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MARKING THE MERIDIAN ON A ZERO SHADOW DAY (ZSD)

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ABSTRACT

In this work, I will be telling you how I derived the E-W line on a small pillar with a flat surface and transferred the same on to the sloped surfaced of my terrace. This was done on April 25th, 2021. And this was verified again on August 18th, 2021. In Bengeluru (latitude of Bengaluru is approximately 130° North), April 25th and August 18th are Zero Shadow Days (ZSDs).

RESUMEN

En este trabajo, compartiré mi experiencia sobre cómo derivé la línea Este-Oeste en un pequeño pilar con una superficie plana y transferí la misma a la superficie inclinada de mi terraza. Esto se hizo el 25 de abril de 2021, y se verificó nuevamente el 18 de agosto de 2021, en Bengeluru (la latitud de Bengaluru es aproximadamente 130° Norte). El 25 de abril y el 18 de agosto son Días de Sombra Cero (ZSD).

Key Words: planetarium — sociology of astronomy

1. WHO I AM

Hi my name is Madan Sriramreddy. I am from Bengaluru, India. At present I am 41 years old. When I was 6 years old I suffered from Brain Fever. I am now suffering from the side effects of the same disease. I have involuntary movements in my right side limbs. I've accepted them as a part of my life. Many a times accepting life as it comes paves a way to lead a happier life. I've done my masters in Sociology from the Bengaluru University. My profound interests are Astronomy and Aeronautics which made me learn Physics and Mathematics as tools to understand Astronomy (I learnt all these things non-formally). I hold a permanent membership of the Aeronautical Society of India. Currently, I am working in a company by name TRIDENT as an HR executive. Simultaneously, I am also studying the Earth's rotation and revolution of the planet through my own observations. Jawaharlal Nehru Planetarium in Bengaluru has been very kind to let me use their facility and guidance especially from Dr. BS Shylaja (she is also a member of the International Astronomical Union) in my study. Once my studies are completed, I wish to submit them as a record to the Jawaharlal Nehru Planetarium and if allowed, with IAU too. In fact, it is through Dr. BS Shylaja that I came to know about this workshop organized by the IAU. Everything was going on smoothly with my study of earth's rotation and revolution with help of shadows casted by a gnomon. But, the outbreak of the Covid-19 our entire country had to undergo a lock down. Even to this day, the planetarium has a restricted access. Therefore, I had to fix a Meridian on the terrace of my house. The terrace of my house isn't an even surface. I have only one pillar which is flat. The dimensions of its surface are 1.5 ft × 2 ft. Therefore, I invented a technique of deriving the East-West (E-W) line on Zero Shadow Day and transferring the East-West line fixed on the flat pillar to the uneven surface of the terrace.

Fig. 1. Main pillar with a flat surface on top.

2. DESCRIPTION OF MY STUDY

I've been studying the positions of the Sun at the Jawaharlal Nehru Planetarium (JNP) from the year, 2013. As mentioned above, my teacher Dr. BS Shylaja (BSS) and the other supporting staff were extremely cooperative in my studies. I defined each position of the Sun with 1. Date of observation, 2. Time of observation, 3. The altitude of the Sun and 4. The azimuth of the Sun. But, during the outbreak of the Covid-19 pandemic, JNP had to be lockdown. That's when BSS advised me to fix a meridian on the terrace. But, the terrace of my house was uneven.

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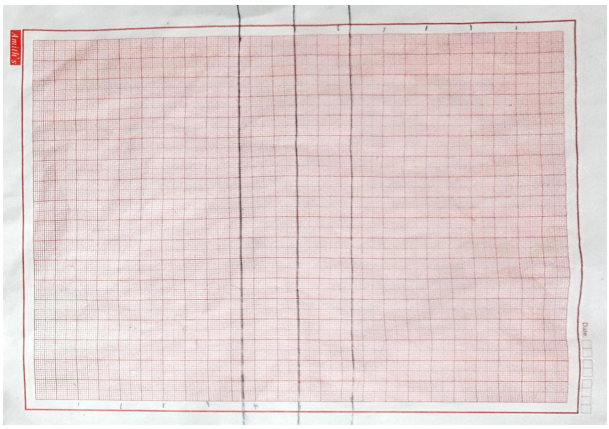

Fig. 2. Graph sheet used to shift the location of E-W line away from the pillar once it is transferred on the ground.

Fig. 3. Side view (left) and top view (right) of the gnomon.

The only feature with a flat surface for me to fix the meridian was a concrete pillar with dimensions of 10.9 X 19. The only gnomon that I had was a foot scale attached to the frame of Saraswathi Vigraha. This had sharp edges around it and a flat surface. This meant I could no longer determine the position profile of the Sun. Instead, I could only record the 1. Zenith distance to the Sun (later convert into the Declination of the Sun), 2. The date and 3. The Local noon. These limitations were because gnomon (the foot scale) had an uneven surface.

3. ZERO SHADOW DAY (ZSD)

If I had to continue studying the Sun's position, I had to invent a new method to mark the Meridian. A ZSD is a day when you cannot measure your shadow at the Local Noon because the Sun is directly above your and your shadow is hidden below you. This happens only in the region between the Tropic of Cancer and the Tropic of Capricorn. Then, I recalled my observations of the Sun's positions on a ZSD from JNP. I had noticed that on a ZSD the Sun passes along the sky in an a line which was almost parallel

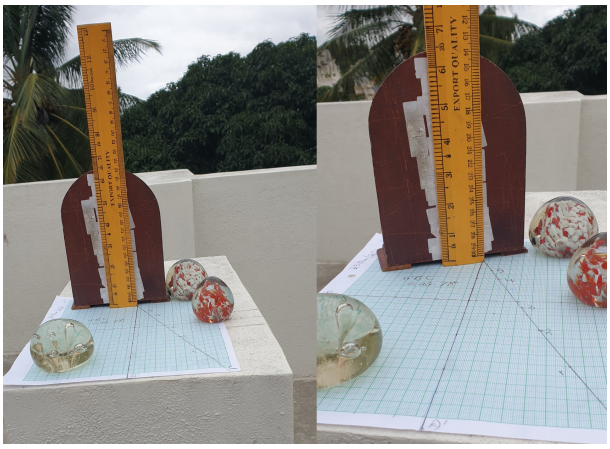

Fig. 4. Gnomon with the scale on the pillar as part of the activity conducted to mark the meridian. Details in the text.

to the E-W line for a very brief period of time before and after the Sun's Meridian passage. Therefore, I decided to take advantage of this occurrence and fix the E-W line on the pillar and then transfer the E-W line to the Surface of the terrace.

4. PROCEDURE

In the following I will present some of the steps part of the activity done on 25 April, 2021, the ZSD in Bengaluru, India. Figure 1 shows the important pillar on my terrace. This is the only flat surface available to me. I've drawn a set of 3 parallel straight lines connecting the leading edge (on to the left side of the pillar) and the trailing edge (on to the right side of the pillar). Each of these straight lines are separated by a distance from each other.

I deliberately chose the distance of 5 cm because the scale that I used to transfer the E-W line has the width of the one meter scale (which is also 5 cm). In order to mark the E-W line on the pillar I had to obtain a perfect fix to the leading edge of the pillar. This was done using a graph sheet. I call the graph sheet an extension sheet, which is shown in Fig. 2. I used it to shift the location of E-W Line away from the pillar once I have transferred it on the Ground. I shift the location of the E-W line so that the shadow of the pillar doesn't interfere with my observations. Again, please notice that I've drawn 3 parallel straight lines that are separated by 5 cm so that it becomes simpler for me to fix the E-W Line using the Leading edge of the pillar as the reference Line.

In Fig. 1(right image)), it is shown you that the leading edge of the pillar has been overlapped by the leading edge of the graph sheet and the three parallel lines (also separated by 2.5 cm from each other)

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Fig. 5. Some of the dots/lines that are marked.

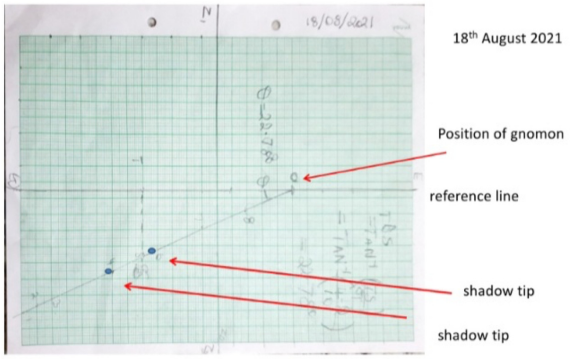

Fig. 6. Description of dots/lines plotted in the graph sheet. E-W line makes an angle of 22.8 degrees with the pillar edge as reference.

have overlapped the three parallel straight lines on the pillar. Overlapping of these three parallel lines is very important because the position of graph sheet on the pillar should be the same at all times. Additionally, a gnomon will be used. Figure 3 shows a side view of the thick edge of the instrument (left image) and the top view (right image). The irregular sharp edges make it extremely difficult for me to establish the central point from which a shadow originates. But, this is a perfect device to establish the E-W Line on a ZSD as the Sun approaches the Meridian.

In Fig. 4 (left image), I've shown you the initial orientation of the foot scale (gnomon). Please note that the straight line on the sheet, dividing into left and right side, is parallel to the leading edge of the pillar. The edge of the scale is aligned to this straight line on the graph sheet and the leading edge of the

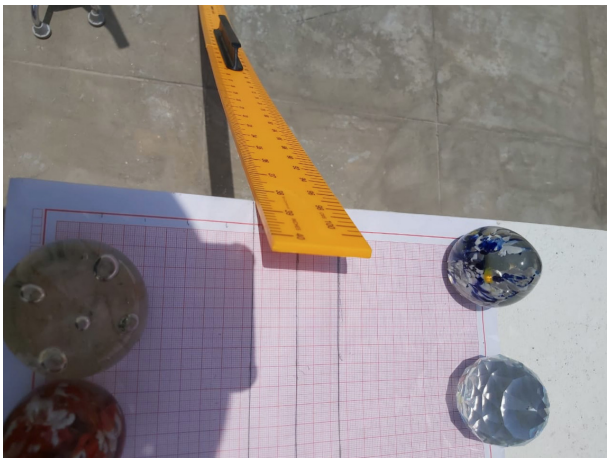

Fig. 7. One meter scale (in orange color) used to connect the leading edge with the ground. See the text for details.

pillar. I conducted this activity when it was about to be the local noon. To set the edge of the scale in line with the sharp shadow casted by the I rotated the scale towards line that marked the shadow. I was really happy to see the shadow length decrease exactly along line that I had predicted.

In Fig. 4 (right image), I rotated the scale to an angle where the edge of the scale was aligned to with the line along which the shadow was decreasing (I called this the shadow line) . The angle between leading edge of the pillar and the shadow line was 22.78 degrees, which meant the angle between the leading edge of the pillar and the E-W line was also 22.78 degrees.

The 2 dots (in black) in Fig. 5 are colinear because they are directly taken from Leading edge of the pillar. With the help of an extension sheet I shifted location of the E-W line to a position where the shadow of the pillar doesn't affect my observations of the position of the Sun. On 18 August, 2021 (a ZSD in Bengaluru) I conducted the same activity to eliminate errors if any. In Fig. 6, the straight line between Z1 and Z2 is the straight line connecting the leading and the trailing edge of the pillar. Afterwards, I got to know the angle of the E-W line relative to the leading edge of pillar (22.78 degrees). I realized the leading edge was more reliable because this was a straight line on a physical object (Fig. 7). Therefore, I decided to transfer the leading edge of the pillar on to the ground. I placed the one meter scale to connect the leading edge of the pillar with the ground. In the picture above, I have shown the one meter scale (in orange color) connecting the leading edge with the ground.

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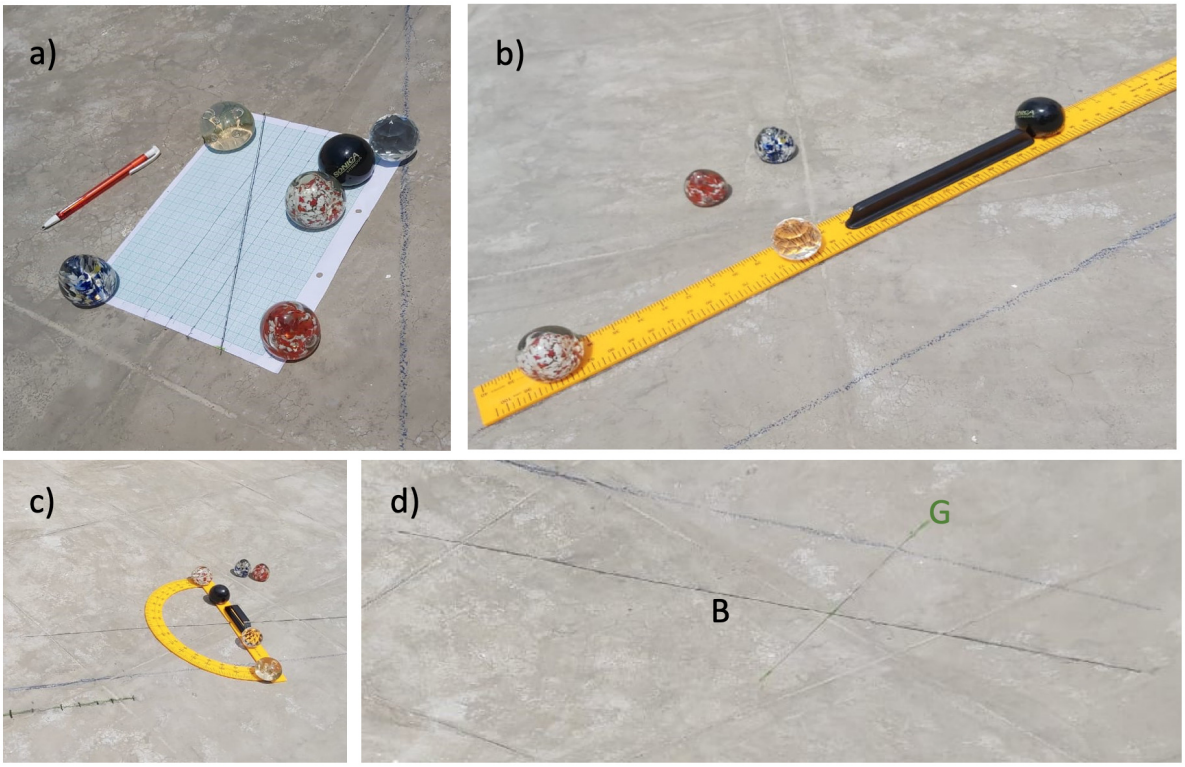

Fig. 8. Description of the drawings made on the ground. Meridian marked on the ground (a), extension of the meridian line (b), E-W line fixed by drawing a perpendicular to the meridian line (c), Meridian/E-W lines (d) identified by colors Black(B)/Green(G), respectively.

I have directly marked the meridian (the two dots marked on the ground across the traversal) using an extension sheet with 3 parallel straight lines spaced 2.5 cm from each other (Fig. 8a). On this sheet I have drawn a traversal cutting the 3 parallel straight lines at an angle of 22.78 degrees. I have connected the 2 dots on the ground shown in the previous picture with a straight line and extended it using a one meter scale, as shown in the Fig. 8b. Then, I fixed the E-W line by drawing a perpendicular line to the meridian with the help of a large sized protractor as shown in Fig. 8c.

Finally, I had meridian and the E-W line as found from for my observations. The straight line marked in green (G) in Fig. 8d is the E-W line and the straight line marked in black (B) is the meridian. This project will continue, and I am currently using the same meridian to record the declination of the Sun, and very motivated to conclude and get results from these measurements.