SURYOTSAV

Developed and Written by
Dr. Vivek Monteiro, Geeta Mahashabde, Gurinder Singh and Navnirmiti Group

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NAVNIRMITI LEARNING FOUNDATION

NAVNIRMITI EDU EQUALITY

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NAVNIRMITI

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Why this booklet?

In 2010 every child in India obtained the right to education of good quality. We can ask the question: 'How can every child in our country get good quality science education? Can good quality science be universalized?'

One good answer to the above questions is Yes! - by "Universalizing the Universe". No matter where we live, we are surrounded by the wonders of nature and the universe. Our own eyes, ears, hands and minds are themselves powerful scientific tools to explore this wonderful universe. Doing experiments and activities with the universe, thinking and estimating, doing a little calculation, is a path to universalize good quality science education. Good science does not require expensive equipment. At low cost one can do interesting and important science experiments and projects. Some experiments require us to share knowledge with science partners living elsewhere. Because science is global, science itself is universal. We can call this 'Universal Astronomy – A beginning'. We published a book by the same title in English and Marathi in 2013. It was translated into some other Indian languages. It reached thousands of people through science organizations affiliated to All India People's Science Network and Active Teachers' Forums.

The People's Science Movement (PSM) is working with the objective of "Science for everyone". A number of organisations working as a part of the PSM have come together to use astronomy for universalization. Mass science popularization campaigns were organized around Solar Eclipses, IYA 2009, Transit of Venus, and now comet ISON.

One such important and exciting scientific event will occur soon. On the morning of December 26th 2019, the moon will come in line between the sun and the earth, causing the shadow of the moon to fall on the earth, creating a solar eclipse. There are many fears and superstitions around eclipses, which originated from the time when humans did not understand why eclipses occur. Some of these are : 'pregnant women should not go outside during an eclipse', 'We should not observe an eclipse, even with eye protection', 'no eating during an eclipse', 'discard water stored in containers after an eclipse' - etc. At a time when India is sending and landing a rocket on the moon it is time to reject and dispel these irrational fears.

Lakhs of people all over India will gather together for mass observation event on December 26 th 2019 as part of Suryotsav Campaign. If we can reach every school, and if in every school we can hold a SURYOTSAV for everyone living around that school, we will truly be building scientific temper through 'science education of the people, for the people, by the people'.

This booklet is another humble attempt to achieve that ambitious goal.

What is SURYOTSAV ?

A festival of scientific knowledge, to be celebrated with participation of thousands of people. It will have activities of day time Astronomy associated with the Sun-Earth-Moon.

The experiments and experiences in SURYOTSAV will have

- activities in which e veryone can participate
- Simple but nontrivial activities
- WOW experience
- activities for going from WOW to WHY and HOW
- Eclipse simulation models
- Safe ways of viewing solar eclipse

There are two important components of this campaign :

1) SURYOTSAV in every school :

As a preparation to mass viewing of eclipse, SURYOTSAVs are being organized in every school. Children will do experiments related to Sun-earth-Moon, will make models of Solar System and eclipse, will demonstrate and explain these experiments to parents and other people from community. Teachers and students together will plan for the public event on 26th December 2019.

2) Mass Eclipse Viewing Programme

On 26th December between 8.30 am to 11.30 am, there will be thousands of programmes of eclipse viewing and breakfast with the eclipse.

Part 1
How to participate in international campaign of Annular Solar Eclipse and SURYOTSAV

How to participate in international campaign of Annular Solar Eclipse and SURYOTSAV

You can participate in the national campaign for arranging mass viewing of solar eclipse for people around you.

Details of eclipse at your location, (what percentage of the Sun will be covered, what time will it start, what time will it end, etc.) are available on the Annular Solar Eclipse app on the following link. You may download this app on your mobile. Keep your location on. All information will be immediately available.

https://play.google.com/store/apps/details?id=com.alokm.solareclipse&hl=en_IN

There are some other apps too.

You would require solar goggles for safe viewing. Photographers may ask for the film. You will have to make yourself familiar with other ways of viewing the eclipse. You will have to practice those methods. You will also have to identify convenient location. You will have to know basic information about eclipse. All this information is given in this booklet.

This booklet is also available on the following websites :
All India Peoples' Science Network - www.aipsn.in
Navnirmiti Learning Foundation - www.navnirmitilearning.org

How to organise a SURYOTSAV?

Organizing a SURYOTSAV in your school does not require much money. With some low cost materials, which are available everywhere, you can do and show many interesting experiments. All the experiments in this activity handbook can be part of the SURYOTSAV.

Who can participate in the SURYOTSAV?

Everyone. Of every age.
Every student.
Every teacher and principal.
Every karmachari.
All parents.
All citizens.

When to hold SURYOTSAV?

It should be held anytime before the solar eclipse on 26th December 2019. The schools, students and teachers who participate in the Suryotsav should organize eclipse viewing celebrations on 26th December.

Part 2
Activities for SURYOTSAV

ACTIVITY 1 - Nano Solar System

Make a nano solar system model – how big? how far?

We learn in school that our earth is a sphere and it has a diameter of 12756 kilometres. 12756 km is too big to imagine. Let's shrink it and reduce the diameter 1000 times. One kilometre becomes one metre. We call this shrunken earth which is reduced in diameter 1000 times as "milliearth".

The diameter of milliearth is 12756 m, that's almost 13 kilometres! Even this is difficult to imagine. Let's shrink it further and reduce its diameter 1000 times again. 12000 becomes 12.

Now the earth becomes microearth, that is, earth reduced 10 lakh times (that is one million times) in diameter. The diameter of microearth becomes 12.756 m, approximately 13 m.

And what if we now reduce the diameter of microearth by 1000 times again? One metre becomes one millimetre. We get a little sphere like a small marble, 12.7 millmetres or 1.27 centimetres in diameter. This is nano earth, a sphere whose diameter is 10 crore times (that is one billion times) smaller than our real earth. (One billion is 1000x1000x1000)

SOLAR SYSTEM REDUCED BY 1000000000 TIMES			
	Actual diameter (km)	**Nano diameter (cm)**	**Nano distance from the Sun (m)**
SUN	1392000	139.2	0
MERCURY	4880	0.488	58
VENUS	12100	1.21	107
EARTH	12756	1.28	150
EARTH's MOON	3474	0.35	38.4 cm from Nano Earth
MARS	6794	0.68	227
JUPITER	143200	14.32	777
SATURN	120000	12	1426
URANUS	51800	5.18	2870
NEPTUNE	49500	4.95	4496

We also know the sizes of other planets. We can find the sizes of Nano Mercury, Nano Venus etc., in the same manner that we found the size of nano earth above.

What is the size of the NANO SUN?

When the diameter of the sun is reduced 1000000000 times, we get 139.2 cm. The nano sun is 139 cm in diameter- this is equal to the height of a school child.

The chart gives the sizes of the "nano solar system" in which length is reduced one billion times. In the first column the diameter of each nano planet is given. In the second column we give the nano diameter. The third column gives the nano-distance of the planet from the nano sun in the nano solar system. Nano Moon's distance is given from the Nano Earth.

(Appreciating the nano jupiter)

Modelling the nano solar system :

There are three easy ways to model the planets in the nano solar system. Sun can be a huge balloon (not easy to find) or a photo printed on a flex banner or a large yellow circle stitched onto a bed cover.

1. With beads or marbles for Earth and Venus, beads for Mercury and Mars, and plastic balls for Uranus, Neptune, Saturn and Jupiter.
2. With fruits and vegetables . Mercury - pepper corn, Mars- dried green pea, Venus and Earth - a kabulichana, or bora seed, Uranus and Neptune- a large lemon, or chikoo, Saturn- a marshmelon or kharbooz, Jupiter- a cabbage or round watermelon.
3. All the planets can be made with clay which is used for constructing idols or matkas.

It is important to try to be quite accurate in modeling the planets.

Hang the poster of Nano Sun at one end of a large ground. Walk away in a straight line for 58 m and place your nano Mercury. From the sun place nano Venus at 107 m and nano Earth at 150 m. You will have to walk 4.5 km to place nano Neptune! Too far away!

At least place thenano planets uptoNano earth at the exact distances!

Can you now imagine how big is our solar system and how far the planets are!!

How big is nano moon? How far is it from the nano earth?

The actual diameter of the moon is 3474 km. When we reduce it by 1 billion times (1000000000 times) we get the nano moon. The size of nano moon is therfore about 0.35 cm. Earth-moon distance is 384000 km. The 'nano' distance of the nano-moon from nano-earth comes out to be 0.384 meters or 38.4 cm. This is quite convenient for modelling . We can take a wooden rod of about 40 cm and set up the nano-moon at its one end. We put a pinhole card at the other end. When we look through the pinhole, it is like looking at the moon from the surface of the earth.

The diameter of Sun is 1392000 km and the diameter of moon is 3474 km. It Means the Sun is about 400 times bigger than the moon. How do they appear to be of the same size in the sky?

Do the following activity to understand the reason.

ACTIVITY 2 - The Apparent Size of Objects

A truck parked on a road on a hill far away from us looks like a small dot. When the same truck comes closer, it starts looking bigger. An aeroplane in the sky appears much smaller. When an object is close to us, it appears to be of its real size. when we take it farther, it appears smaller. Whenever we look at an object we perceive its apparent size. As the object's distance from the viewer's eye increases its apparent size decreases. How can we measure the apparent size of objects?

You might have used a pencil to compare sizes of objects while drawing them. Measure the sizes of different trees around you using a pencil. However you will have to fix the distance of the pencil from your eye. Let us say you keep the pencil at an arm's distance by holding the pencil in your hand with your arm fully stretched.

The apparent size of an object can be measured in terms of angle subtended by the object at the eye.

Find a tree which doesn’t fit in the length of the pencil. Keep walking away from the tree until it fits in the pencil.

Ask your friend to stand at a distance of 1 m from you. Now start moving away from your friend and observe him/her from different distances1m, 2m, ... and so on.

Measure your friend’s apparent height using a pencil at these distances. Note down your all your observations and questions.

Activity 3 : When do two different sized objects could appear to be of the same size?

Find a doll of about 15 cm height. If you can't find one, make a clay doll.

Make a cardboard frame having two doors as shown in the picture.

Take a table of about 1 m length. You are going to observe from one end of the table. At the other end of the table fix the cardboard frame of doors. Make your doll stand in one door. The doll should be at a distance of 1 m from your eye.

Ask your friend (whose height is about 150 cm) to stand behind the doll at a distance of 10 m from you. Ask your friend to move towards left or right such that you can see him through the other door.

Wow! The sizes of doll and the friend appear to be the same.

Your friend is ten times taller than the doll. But it appears to be of the same size as the doll. Try reasoning about why this happens.
One can also use a pinhole to view the doll and the person. So for this, place the pinhole close to one of your eyes and look at the doll and the person through the pinhole. Pinhole is helpful in identifying the more precise position of the observer, which will be the pinhole's position. Viewing through pinhole is especially useful when someone has spectacles. One should remove the spectacles and look through the pinhole to observe the sizes of the doll and the friend. The interesting fact about looking through a pinhole is that you will see sharp images even without your spectacles ! We will be using the pinhole later on to do many more interesting activities.

Now let us measure the distance between observer's eye (or the pinhole placed close to observer's eye) and the friend and let's say this distance is d1.

Also measure the distance between the observer's eye (pinhole) and the doll and let's say this distance is d2.

Now measure the height of the friend and let's say it is h1. Also measure the height of the doll and let's say it is h2.

Find the ratios $\frac{d1}{h1}$ and $\frac{d2}{h2}$

Do you notice any relation between the two ratios d1/h1 and d2/h2?

Can this help us in understanding the reasons for why the sizes appear to be same or why the size of an object decreases as it moves farther? Ponder over these questions.

Also, you might have a number of questions by now, try writing and discussing your questions with friends and your teacher. Don't get discouraged if you do not find answers to your questions immediately. It is more important that you are having some questions and discussing those with your fellow learners.

About the Sun and the Moon :

What will be the ratio of the distance of the moon from earth to the size of the moon?

384000 km / 3550 km = 108.2

Is it the same as the ratio of nano distance of nano moon to the diameter of nano moon?

38.4 cm/0.35 cm = 109.7.

This number is quite close to 110.

This is also the ratio of distance of sun to size of sun. What does this tell us about the moon and sun?

We understand this through the next experiment, which answers the following question :

When do different spheres appear to be the same size?

ACTIVITY 4 : When do different spheres appear to be the same size

Look at these three photographs. The first photograph is of two sets of balls. The brown balls are of the same size- 5 cm diameter. The green ball and the orange ball also have the same diameter -14 cm. Place the green ball and the brown ball in a line on two benches at a certain distance from each other. Also place the orange ball and the other brown ball in a line with a different distance between them.

The green- brown pair of balls are now to be observed through a pin hole from a certain distance such that they appear to be next to each other. The point of observation is adjusted until the brown ball and the green ball appear to be of the same size when both are viewed through the pin hole aperture.

At this point also take a photo with your smart phone camera and confirm that indeed the two balls appear to have the same diameter.

Measure the diameter D1 of the brown ball and the distance S1 of the ball from your point of observation. Measure D2 and S2 for the green ball.

Repeat the same process for the orange and brown pair of balls. Measure D'1, S'1, D'2 and S'2 for this pair also.

Verify that S1/D1 is approximately equal to S2/D2 when the two balls appear to be the same size.

Verify that S'1/D'1 is also approximately equal to S'2/D'2.

We now can understand why we have a solar eclipse, with the moon just covering the sun. For both the moon and the sun, the ratio distance/diameter (S/D) is the same. It is about 110.

ACTIVITY 5 : Simulating a solar eclipse : Using LED bulb as the Sun.

You can do this experiment at school, college or home using easily available simple materials.

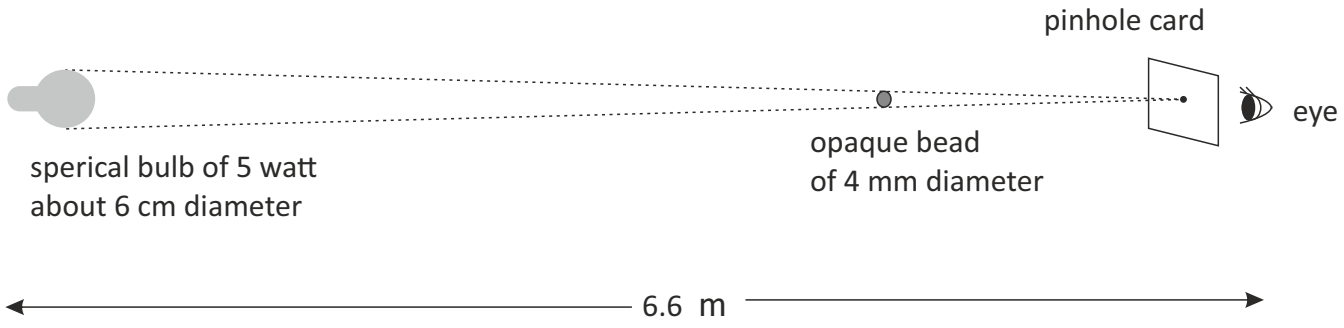
Materials needed :

- Model Sun - a spherical white LED bulb . A 5 watt bulb is about 6 cm diameter.
- A board having bulb holder with a long cord connection ,which can be placed anywhere.
- A stiff plastic ball to make a ball mount. (A ball with diameter between 10-14 cm is ideal.)
- Wooden strip, from 40 cm – 60 cm in length
- A pin having about 3 to 4 mm bead on top as the model moon.
- Model moon : The nano moon (a pin having a bead on top), or a small opaque spherical bead or ball bearing about 4mm in diameter.
- Opaque cardpaper
- Brown sticky tape, scissors, etc.

With simple equipment which you can easily make yourself, this is how you can create an eclipse with a model sun and a model moon . This experiment is best done in a dark room.

Procedure :

We want to make the following arrangement :

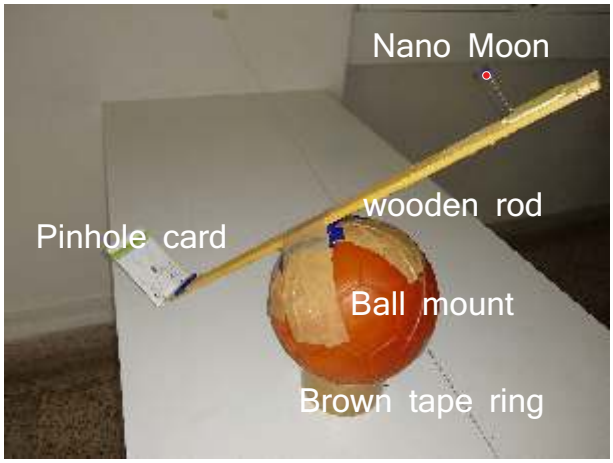


The bulb is the model Sun, opaque bead is the model Moon and eye near pinhole is the human observing from the earth. When we see towards the Sun, if the moon comes in between, the shadow of moon will fall on the earth and the Sun will get eclipsed.

How to get the above arrangement ?

- Fit the LED bulb into the holder and keep it so that the bulb is horizontal and the side facing you looks circular, just like the sun. It should be kept at a height of about 3- 4 feet above the ground on a table or tall stool.

- Make the ball mount by cutting a small hole in the ball and filling the plastic ball with sand. This increases the weight of the ball mount and makes it steady on its base ring. Seal the hole with sticky tape. The cardboard roll of the sticky tape can be used as the base ring for the ball mount.
- Cut a piece of the card paper. Punch a pinhole in the centre of the card with a pin. Fix this card at one end of the wooden strip as in the photograph. This is your point of observation.



- The diameter of nano moon should be about 3.5 mm. Fit the nano moon on the wooden rod at a distance of around 38 cm from the pinhole card (110 times the diameter of the moon). At this distance, when you look at the model moon, it appears just as big as the real full moon. (This is because the earth-moon distance is approximately equal to 110 moon diameters)
- Fit the rod (with pinhole on one side and nano moon on the other side) on the ball mount. Adjust the mount on its base so that the rod points towards the sun.
- The eye – sun distance should be about 6.6 m if the LED bulb is of diameter 6 cm. (110 times the diameter of the bulb). If the bulb is larger (or smaller) the distance must be increased (or decreased) to equal 110 diameters. At this distance, when you look at the model sun, it appears just as big as the real sun. (This is because the distance of the sun from the earth is 110 sun diameters)

- Place the ball mount and strip at the same level as the model sun, at the appropriate distance mentioned above.
- Turn on the lamp, so that the model sun is shining brightly.
- Looking through the pinhole see the sun, and adjust the ball mount so that the wooden strip is pointing at the sun, and the pinhole, model moon, and model sun are all in the same straight line.
- Make further fine adjustment of the mount so that the shadow of the nano moon falls on the pinhole. When you look through the pinhole you will see an eclipse.

- So, thus we can understand that the eclipse is just the shadow of the moon falling on us when the moon comes between the sun and us, and all three are in a straight line. That is why solar eclipses always occur only during amavasya, when the sun and the moon are on the same side of the earth. But you cannot see the eclipse on every amavasya. Why? The orbit of the moon is slightly inclined as compared to the orbit of the earth. Therefore the Sun-moon-earth do not come in a straight line on every amavasya.

ACTIVITY 6 - Simulating the solar eclipse - using the real Sun

Safety Note : Take two cards and make a pinhole in them. Put a solar filter between these two cards and staple them at the ends. There should be no hole in the filter. when you look through this pinhole you will not see anything else. You will see only the Sun. This experiment should be done with proper eye protection and only with proper teacher supervision.

- Use the pinhole card with filter and make an arrangement like in the experiment 5.
- Adjust the ball mount such that the shadow of the nano moon falls on the pinhole.
- The person observing through pinhole will see the Sun eclipsed.
- As the Sun moves in the sky, the eclipse will slowly appear to abate and the entire process will take about 2 minutes.

You may contact Navnirmiti for the solar filters.

ACTIVITY 7 : Observing the Sun through a safe solar filter.

We should never look directly at the sun. It may severely damage your eyes.

We can look directly at the sun if we protect our eyes with a safe solar filter. Not all solar filters are safe. A safe solar filter reduces the intensity of the sunlight by a factor of one lakh times. Make sure that your solar filter is safe before looking at the sun with it. A science organization in your area may be providing filters certified by the scientists. (You may also contact Navnirmiti for the same). Also make sure that the filter is not damaged.

On the day of the eclipse, the disc of the Sun will be partially visible as the moon passes in front of it .

ACTIVITY 8 - The Surya Sandesh Card - Sun Card

Draw and cut of a sun card. Using a cutter carefully remove the various symbols. Hold the Surya Sandesh card close to the ground in the sunlight. Examine the shadow cast by the card. You will see the various signs on the card projected on the ground.

Now slowly raise the card towards the sun as high as possible. The different signs all become the same. They all become circles of light, circles of our broadening understanding. As you go higher and higher, the circles touch each other, an expression of unity, of coming together, of our essential oneness as human beings, as citizens of secular India and as citizens of planet earth.

This is not a miracle, but a scientific phenomenon. The circles of light that you see are all images of the sun. They are round because the sun is round. Therefore the poem on card has 'Many Signs, One Sun.'

This effect is known as pinhole projection or pinhole camera.

SURYA SANDESH

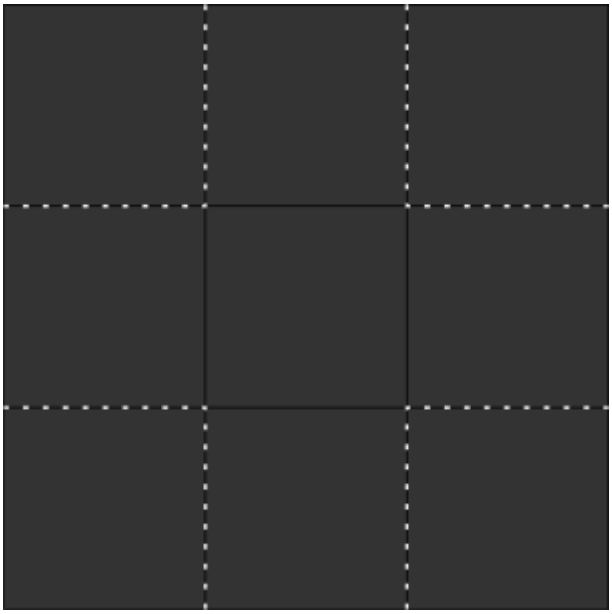
तमसो मा ज्योतिर्गमय

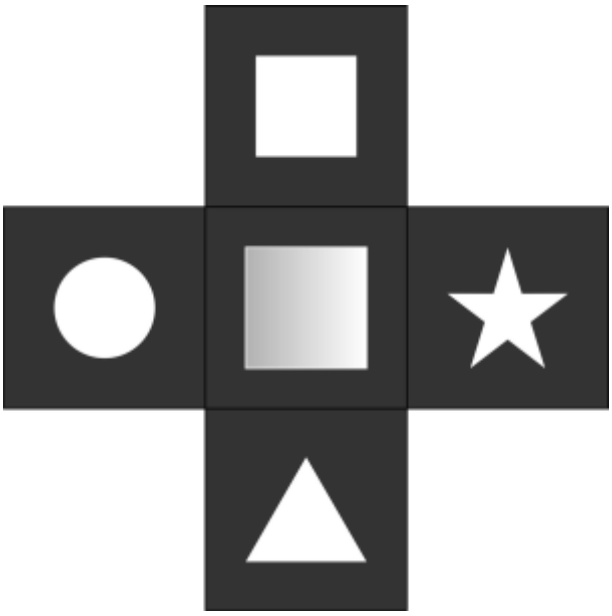
From Darkness to Light

Many Schools,	One Experiment.
Many Signs,	One Sun.
Many Faiths,	One God.
Many Races,	One Human.
Many Cultures,	One nation.
Many Nations,	One World.
Many Problems,	One Resolve.

Let's come together to build a better world.

ACTIVITY 9 : Magic Mirror





Make a Magic Mirror :

We need three small mirrors with different shapes: round, square, triangle. What if you have just a single mirror? How can you get different shaped mirrors with a single mirror? Simple! cover the mirror with a paper mask (black paper) with the desired shaped hole cut in it.

Take a 15 × 15 cm black coloured square drawing sheet. From each corner cut away a square piece of 5 × 5 cm. Now the sheet looks like a large plus sign. Then cut holes of shapes of a square, a star, a circle and a triangle on the extended parts as shown, These will be used as masks on the mirror. Fix a small 3 cm × 3 cm plane mirror at the centre. (If the size of your mirror is different thentake drawing sheet of appropriate size accordingly).

Magic Mirror Experiment :

Hold the circular mirror outside in the sun. Reflect the sunlight on your friend's shirt (or on some close by object). What is the shape of the image on your friend's shirt? Repeat the experiment with the square and the triangular mirror.

We get a square shaped reflection with a square mirror, a triangular reflection with a triangular mirror and circular shaped reflection with a circular mirror.

Now cast the reflections with all these mirrors on a distant wall (about 20 metres away) What do you see?

Wow!

There is a circular reflection for all the different shapes of mirrors, whether the mirror is square or triangular or any other shape.

WHY?

We will understand this by performing some more activities.

Let us first start by casting reflection of a triangular mirror (or a square mirror) on a wall from a closer distance, say about 1 meter. Now slowly start moving away from the wall while still casting reflection on the wall. So what did you observe. Did the shape of reflection change as you moved farther?

Reflections of a tubelight

Now go inside a dark room and switch on the tubelight. Try casting the reflection of tubelight using magic mirrors on a very close by wall of some object. What shape did you observe?

If cast from a very close distance the shape of reflection will be the shape of the mirror.

Now move away while still casting reflection of tubelight using the magic mirror.

Did you observe the change in the shape of the reflection? What is the shape of reflection you observe?

You might have noticed that the shape of reflection is actually the shape of tubelight.

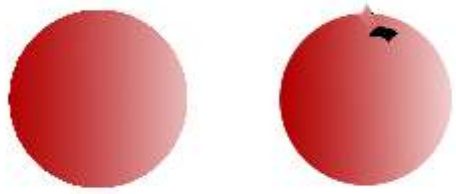
Now can you try thinking about what is the circle in case of reflection of sunlight?

Reflection of sunlight during eclipse

Now can you think what would be the shape of reflection of sunlight using a mirror during a partial solar eclipse when projected on a distant wall?

You can try drawing the shape of both sun and its image using a mirror during a partial solar eclipse on a sheet of paper or your notebook. Find out what your friends have drawn. You can have a discussion with your friends about their drawn shapes and why they have drawn those shapes.

ACTIVITY 10 - Projecting the Sun using ball mirror solar Projector in a dark room



Make a Ball Mount

Take a plastic ball. Using a cutter, cut open a small window as shown. Fill the ball with sand (so as to make a heavy and steady 3-dimensional ball mount) and seal it with sticky tape.

Place this ball mount upon a suitable ring on a stool or on any rigid platform. Now your ball mount is ready for use. Instead of a plastic ball, you can also use a small earthen matka, a coconut , or a water melon as the ball mount.

Make a ball and mirror solar projector and use it to project the Sun

Take a ball mount. Now take a small plane mirror. Cover it with a brown paper with circular hole on it and then stick this mirror to the ball mount as shown.

Place this ball mirror upon a suitable ring on a stool or on any rigid platform in the sunshine.

Now your ball mirror solar projector is ready for use.

Project the image of the Sun with this ball mirror. Adjust the angle of the mirror so that it projects the Sun into a darkroom / dark place, on a white screen. Increase the distance of the mirror from the screen to around 30-40 metres. At this distance you can get a nice big image of the sun around 30 cm in diameter.

Observe the position of the image carefully. Is it still, or is it moving? Why does it move?

ACTIVITY 11 : Pinhole projectors in nature: tree shade solar telescope

Have you noticed, that on a sunny day, in the cool shade of a tree, you see, here and there, some bright discs on the ground?

These bright discs are images of a bright object in the sky. And this bright object in the sky is sun. The images are formed due to 'the pinhole camera' effect.

In the suncard experiment you have noticed a similar thing. When you raised the card each of the symbol or hole, got projected as a circle.

Now we understand those round discs of light which we see in the dark shade of the tree. They are the images of the round sun with the spaces between the leaves acting as the pinholes.

It is interesting to see these circles moving from one place to another or sometimes disappearing and appearing again at the same place, as the wind shakes the leaves.

So how these projections would look like during a partial solar eclipse? Can you guess? See the picture below.

Photo - wikimediacommons

ACTIVITY 12 : Images of the Sun using kitchen implements

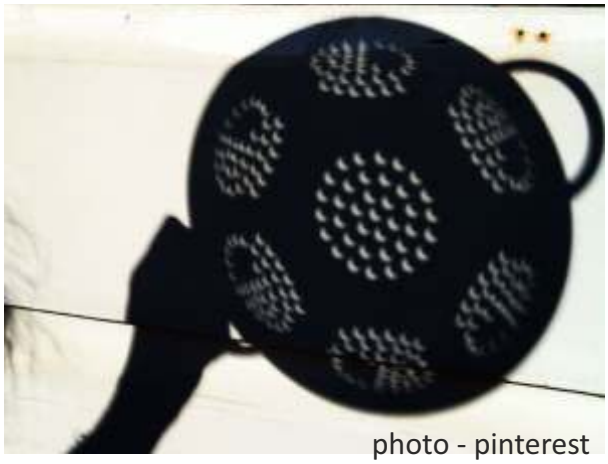


photo - pinterest

In every kitchen there are graters, strainers and other kitchen implements with multiple holes. Hold these close to the ground in the sun. We see the projected holes. Raise the grater towards the sun. We see a beautiful pattern of circles formed, which are images of the sun. During the eclipse these will become crescents of light.

ACTIVITY 13 : Make a Portable Darkroom

To get as clear and sharp an image as possible with pinholes or with your ball mirror solar projector, the image should be taken in a room which is as dark as possible. Here is how you can make a 'darkroom' which can be taken anywhere - a portable darkroom.

Take a large cardboard carton, like the carton of a TV set.
On one inside wall paste a sheet of white paper. This is your screen.

On the opposite side cut a circular hole which is about 30 – 40 cm in diameter. The rays of light will enter from this hole and fall on the screen.

Now seal the carton on all sides with tape, so that except for the circular hole you made in one side there is no other opening for light to enter. You can paste black paper on the inside walls of the 'portable darkroom' to make it even darker.

Now you have a portable darkroom. On one inside of the box you have a screen. On the opposite side you have a hole for light to enter. There are four remaining sides of the box . On one of these sides with a knife cut a small flap which you can open and close as a window to observe the screen.

Your portable darkroom is ready for use. You can keep it on a stool anywhere and use it for public programmes in a playground or open space.

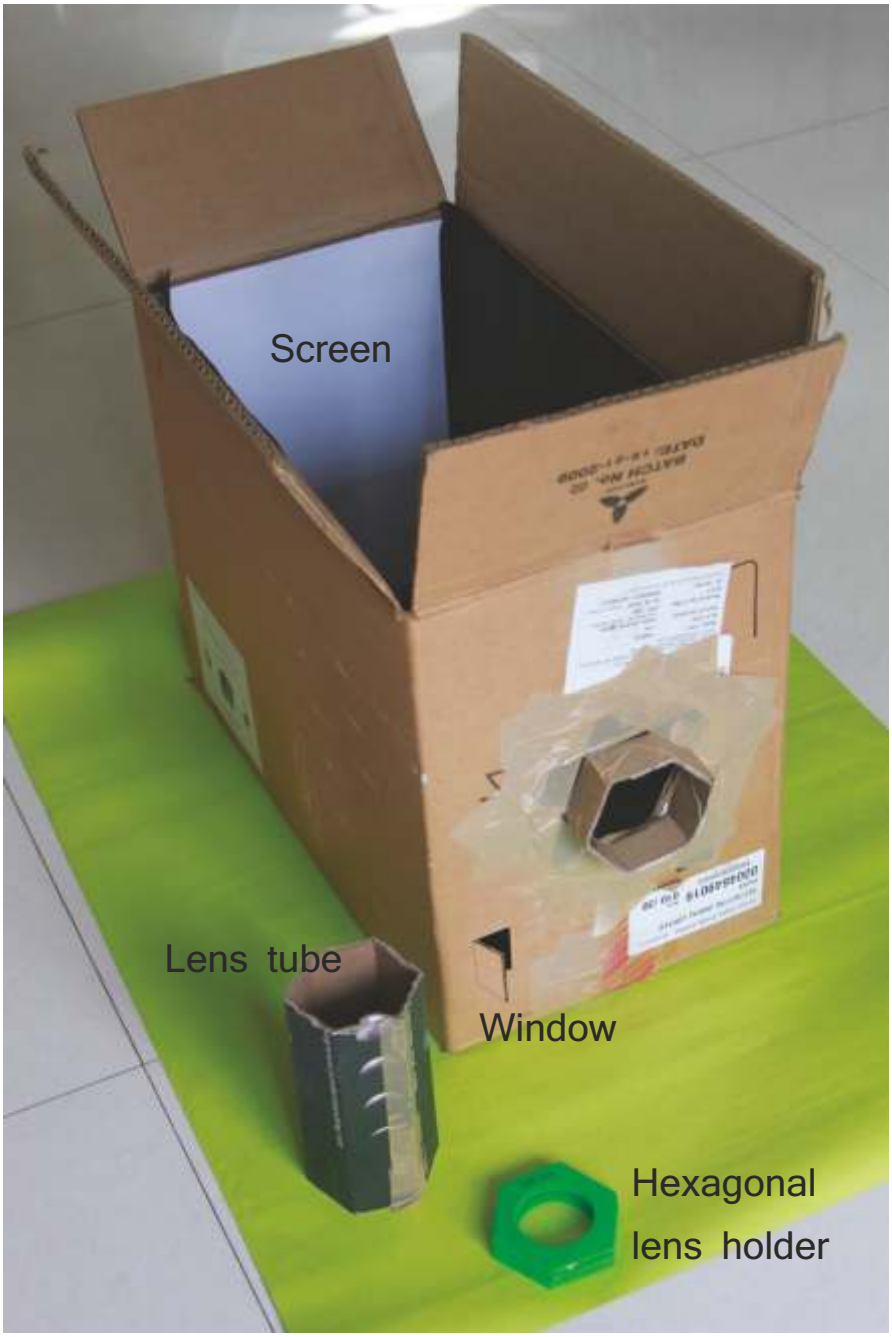
ACTIVITY 14 : Make a Single Lens Colour Projector (Colour TV)

You can use glass lenses to make a telescope to look at distant objects and make them look closer.

To see how a telescope works, first, we make a projector with a single lens.

Take a convex lens with focal length about 50 cm. The diameter of the lens can be about 5 cm, or 2 inches. Such a lens maybe available in your school science laboratory, or from a science shop. The further steps are similar to making a portable darkroom which we saw in the previous activity. The only difference is that instead of making a large hole in the front, we make a smaller hole.

Take acardboard carton, which has one side of length around 40 cm. On one inside wall paste a sheet of white paper. This is your screen. On the opposite side cut a hexagonal hole. The diameter of the hole should be such that it is slightly more than the diameter of the tube holding the lens, which we will next see how to construct.



Hexagonal Lens holder

Make a hexagonal holder for your lens by keeping it between two hexagonal pieces of cardboard, each having a 4.5 cm circular hole in the middle .If your lens is 5 cm in diameter, the diameter of your hexagon should be around 7 cm, and the side of the hexagon around 4 cm.

Lens tube

Now fold another piece of cardboard into the shape of ahexagonaltube.The hexagonal holder for your lens should fit tightly inside the hexagonal tube, at one end. This tube should be around 15 cm in length. Each side of the hexagon will be around 4 cm. This hexagonal tube should just fit

inside the hexagonal hole you have made in the carton (portable darkroom). You can make a small neck around the hole in the carton to hold the tube better. Fit the lens tube such that the lens is outside the carton.

The tube holding the lens can move forward and backward inside the hole in the carton, so that you can adjust the distance between the lens and the screen. When this distance is equal to the focal length of the lens, you will see a sharp colour image of the scene facing the lens on the screen. The image will be upside down.

Now seal the carton on all sides with tape, so that except for the hexagonal hole you made in front there is no other opening for light to enter. You can paste black paper on the inside walls of the 'portable darkroom' to make it even darker. The darker the inside, the better your image.

Make a small window on one side or on the side of the lens to peep into the darkroom.

Your colour TV/ camera is ready.

Your colour TV can be held on your shoulder with the lens pointing backwards. You can see the whole world around you moving in colour, but upside down.

ACTIVITY 15 : How is the Telescope Made?

Images with a single convex lens

In the previous activity we made a single lens projector – a colour TV.
Here we used a convex lens to project the image. This image was upside down. This kind of image is called a 'real image', because it can be projected on a screen.
We can also use the convex lens as a magnifying glass. We hold the lens to our eye and look at an object through the lens. Here the image which we see may not be upside down. It looks larger than the image we see with our naked eye.
These are two different ways to use the convex lens, and we get two different kinds of images.

Images with two convex lenses

Lets see what happens if we make a hole in the back of our colour TV and fit a small convex lens.
Now we have two lenses. What will we see? Will we see a magnified image- a bigger image?
Let's look through the lens fitted on the screen of our upside down colour TV. Yes ! We do see a upside down image. It is magnified.

WE HAVE MADE A TELESCOPE! OUR UPSIDE DOWN COLOUR TV HAS BECOME A REAL TELESCOPE!

We can read an upside down newspaper from a distance!
So now we know how to make a telescope. In the next activity we make a real telescope with two convex lenses.

ACTIVITY 16 : The Galileoscope

Galileo was not the first person to build a telescope. Before him others like Lippershey from Holland had built telescopes. But Galileo was the first person to turn the telescope to the skies and use it for astronomy.

This is a photograph of Galileo's telescopes. The most important part of the telescope is the optics- the lenses. Galileo's telescopes had two lenses. The front lens, called the objective, and the rear lens, called the eyepiece.The front lens has a long focal length. The eyepiece has a small focal length.

You too can build your own telescope, with two lenses, and mountboard, like the one shown in the photograph below. With this telescope, you will be able to see the moons craters. You can also observe different stars and planets using this telescope. You may be able to see the 4 moons of Jupiter using this telescope, and Venus in the crescent phase.

You can make a ball mount for telescope with 4 strings coming out of the ball. The strings should be put before filling the sand. Use your ball mount to mount the telescope.

For obtaining lenses and more details, you can contact:
'Samatesathi Gunavatta' at Navnirmiti Learning Foundation Pune. 9850303396
'Discover It' Centre at Navnirmiti Mumbai. 022 - 25786520

NEVER LOOK AT THE SUN THROUGH THE TELESCOPE.

ACTIVITY 17 - Imaging the Sun with a Telescope

Be careful to never look at the sun directly through the telescope.
However, you can use this telescope to project the sun on to a screen.

For projecting the Sun on a screen with your telescope, mount your telescope on ball mount . Keep it such that the objective lens points towards the sun and eyepiece is towards a screen below.

Now align the telescope in the direction of sun rays, **not by looking through it**, but by another method of minimizing it's shadow on the screen. When you get the smallest shadow of the telescope it is properly aligned.

At this point you will see a disc of light forming on the screen. Now carefully adjust the length of the telescope to get a sharp focussed image. When you get the sharp image you can further move the screen to get a larger image of the sun. When you could get a sharp image of the sun on the screen, you may be able to see some sunspots, even with this simple telescope.

You will have to adjust the telescope repeatedly because the image on the screen will shift due to the Sun's movement in the sky. Practice how to adjust and get sharp images quickly so that on the day of eclipse you can show it to large number of people.

You can improve the viewing quality of the image by creating a shaded patch on the screen by placing a paper shade at the objective end of the telescope as in the photograph.

Annular Solar eclipse of 26th December 2019

On December 26, 2019, between 8 am and 11:30 am, annular solar eclipse will be visible across the parts of the country. However most parts of the country would witness only a partial solar eclipse. Only the parts of Karnataka, Kerala and Tamil Nadu would witness annularity for few minutes around 9:30 am. The annular solar eclipse will be visible along a path that runs across the south of India. The annular solar eclipse will also be visible in other parts of the world like Saudi arabia, Oman, Sri lanka, Indonesia and Malaysia.

Many cities like Mangalore, Kannur, Coimbatore and Tiruchirappalli lie in the path of annularity.

To observe the solar eclipse, you can use all the ways that you have learned to observe the sun:

1. Pinhole projectors - Using pinhole cards, kitchen implements etc.
2. Projecting the Sun in a darkroom using ball and mirror projector
3. Observing the Sun using a certified solar filter for direct viewing
4. Telescope projection
5. Observing the eclipse in shadows of tall trees

What to observe during a solar eclipse?

- Observe the changing crescent shape of the sun as the moon progressively covers the sun.
- Observe the shape of the sun in the patches of light which can be seen in the shade of a tree. Normally these are discs of light. During a solar eclipse, these appear as crescents.
- Observe that shadows get sharper and clearer as the visible part of the sun gets smaller and smaller as it gets covered by the moon.

Have a breakfast with Eclipse. Enjoy the Eclipse.

Part 3 : Scientific rules to be followed during eclipse.

- Never look directly at the Sun with your naked eyes.
- Never look at the Sun through telescope, binoculars etc. Your eyes may be damaged.
- X-Ray film may not always be safe for viewing the eclipse.
- Use safe solar filter to look at the Sun. Safe filter cuts down the intensity of the sunlight by a factor of one lakh across all colours in the sunlight and also the UV and infrared part.
- Do not use the filter if it is damaged.
- Do observe the eclipse using safe methods. Show it to your friends, family and community. Everyone should enjoy such celestial events. Organise a mass viewing program.
- As we have understood with these experiments, am eclipse is just the shade. We daily walk, eat and drink in the shade. Nothing happens to us. So during an eclipse we all, including pregnant women, can do the same things. There are no bad effects. There is no poison in shade, that is why the question 'Why risk poisoning' ? is meaningless. Do not give any importance to such unscientific utterings. Do read the articles of Nilima Sahasrabuddhe, Aniket Sule and Shantanu Abhyankar in this booklet.
- Fear not, Enjoy the Eclipse!
- Propagate Scientific Attitude.

Part 4
Eclipse Articles

Fear Not, Enjoy The Eclipse !!!

Neelima Sahasrabuddhe

English Translation - Vivek Monteiro

It has been known from ancient times that when the sun, moon and earth come in a straight line, the shadow of the moon falls on earth, or the earth shadow on the moon, and we see an eclipse.

This does not happen in the normal risings and settings of the sun and moon.

Actually it is a happy coincidence that the discs of the sun and the moon appear the same size when viewed from earth. Though their sizes are different, and their distances from earth are different, it is remarkable that when seen from earth both appear the same size. The earth revolves around the sun, in a definite orbit and with a definite speed. The moon revolves around the earth, with its definite path and speed. And yet they occasionally arrive at positions where the moon covers the sun , or else the earth shadow falls on the moon. This we can observe sitting in our courtyards. It is such a rare opportunity, presented to us without any special effort, that we should gladly avail of and enjoy the spectacle.

Like the rising red sun, the phases of the moon, the full moon, or a monsoon rainbow, an eclipse shadow is a strange natural experience.

But then, why are some people afraid of eclipses ? Why do they refrain from eating during one, discard food, or believe that eclipses bring crises and should not be viewed ? How might these taboos have arisen ? There is a book written by N.C. Rana when he was a Professor at IUCAA in Pune which discusses this question in detail. The book published by Vigyan Prasar is available at arvindguptatoys.com website.

Briefly, this is what he writes :

" When, exactly, an eclipse will occur can be calculated only with mathematics, there is no other way. So until this was understood it was perhaps natural that people feared eclipses."

The second reason has to do with eclipse viewing . During the totality phase of a total eclipse the sun's disc is completely covered and we can look at it with naked eyes. But within a short time the intensity of the sun's rays resume and suddenly increase . These light rays entering through the earlier expanded eye pupil can possibly permanently damage the eye retina with their intensity. Since we do not know the exact duration of totality, this might happen… so… 'better not to look at the eclipse at all'…. this is simpler to prescribe.

Immediately prior to the eclipse, some moving wavy patterns are visible on the ground, or on a spread sheet , or on the surface of a water body. These shadowy patterns look like snakes, which might have appeared fearful, and given rise to the belief that they would spoil food and water.

In brief, these beliefs are the result of fearing what we do not understand.

But today we know where, when and why solar eclipses occur in all detail. We know the precautions to be taken to observe the sun safely. This is why we should surely avail of this opportunity to view a wonderful spectacle and see it with our own eyes.

The kings of ancient times thought of themselves as the descendants of the sun and the moon. A darkening of the sun or moon was seen as a crisis to be feared. But today we understand that this is no crisis , but only a shadow, don't we ?

In every 100 years 240 solar and 380 lunar eclipses occur somewhere on earth. But in a given village, or country, an eclipse occurs only a few times in a century. For most of us the chance to actually view an eclipse is rare. So whenever there is an opportunity to view an eclipse, do not miss the chance.

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Who Is Scared of Eclipses?

Dr. Aniket Sule
Homi Bhabha Centre for Science Education.

While growing up, most of us have heard instructions from grandparents about how to be 'careful' during eclipses. No! I am not talking about safely viewing the eclipse. My grandparents were more worried about how to avoid 'ill effects' of eclipses and if you have been raised in a typical Indian family, I bet you would have also seen similar worried elders in your family. All kids are naturally curious. So “don't do something” is never enough for them. At that age, the question “Why?” comes almost naturally. Then either the same elders or somebody else in the family would have tried given you an 'explanation' about why there may be some merit in the instructions to avoid the eclipse. Over the years all of us keep accumulating a long list such 'Dos and Don'ts for eclipses' and their supposed explanations. But do we ever pause and analyse what we have been fed or do we just accept it at its face value? Let us discuss the most popular eclipse myths.

In India, the most common superstition is to not view the eclipse at all. First total solar eclipse of independent India was on February 16, 1980. The science communicators who witnessed that eclipse recall curfew like situation in almost every village and only few non-scientists venturing out on the streets. The situation has improved progressively. I remember the total solar eclipse of October 24, 1995, which we saw from a small village in *Bundelkhand*, UP. The local police and several villagers had also gathered to see the eclipse with us. After that all Total / Annular solar eclipses have been broadcast live on television. Nowadays, whenever we announce public viewing of the solar or lunar eclipse anywhere in India, the response is always overwhelming in numbers. Needless to say, all of us who have witnessed multiple solar and lunar eclipses over last 40 years are all in excellent health and are real excited waiting for the upcoming ASE on December 26, 2019.

There are variants of this superstitions, where people prevent pregnant women from viewing the eclipse. They seem to think that the baby in the womb will develop deformities if a pregnant woman sees an eclipse. Some people advice pregnant women not to hold any sharp objects in their hand during the eclipse as they claim the said sharp object will leave a birthmark on the unborn child. Although no exact origin of this superstition can be found, it is possible to speculate that this might have originated from birth of some unfortunate child of some powerful kind with birth defect and the court astrologers blaming it on some eclipse which occurred during the pregnancy. In old days, kings used to offer donations to poor people on all special occasions including eclipses. That gave rise to a custom of poor people asking for alms during eclipses. As the kings used to take ritualistic baths before such large donations, some people started believing that that it is important to take holy bath during or just after the eclipse.

Some other people believe that the food kept outside goes bad during an eclipse. Some other people contend that not all food but just the cooked food goes bad. Some people further suggest that adding a *Tulsi* (Basil) leaf to each food container would miraculously solve the problem. To change the narrative, Public Outreach and Education Committee of Astronomical Society of India (ASI-POEC) launched a social media campaign titled '#eclipseeating', whereas we encouraged people to take selfies while eating during any

eclipse and post it on social media. We intend to continue this even during future eclipses.

If we ask any of these people the “Why?” question, they would give one of the three justifications. The most simple minded people simply say that there are some mysterious rays coming from the eclipsed body towards us and hence all these precautions are necessary. Now we know the lunar eclipse happens when the Moon enters the Earth's shadow and hence hardly any sunlight reaches the lunar surface. How can one expect sudden mysterious rays to appear if sun rays not reaching the moon is the basic science behind the lunar eclipse? The solar eclipse happens when the Moon just passes over the Sun's disk. Just before and just after the eclipse the moon is present in the sky but we can't see it as its sunlit side is away from us. The Earth-Moon duo are just tiny rocks located very far from the big Sun. There is no change in the internal processes of the Sun when this insignificant moon pops in the path of sunlight on the way to equally insignificant earth. Thus, even in this case there is no question of any special rays.

However, most people don't analyse this through. Hence all temples remain closed during the eclipse and post-eclipse there are rituals to wash idols with holy water. Often, even the people working in scientific labs lack scientific temper. One such group from a south Indian university, tried to conduct experiments to 'prove' that there is more bacterial growth in food during the eclipse period. However, their results failed to show any difference between 'exposed' sample and 'control' sample, which means food kept outside during the eclipse doesn't behave any differently than other 'normal' food. Is anyone surprised?

But then what may have been social reasons for such superstitions? There is no definitive answer but one can make an informed guess. Think of dimly lit Indian kitchens in big houses in pre-electricity days. During eclipse several animals and reptiles get confused due to change in ambient light and it may have happened that during some eclipse, some reptile might have mistakenly entered some cooked food jar and people might have eaten that food which was spoilt due to a dead reptile. Probably, after that people in that house thought it may be safer to keep food covered or throw away any open food as a precaution against such instances and then that practice was blindly followed by others. But now in our modern homes, do we have to follow such customs?

During recent eclipses we have also seen tweets from self-styled godmen who claim that moon goes through whole cycle of phases during an eclipse. Apparently, this normal 28 day cycle occurring in just 3-4 hours is what causes accelerated spoiling of food. Nothing can be farther from the truth. If one simply goes out and observes an eclipse, one can easily verify that the shapes of partial phases of eclipse and shapes of moon during a lunar cycle differ significantly. During a lunar cycle, one can see a crescent, an exact semi-circle and gibbous shape. In other words, the line separating dark and bright parts of the lunar disk sometimes appears convex, sometimes straight and sometime concave. On the other hand, the same line will always be convex, because it is edge of lunar disk in case of solar eclipse and the edge of shadow in case of lunar eclipse.

Traditional Hindu mythology, ascribes the eclipses to two body parts (*Rahu* and *Ketu*) of the immortal demon *Swarbhanu*. This demon swallows either the Sun or the Moon causing the eclipse but releases them

again as he cannot control them. In calendrical astronomy, the Indian names for the nodes of the lunar orbit are *Rahu* and *Ketu*. For this reason, they also make appearance in *Panchanga* and hence in horoscopes. This confuses many people and they start believing that these two imaginary points are same as the demons *Rahu* and *Ketu* described in mythology.

Even modern scientific information regarding eclipses can be misunderstood and misinterpreted. The Sun is extremely bright source of light and staring at it continuously on any day can damage your eyes. During eclipse, there is more excitement to watch the Sun and there is a danger of people trying to stare at the sun even when their eyes are hurting. Thus, we always warn people not to watch eclipse with naked eyes. We assume that people will be sensible enough not to stare at the Sun on other days. But, as people see these warnings only in eclipse context, they think that some damaging rays come towards earth only during the eclipse and that is the reason for such explicit warning.

India is not the only country with eclipse related superstitions. You will find strange superstitions in all cultures around the world, modern as well as tribal. However, that is not an excuse to pass the buck on other societies to act first and eradicate superstitions in their cultures before tackling Indian superstitions. These superstitions contribute to collective ignorance and must be eradicated at once. Let us hope by the time of next major eclipse, most of these superstitions would have been consigned to history and we would not need such an article to educate people.

Contact : aniket.sule@gmail.com

Our Eclipsed Persona

Dr. Shantanu Abhyankar
M. D. (Obgyn), Wai.

The telephone lines will soon be abuzz. Mothers will be calling their daughters, mothers in law would be talking to their daughters in law, sisters in law will chat with sisters in law, etc., etc. The talk will mostly be about congratulating the young pregnant lady. Talk full of love, care, compassion but also warning against evil and '...eclipse maimed her baby, be careful...' type of talk. 'I will be relieved once everything goes well. Take care dear, be cautious and be careful. It's the eclipse. If you don't follow all that comes by tradition you are doomed. You may be highly educated but that's for your career. Back home you must follow the tradition. Don't try be extra smart with us elders. We wish you well. Just want to help and guide.'

Why risk things when there are simple ways to eliminate the risk? How dose staying home, fasting, sitting at a place, for a day matter?

'Why risk things?' is a dangerous argument. The fact is that there is no evidence of the eclipse being inimical to the fetus. There was an era when no one knew why babies are born with a deformity nor why eclipses happen. It was in such times that people associated the two unrelated phenomenon. There will always be some babies born with some defect; hare lip, syndactyly (fingers stuck together), spina-bifida and such other. Each is now known to be caused by several different factors. Blaming the eclipse for a congenital defect is laughable. Once you assign a cause it puts a stop on further investigations. A wrongly attributed etiology will only lead to a wrong and misguided preventive strategy.

No one desires an anomalous child. Everyone wants a normal, healthy baby. But birth is a biological process. It does go wrong from time to time. Humans can churn out thousands of cars, one after the other, in a modern factory with zero defects. But nature can't. All that you sow doesn't grow. Whatever you harvest isn't all flawless. Whatever is true of the grasses and the seeds, of the birds and the bees, holds true for humans as well. This is what learn from biology. Medical science has a list of dos and don'ts for a healthy baby. Rubella vaccination, folic acid supplements, control of diabetes and such other disorders, preconceptionally and regular antenatal checkups later. Not following these well studied norms and labeling some celestial phenomenon as teratogenic isn't wise.

Annually there are at least four eclipses, sometimes even up to seven. It's obvious that almost every pregnancy is exposed to an eclipse. However the incidence of anomalies is paltry. Societies without any taboos about the eclipse should have anomalous babies aplenty. Which is not the case. The anatomical layout of the fetus is complete by the twelfth week in utero. Defects such as cleft lips, syndactyly, spina bifida have already been cemented by this time. Thus sticking to eclipse-taboos post the twelfth week is moot. It's seen that 96% of the term babies are normal, of the rest 2% will have minor defects and 2% will have major ones. So any ritual aimed at avoiding birth defects is bound to have 96% success rate. That's one reason why such fallacies continue to rule popular imagination. People see this as a strong proof of efficacy

of such practices.

In fact one is not inviting trouble by not following eclipse taboos. On the other hand following traditional dos and don'ts is certainly risking trouble. The gravid women has lots to suffer throughout the eclipse rituals. She is expected to be sitting at one place, awake and starving. This is preposterous. If she cuts some veggies the child is said to develop hare lip, if she crosses her fingers the child likely has fused digits. She is subjected to tremendous psychological stress. A women who believes all this must be having a tough time. She sits at a place, all the time worrying, till the celestial shadows move away. She will blame herself for any untoward outcome. The kin will blame her too. This is nothing short of ragging.

The traditional practices expected of a gravid women during an eclipse are not harmless goodwill gestures. They are in fact harmful. She is expected to starve. The pregnant women can't tolerate hunger. Moreover the baby entirely dependent on the mother for all its nutritional needs. Prolonged fasting causes hypoglycemia, even syncope. The fetus suffers hypoglycemia too. A very low sugar level, followed by a sugar spike after a binge meal, is even more harmful to the fetus. But she is expected to fast regardless of all this. Good intentions aren't enough of a justification for every act and deed.

She is expected to be immobile. Sitting at a place, especially during pregnancy, causes blood to stagnate and clot and this can sometimes lead to a life threatening embolus.

She's not even supposed to have water. Avoiding fluids leads to oliguria (reduced urine). Regular voiding helps to flush out the ever growing microbial colonies in our bladders. Infrequent voiding abets the growth of microbes. Urinary infections in pregnancy can cause preterm births and underweight babies. This is inviting trouble, not warding it off.

Moreover the gen next is watching you. They learn from you. They learn that this is the way to be deeply anxious about a celestial happening. This is how to create a dichotomy between science texts and real life. This is the way to meekly accept, to fall in line with the most irrational of traditions and rituals. This is the way to shut your thinking and blindly follow the masses, wherever the road might lead. When you blindly follow such harmful practices disguised as respecting tradition, you are in fact indoctrinating the gen next with the idea of unquestioned obedience. This is truly risky.

It's amazing to note the ideas about eclipses nurtured by cultures across the globe. Some have thrown the sun and the moon to the dogs while others have employed bears to do the honors. The bears let go only after a ritual sacrifice. Some have imagined quarrels between the sun and the moon while others have tales of curses thrown and wishes granted. Several tribes have stories of demons eating away at the heavenly discs.

A Korean tale, tells us of a dog who bites into the Sun, causing the eclipse. The Koreans then beat drums with such zest, that the dog lets go the Sun and scoots, leaving the sun to rise and set on its own again. An Arab tribal is expected to bathe in the sand and blow some towards the sun. This is supposed to be virtuous

and in gratitude of the Sun's daily toil. The Italians have a different take though, they believe that flowerbeds seeded during the eclipse, give colorful blooms.

Humans are insignificant compared to the sun, moon and the earth. But we ingratiate ourselves with such stories. However the scientific explanation is equally enthralling, as awe inspiring, as poetic and much more precise and magical. It will wither away your ego. You begin by accepting that the heavenly objects are simply there in the sky, without any support. Just retire from your mindscape, Shesha-naag, Atlas, the tortoise and sundry fulcrums of the globe. Then understand that the Sun which so obviously appears to be going around the earth, is stationary and it's the earth that's doing the rounds. Then know that the moon circles the earth as each revolves around its own axes. Then their orbits, their speeds, their angles, their shadows sweeping the space, sometimes engulfing the earth or the moon. This is simply mind blowing. This lets you predict eclipses, this lets you date them way back in the past too. This tells you the start, the finish, the extent and the type of the eclipse. There no need to beat the drums, no need to appease the imaginary bear, to ingratiate the gods. The eclipses are certain to begin and certain to end at a predictable time. Eclipses are just shadows playing in space. Why worry about their ominous consequences? Even a schoolboy can explain an eclipse with a torch and two balls.

During a solar eclipse the moon casts its shadow over our planet. When you carry and umbrella in the bright sun, or stand at a bus stop you are under a shadow. This is just akin to a solar eclipse, isn't it? The roof casts a shadow over you, at home; the tree casts a shadow when under a tree. Why worry about a shadow. The moon casts its shadow over the earth during a solar eclipse and the earth casts its shadow on the moon during a lunar one. An ox's shadow might fall over a pregnant sheep standing next to it in the barn or the sheep's shadow might darken the hen-coop. Do you pray or worry about hare lipped lambs? Or about aborting hens? Do you believe that a human shadow brings bad omen to another human? If not why ascribe such properties to the shadows of the earth and the moon?

I think we have schizoid personas. We have a rational self for school, college, education, career and an irrational one for our daily chores. The irrational one eclipses our home and life. We will have to annihilate the irrational and learn to live as one person, glowing brightly leaving the umbra of the eclipse far behind.

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www.navnirmitlearning.org

www.aipsn.net

Annular Solar Eclipse App
by Alok Mandavgane
https://play.google.com/store/apps/details?id=com.alokm.solareclipse&hl=en_IN

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