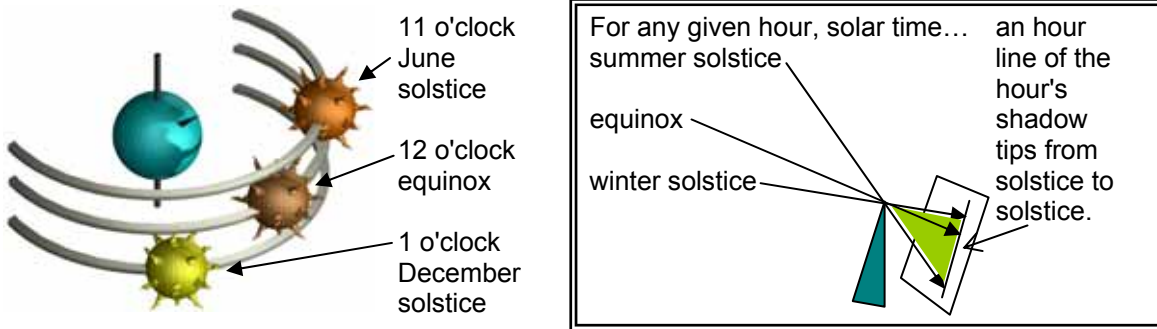


HOW THE SUN'S RAYS CAUSE RANGES OF SHADOWS

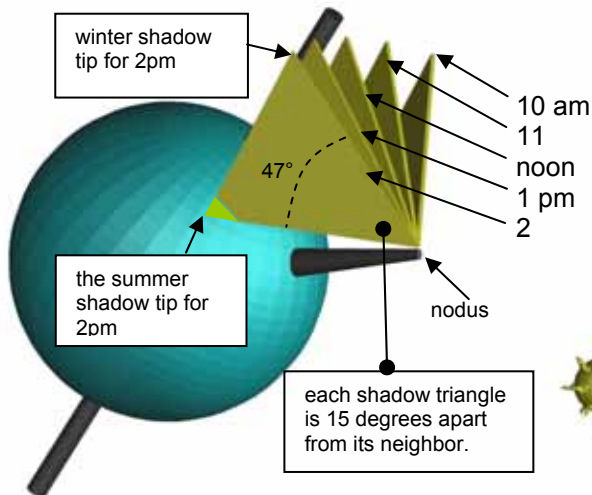
For a sundial, the sun rotates around the earth, and as there are 360 degrees in a circle and 24 hours in a day, that means the sun rotates around the earth's polar axis 15 degrees per hour. Those 15 degrees define solar time, and as we have seen, it varies from clock time due to many factors, one being that the earth's annual orbit around the sun is elliptical, not circular.



The sun moves north from December to June, south June to December as shown above. If we made a shadow casting device (called a gnomon) with a tip or other mark on it (called a nodus) that caused a clearly defined point or tip of a shadow, and at the same solar time each day marked the shadow's tip, over a year a line would be drawn by that shadow tip, an hour line, see above right pictorial. The hour line results from the base of a triangle, solstice to solstice, of shadow lines for that solar hour.

If clock time were used as opposed to solar time, then that line would look like a figure of eight, and demonstrate the equation of time. Some sun dials have those figures of eight on their hour lines, and it is called an analemma, and it is not symmetrical.

In the pictures below the hour shadow triangles are in one hour increments for simplicity, they are triangular because, as above, they show the range of the hour's shadow tip throughout the year.

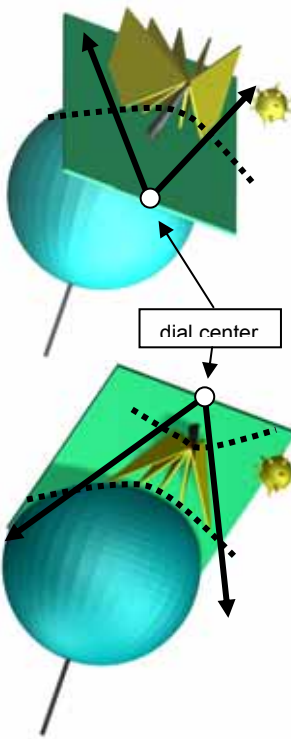


One hour increments are common on many sun dials, and each hour from winter to summer solstice builds a set of shadow ranges. Each is triangular. Each is 47 degrees at the apex, this being twice the sun's journey of 23.5 degrees (approximately). And the apex, as far as shadows go is a point (called a nodus) on a shadow casting device (called a gnomon).

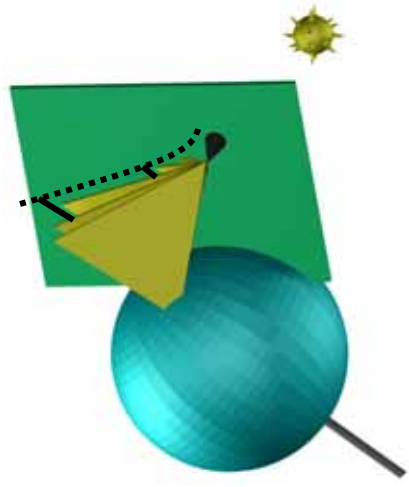
To the left is planet earth shown rather large, and to its right is the sun, shown rather small. And some triangular shadow rays are shown from 10 am to 2 pm each being 15 degrees from its neighbor.

Each of the rays shows the winter and summer solstice limits. Those limits form an hour line when they hit a surface. And each shadow ray triangle thus shows where each hour line will be.

The surface holding those hour lines (called a dial plate) can be at any angle to those rays, horizontal and vertical are the two most common. And vertical dials may southerly or they may face east or west. The pictures below show a horizontal, then a vertical south facing dial, then on a west facing vertical dial.

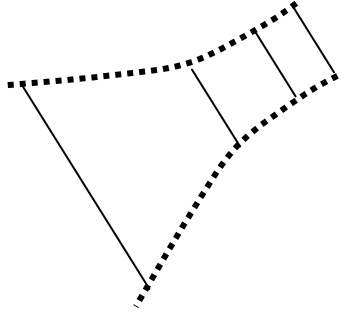
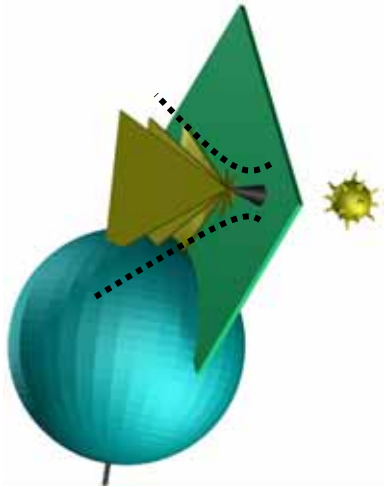


To the left is a dial plate for a horizontal dial. The solid lines are for 10am and 2pm, as on the previous page. The dashed line is the limit of the summer shadow tips, it marks the summer solstice, around June 21. The hour lines do not center on the base of the gnomon, they have a "dial center" elsewhere. And if a line were drawn from the dial center to the nodus, the tip in this case of the gnomon, it would be called the style, and the angle it would form with the dial plate would be the dial's latitude.



To the left is a dial plate for a vertical south facing dial. The solid lines are for 10am and 2pm, as before. The dashed lines are the limit of the solstice shadow tips. The top "U" shaped curve is the winter solstice, around December 25, and the lower "∩" marks the summer solstice, around June 21. The hour lines do not center on the base of the gnomon, they have a "dial center" elsewhere. And if a line were drawn from the dial center to the nodus, the tip in this case of the gnomon, it would be called the style, and the angle it would form with the dial plate would be the dial's co-latitude. Of course the angle it would form with the horizontal would be the latitude..

To the left and right are dial plates for the vertical dial which is facing true west. The pure east or west facing dial center is at infinity! Solid lines are hour lines, dotted lines are annual limits. The upper curve is the winter solstice curve, the lower is for the summer.



And dial plate shape may be modeled in this manner, such as the armillary, equatorial, or any irregular shape.