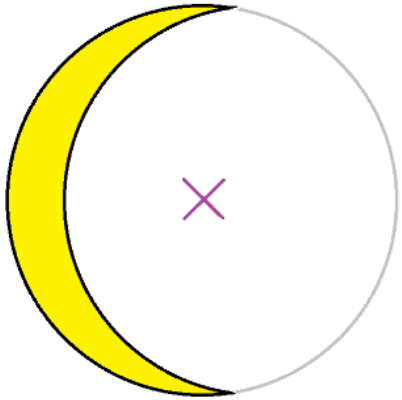
Exercise 5

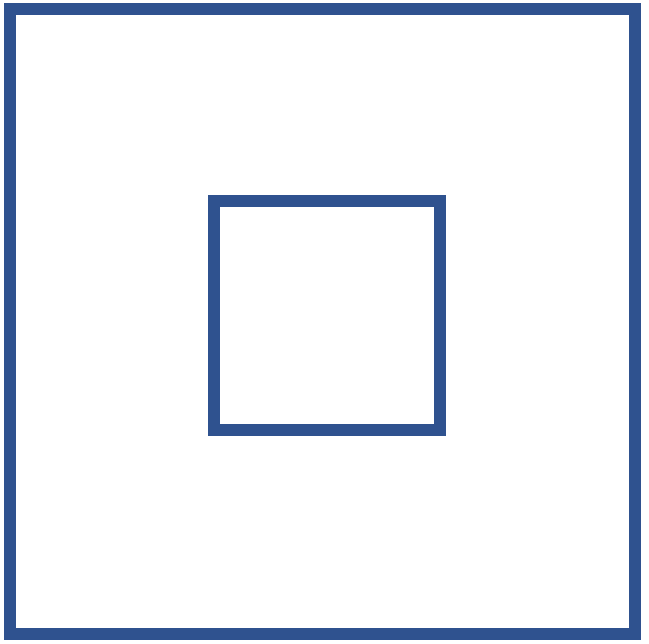
- **Draw a crescent moon with a diameter of 3,5 cm.**
- **Make four or nine copies on a plastic transparency.**
  Cut them out including the cross.
- **Consider a 2 cm square aperture to make the image visible.**
- **Cut the exercise sheet**
- **Use the rope construction to mark all the images on the wall.**





Answer to exercise 5



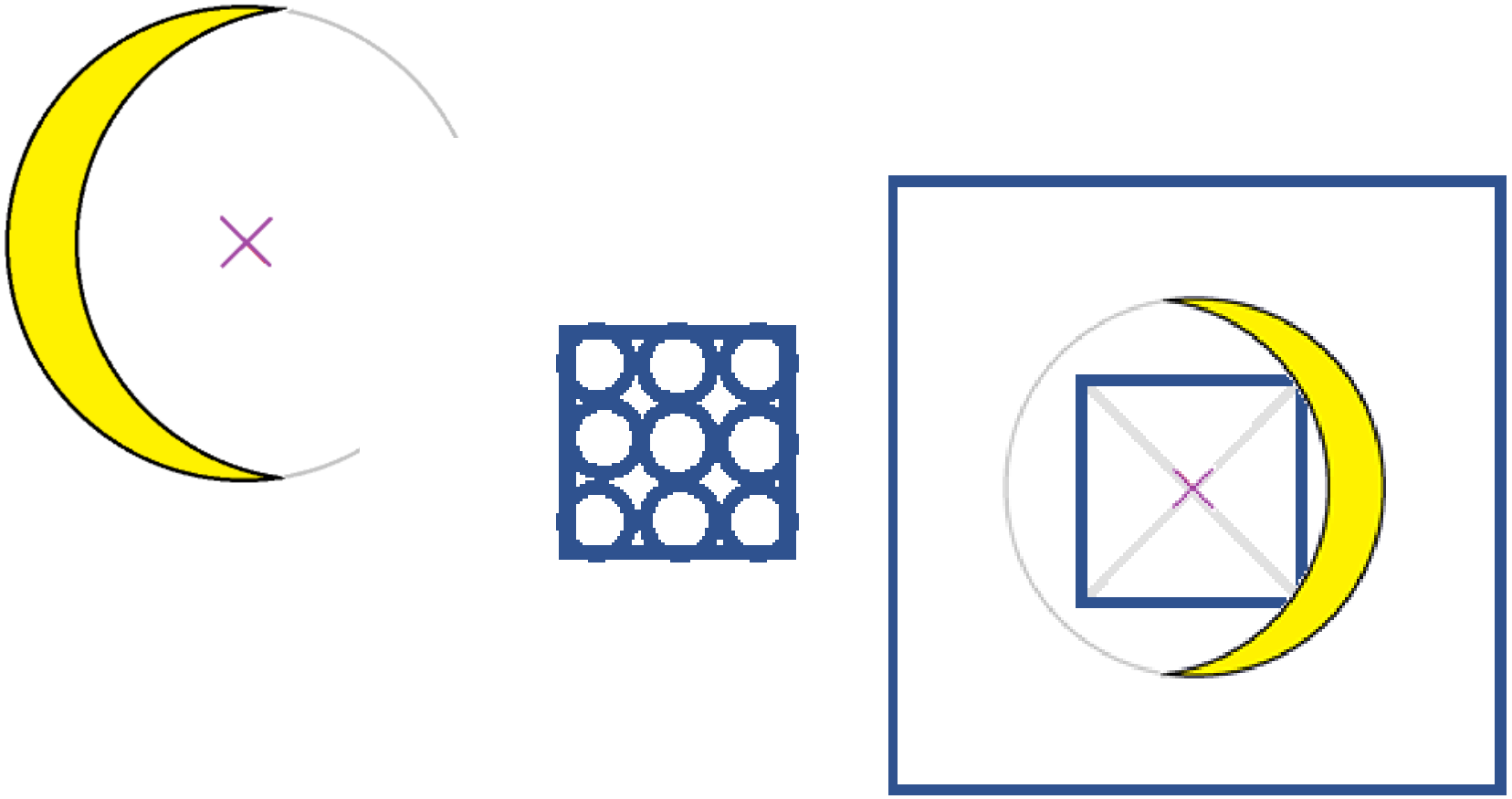


The crescent moon is in the sky.

Suppose the aperture has nine small holes.

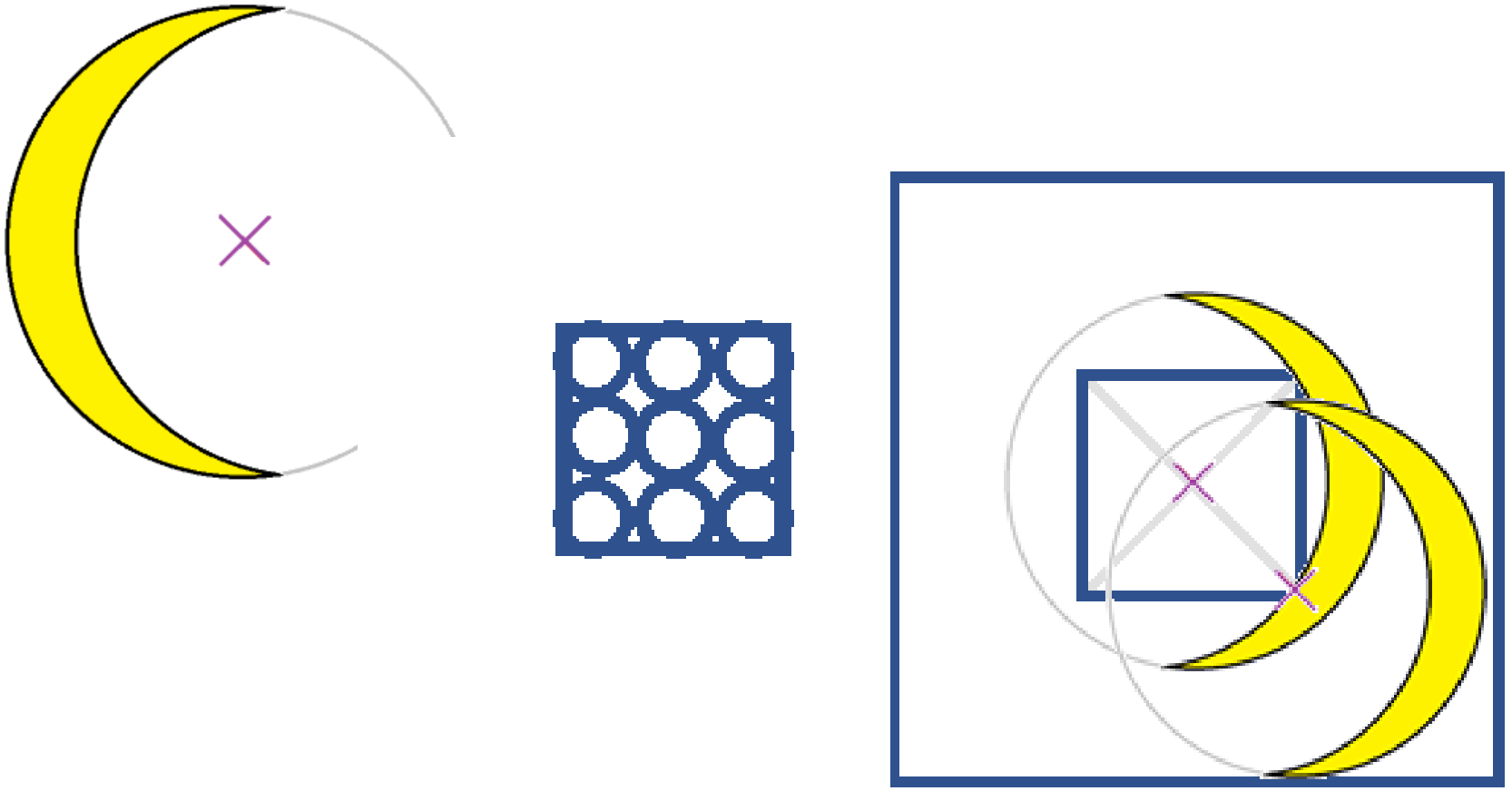
The inner box has the size of the aperture.

Answer to exercise 5



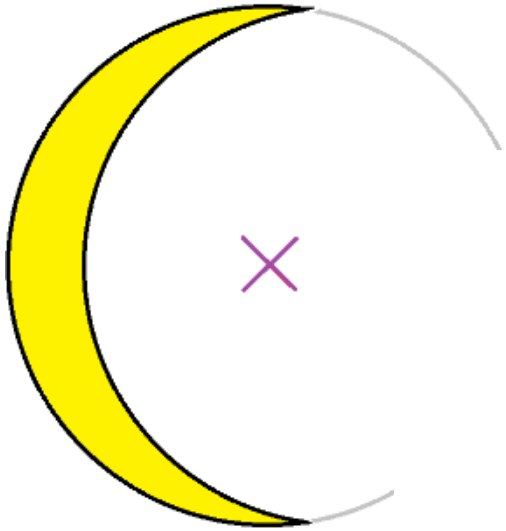
- **Project the first image at the center of the aperture**

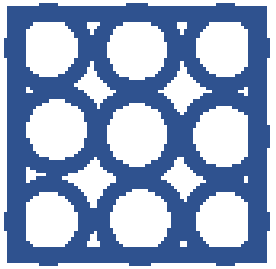
Answer to exercise 5

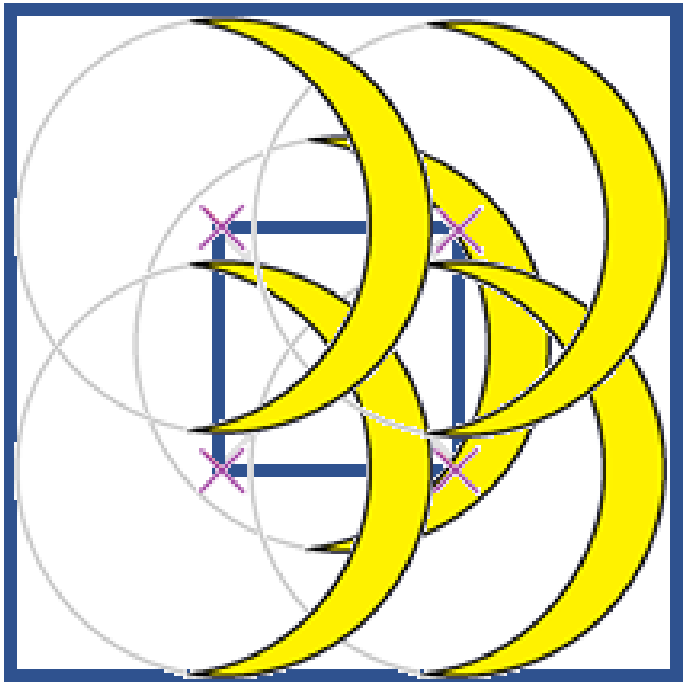


- **Project the second image in the bottomright corner of the aperture**

Answer to exercise 5

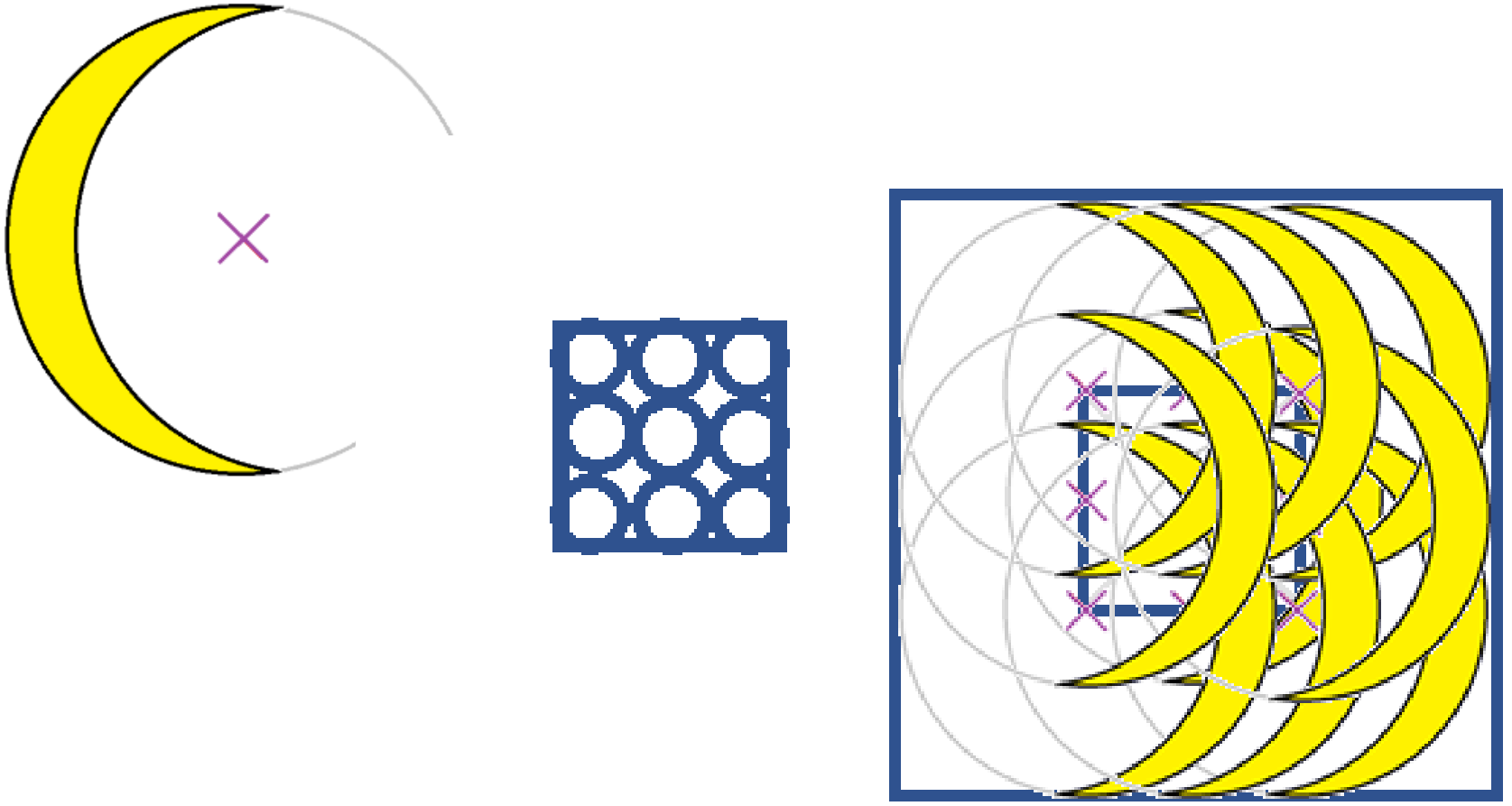






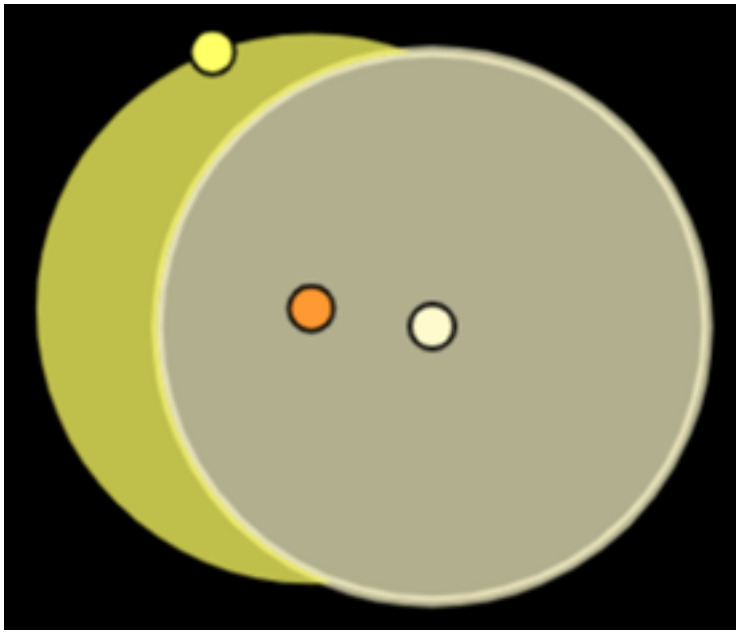
- **The sum of all the corner images**

Answer to exercise 5



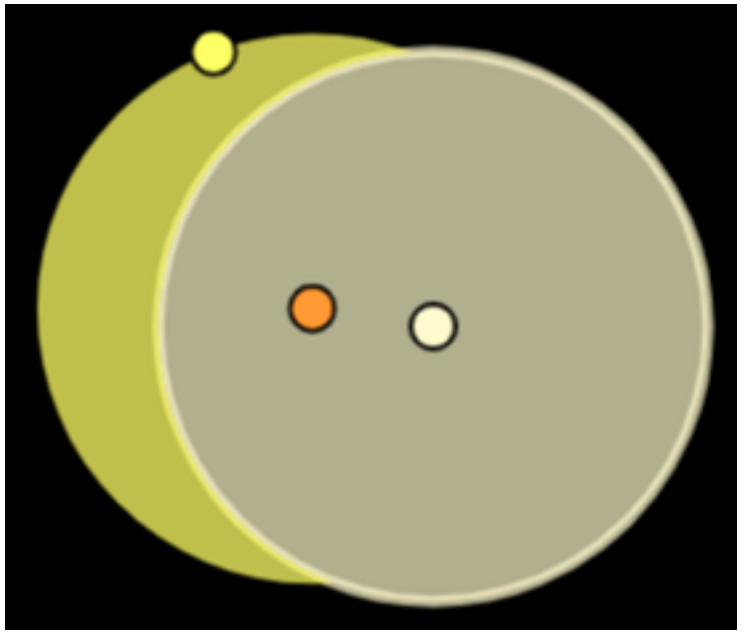
- **The sum of all nine images**

Animation: every spot in the aperture receives the image of the eclipse



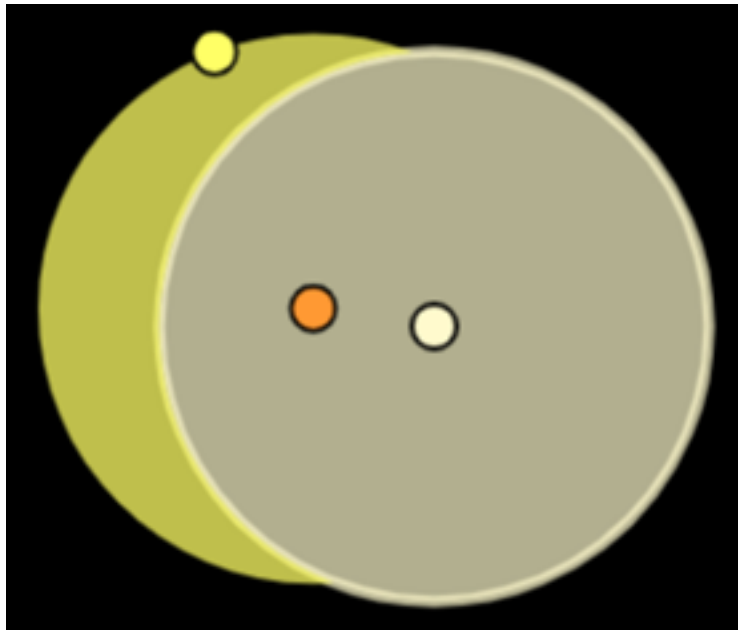
Point-wise approximation of the light source by a spiral: started in the center of the aperture

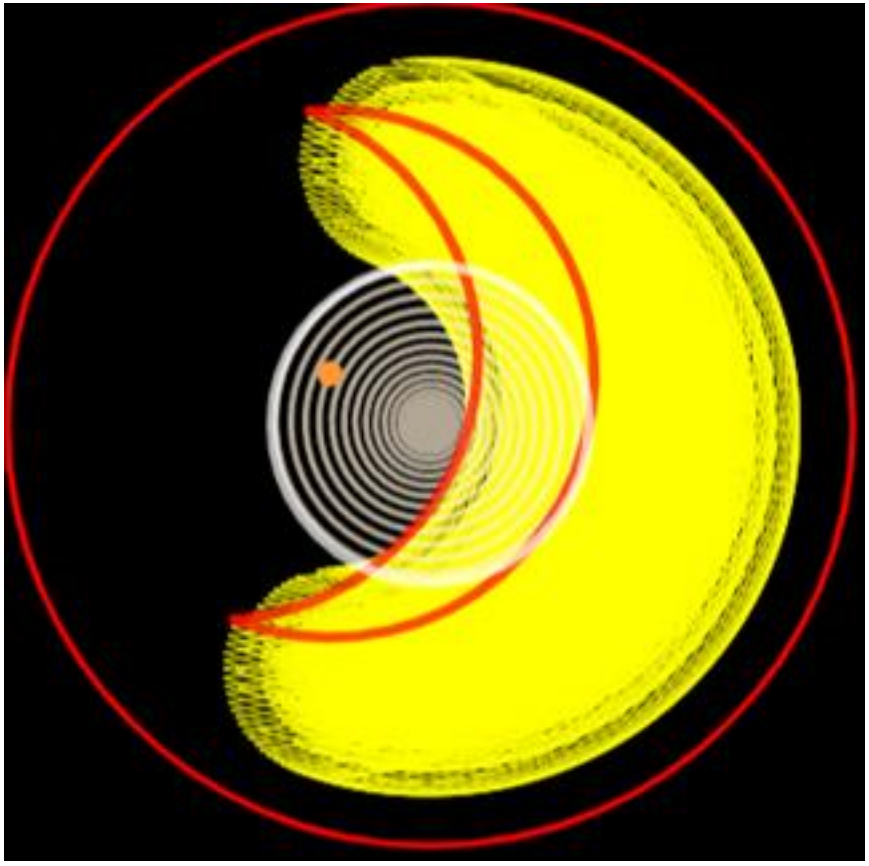
Animation: every spot in the aperture receives the image of the eclipse



Copy the image of the eclipse for each point on the spiral

Animation: every spot in the aperture receives the image of the eclipse

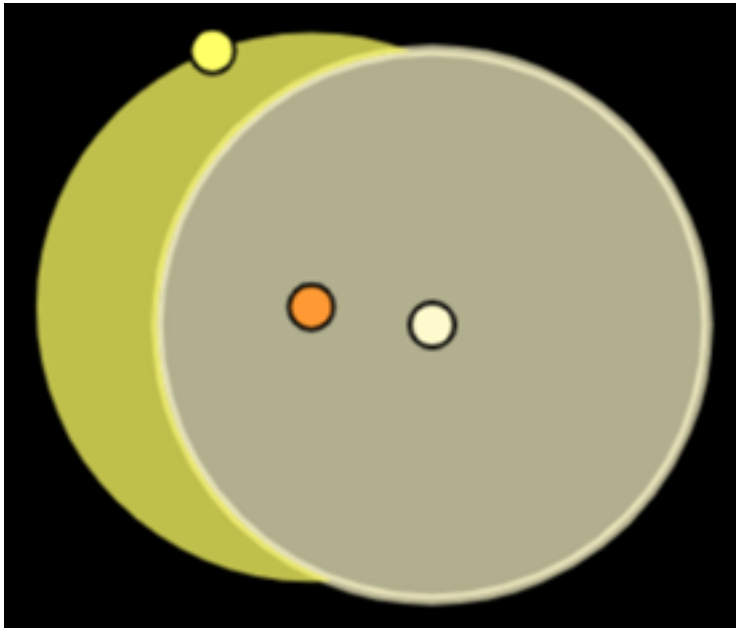


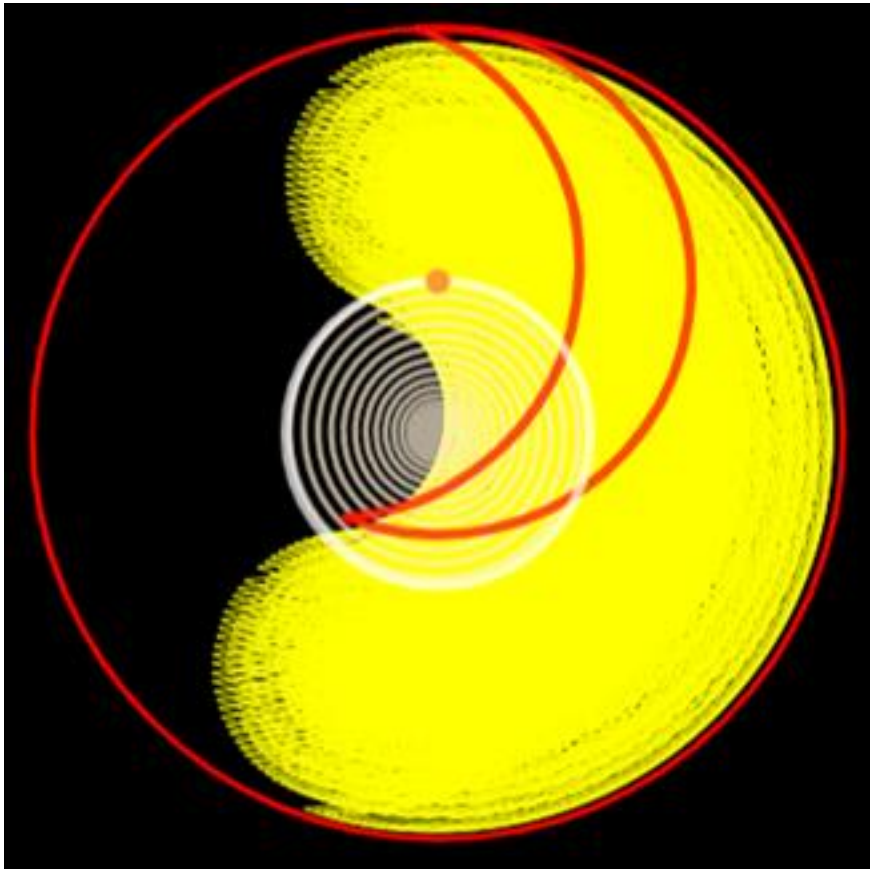


20 mm round aperture

At the left, the results of the combined images from points in 70% spiral

Animation: every spot in the aperture receives the image of the eclipse

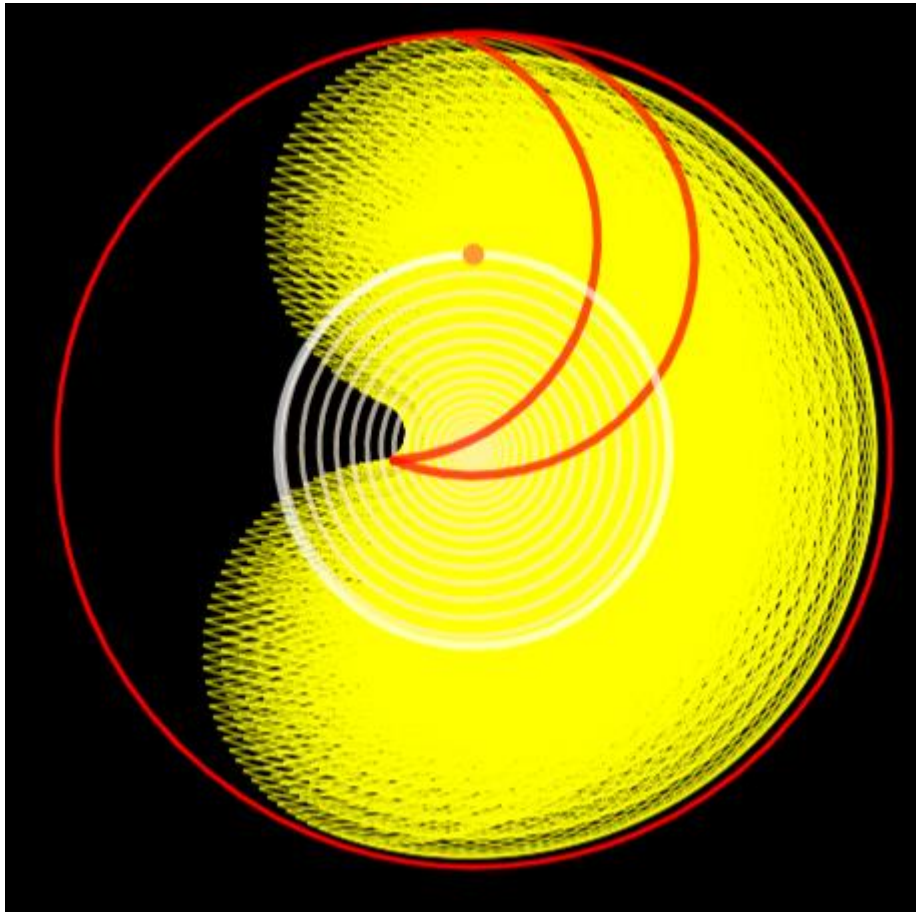




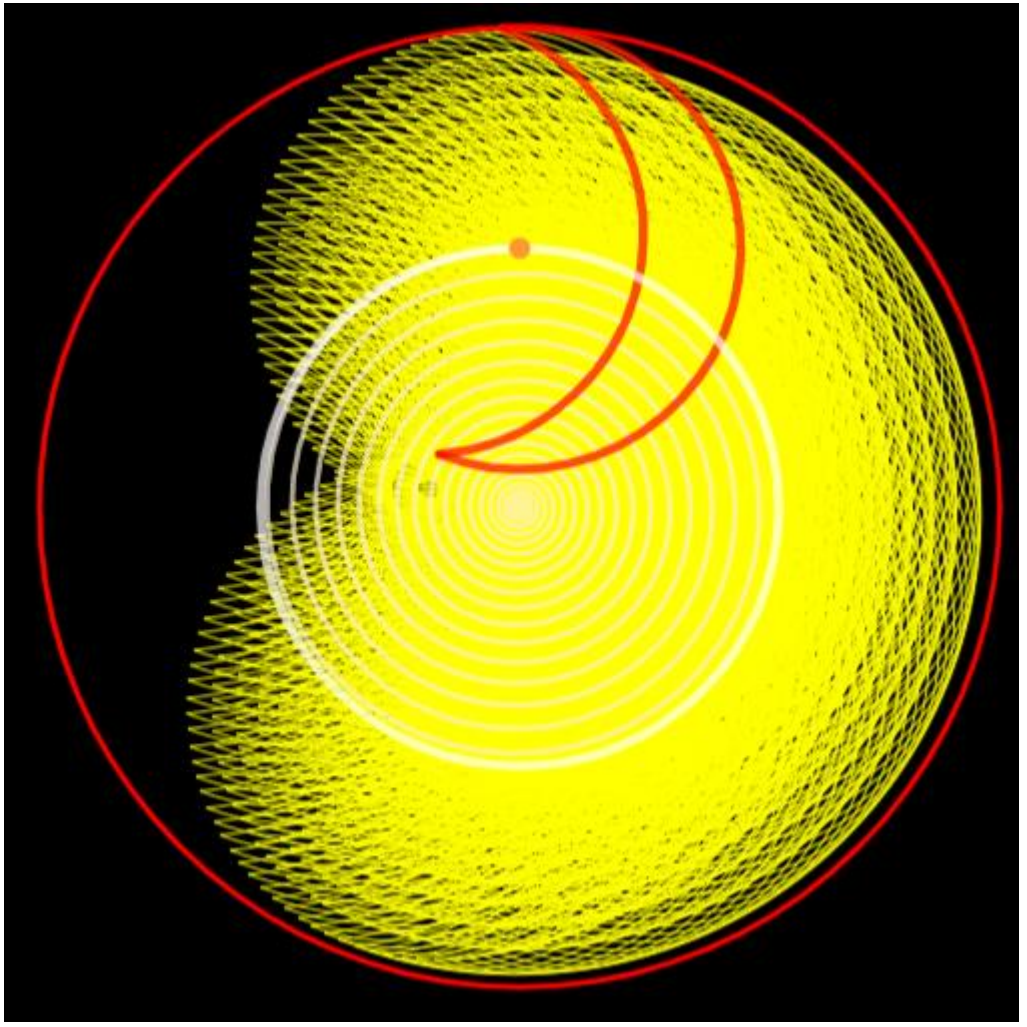
The results of the combined images from all points in the spiral

Animation of larger apertures

30 mm aperture



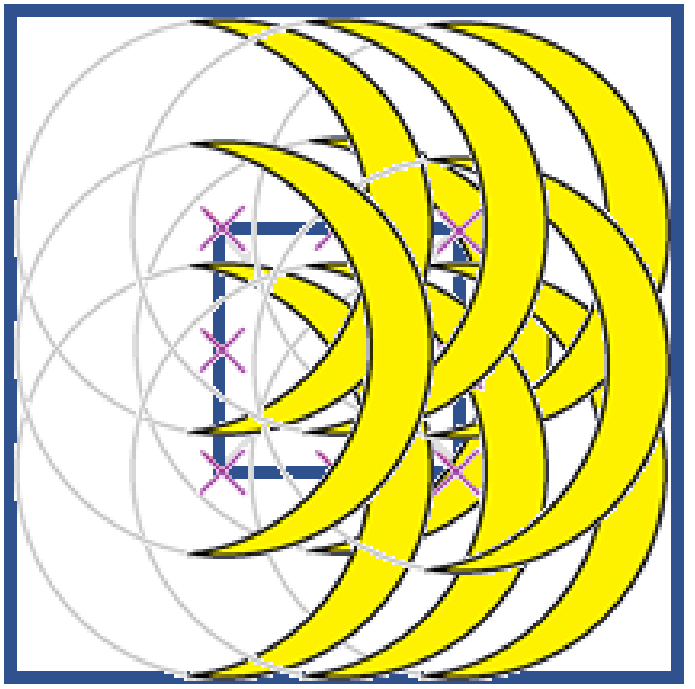
40 mm aperture



Check the aim of the workshop

Understand

- **the nature of the rays of sunlight**
- **the shape of shadow**
- **the distortion of the image**



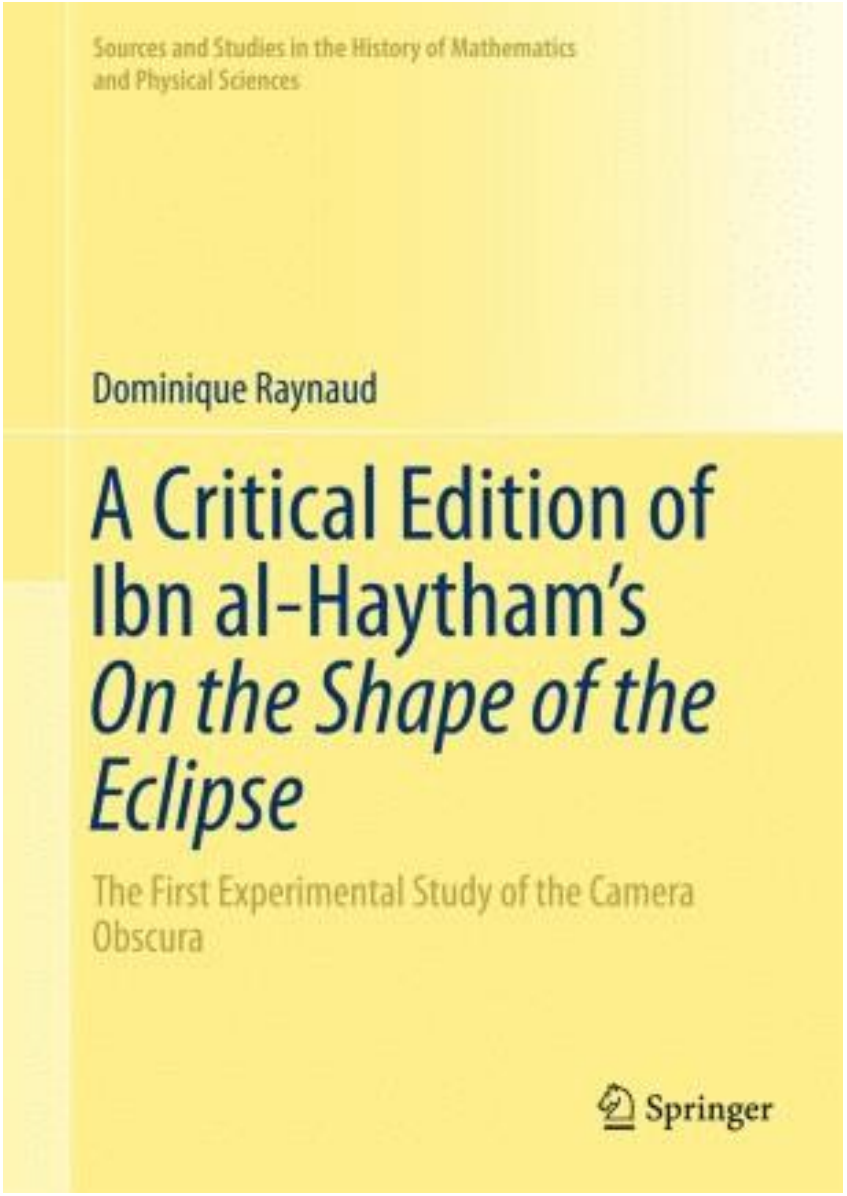
Construct

- **the distorted image**

Prerequisite

- **basic geometry**
- **basic trigonometry**
- **paper, rope, paper ruler, pencil, transparencies**

Raynaud: A Critical Edition of Ibn al-Haytham's On the Shape of the Eclipse



Check aim of the lecture

- **Academic**
- **Foreign languages**
- **Education**

Academic

You have to

- **Dig deeper,**
- **Search for the original sources,**
- **Don't be afraid of foreign languages,**
- **Never take old man's opinion for granted,**
- **Discuss**
- **Experiment**
- **Rely on yourself**

Language skills

Prof. Dr. Fuat Sezgin insisted that you should learn one new language a year.

Have friends all over the world to check and confirm your translations.

Education

- **Forget Newton's apple.**
- **Underline his endless attempts to try every formula to verify that his formula is the only one that describes gravity.**

Thank you
See you at www.henkhietbrink.nl