iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** V **Month of publication:** May 2020

DOI: http://doi.org/10.22214/ijraset.2020.5182

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

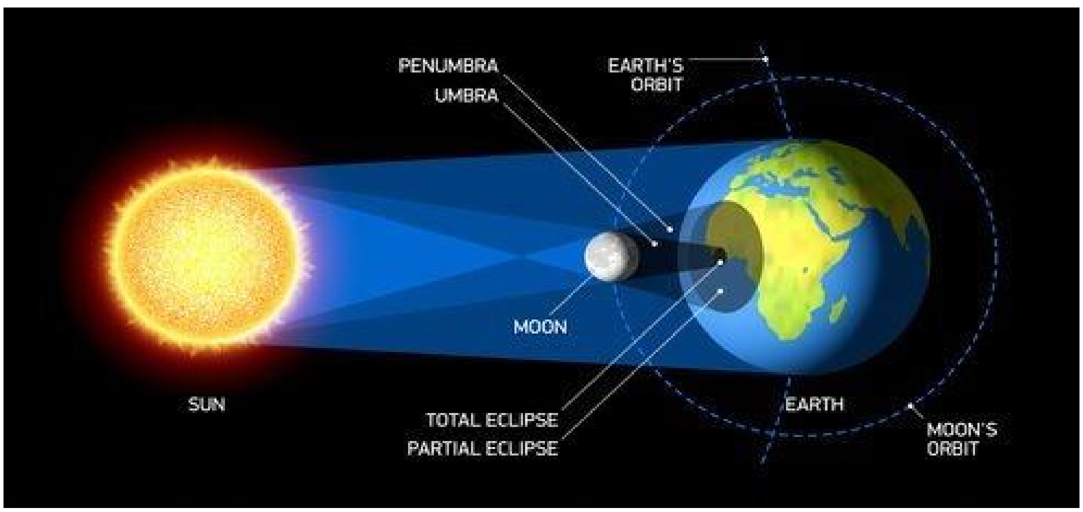
Geometrical Construction of Solar Eclipse

Himani Patel[1] , Akash Patel[2]
[1,2] *P.G. Department of Physics, Sardar Patel University, Vallabh Vidhyanagar, India*

***Abstract:** Geometrical Construction of annular solar Eclipse on 26th December 2019. In this projection of the solar eclipse assumes that observer is at moon, looking down on earth, viewing the moon's shadow as it passes over the earth disc. The earth to him appears as a plane equal to the moon's horizontal parallax.*
***Keywords:** Elements for computations, Graph, observations from the projection, Results from Graph*

I. INTRODUCTION

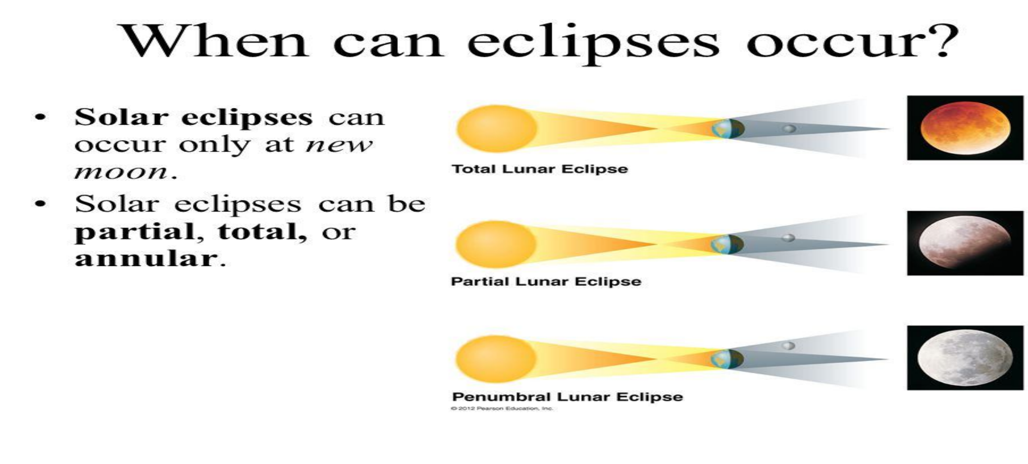
Solar eclipse occurs when the moon passes between earth and the sun, thereby totally or partially obscuring earth's view of the sun. This configuration can only occur during a new moon when the sun and moon are in conjunction as seen from the earth.



A. Types of Eclipse

Depending on what part of the shadow you are located in there are three types of eclipse:

1) *Total Eclipse:* A total eclipse is where the sun is covered completely by the Moon.
2) *Annular Eclipse:* An annular eclipse is when the moon covers the sun, but the sun can be seen around the edge of the moon.
3) *Partial Eclipse:* A partial eclipse is where when only a portion of the sun is blocked by the moon.



International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

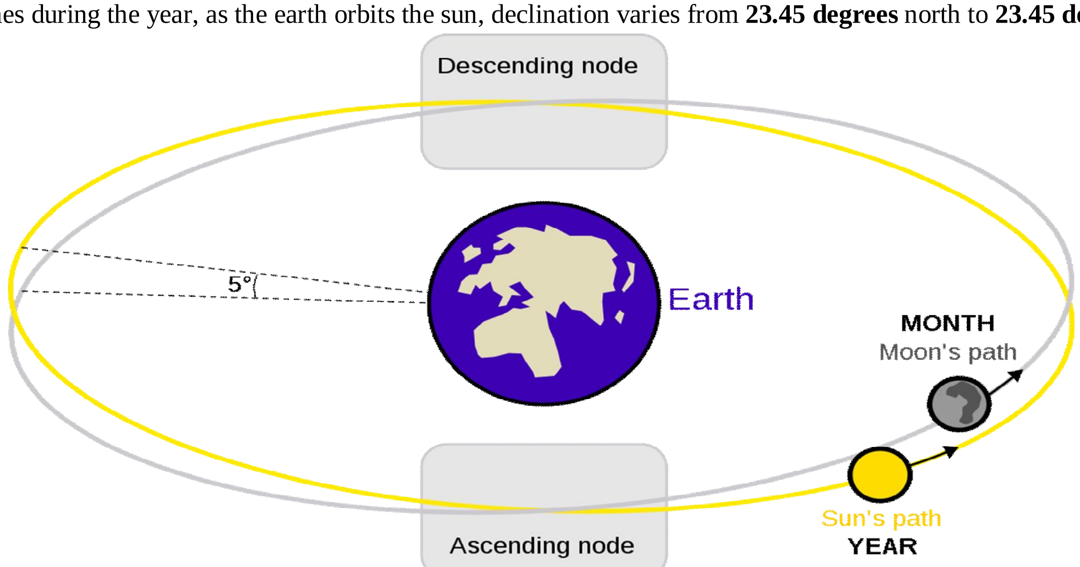
B. Some Definitions

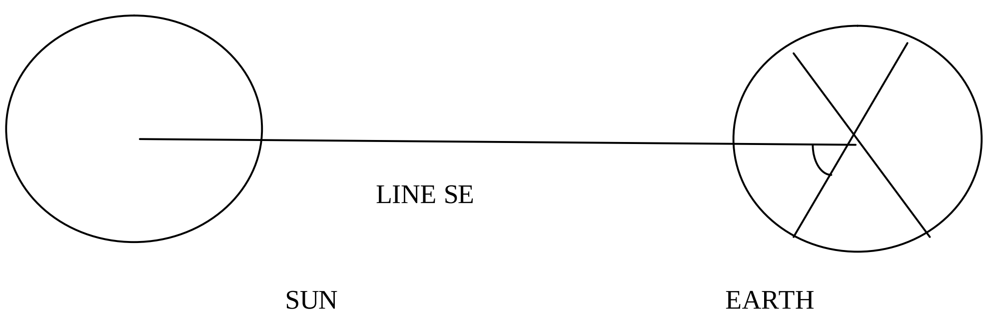
Central solar eclipse:

It is an eclipse during which the central line of the umbra touches the Earth's surface. It is possible,

Though extremely rare, that part of the umbra intersects with the Earth (Thus creating an annular or total eclipse), but not its central line. This is then called a non-central total or annular eclipse.

1) *Greatest Eclipse:* For solar eclipses, *Greatest Eclipse* (GE) is defined as the instant when the axis of the moon's shadow cone passes closest to Earth's center. The computation of the duration of the total (or annular) phase at this point is typically done using a smooth edge for the Moon that ignores the effects of mountains and valleys along the lunar limb. For total eclipses, the instant of Greatest Eclipse offers a good approximation (typically ~1-2 seconds) to the *Greatest Duration* of totality along the entire eclipse path. The instant of Greatest Eclipse is easily calculated for total, annular and partial eclipses, and is the standard time used for comparing different eclipses with each other. For annular eclipses, the instant of *Greatest Duration* may occur either near the time of *Greatest Eclipse* or near the sunrise and sunset for lunar eclipses, *Greatest Eclipse* is defined as the instant when the moon passes closest to the axis of Earth's shadow.
2) *Penumbra:* Faint outer shadow; partial eclipse are seen from within this shadow
3) *Umbra:* Dark inner shadow; total eclipse are seen from within this shadow.
4) *Node Point:* The moon's orbit is inclined about 5°8' to earth's orbit around the sun. The points where the lunar orbit intersects the plane of earth's orbit are known as the nodes. The moon moves from south to north of earths orbit at the ascending node, and from north to south at the descending node.
5) *Declination:* The earth's equator is tilted **23.45 degrees** with respect to the plane of the earth's orbit around the sun, so at various times during the year, as the earth orbits the sun, declination varies from **23.45 degrees** north to **23.45 degrees** south.





Moon's Parallax- It is defined as an angle subtended at the moon by the earth radius.

6) *Greenwich Time (GMT):* Universal Time is actually based on the mean sidereal time as measured in Greenwich, England. It's also approximately equal to mean solar time from Greenwich.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

II. CONSTRUCTION OF THE GENERAL ECLIPSE

The projection can be drawn on any reasonable size of blank paper but will be very convenient on big graph paper.

A. STEP-1

Find moon's Horizontal Parallax- sun's Horizontal Parallax
$=0^{\circ}\,58'\,44'' - 0^{\circ}\,0'\,8.5''$
$=58.6'$ (88 mm)
(Take a suitable scale $1' = 1.5$ mm)
Now draw a circle with radius 88mm with centre as C. Draw a horizontal line BCH passing through C and representing the diameter of the circle.

B. STEP-2

Through C draw line CDPL perpendicular to HB. This line represents the plane of earth's axis as seen from moon.

C. STEP-3

Draw another circle with radius equal to
Moon's Horizontal Parallax – sun's Horizontal Parallax = a
Sun's semi-diameter + moon's semi-diameter = b
Now take a+ b
$= 0^{\circ}\,58'\,35.5'' + 0^{\circ}\,31'\,48.5''$
$= 1^{\circ}\,30'\,23''$
$= 90.40'$
= 135.75mm

D. STEP-4

From P take PA and PF each equal to obliquity of eclipse $23^{\circ}\,26'$ and draw a chord AF with AF as the diameter describing semicircle ALF.
Point A represents Vernal Equinox, F the Autumn Equinox where as D represents the two tropics.

E. STEP-5

Find the distance of sun from the tropic nearest to it.
$274^{\circ}\,6'\,55.1'' - 90^{\circ} = 184^{\circ}\,6'\,55.1''$
$274^{\circ}\,6'\,55.1'' - 270^{\circ} = 4^{\circ}\,6'\,55.1''$
Longitude of sun is nearest to 270°
Take LT equal to $48^{\circ}\,21'\,12''$ and draw TE parallel to LC.

F. STEP-6

Draw CG the axis of moon's orbit so that angle GCE is equal to moon's visible path with the ecliptic.
CG is to the left of CE if node is Ascending.
CG is to the right of CE if node is Descending.
Here, we are calculating for 26th December 2019 solar eclipse which is descending node.

G. STEP-7

Take Cn= Moon's latitude. Here, 44.73mm. Draw a line which passes through n & which is perpendicular to CG. Here line k l r m n p q.
This line represents the centre of shadow or moon's path across the disc. Join points Ck, C1, C2, Cq

H. STEP-8

Take moon's semi-diameter as radius ($15'\,33'' = 23.32$mm) and draw moon's disc centered at points k & q.
Take sun's semi-diameter as radius ($16'\,15.5'' = 24.38$mm) and draw sun's disc centered at points 1& 2.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

I. STEP-9

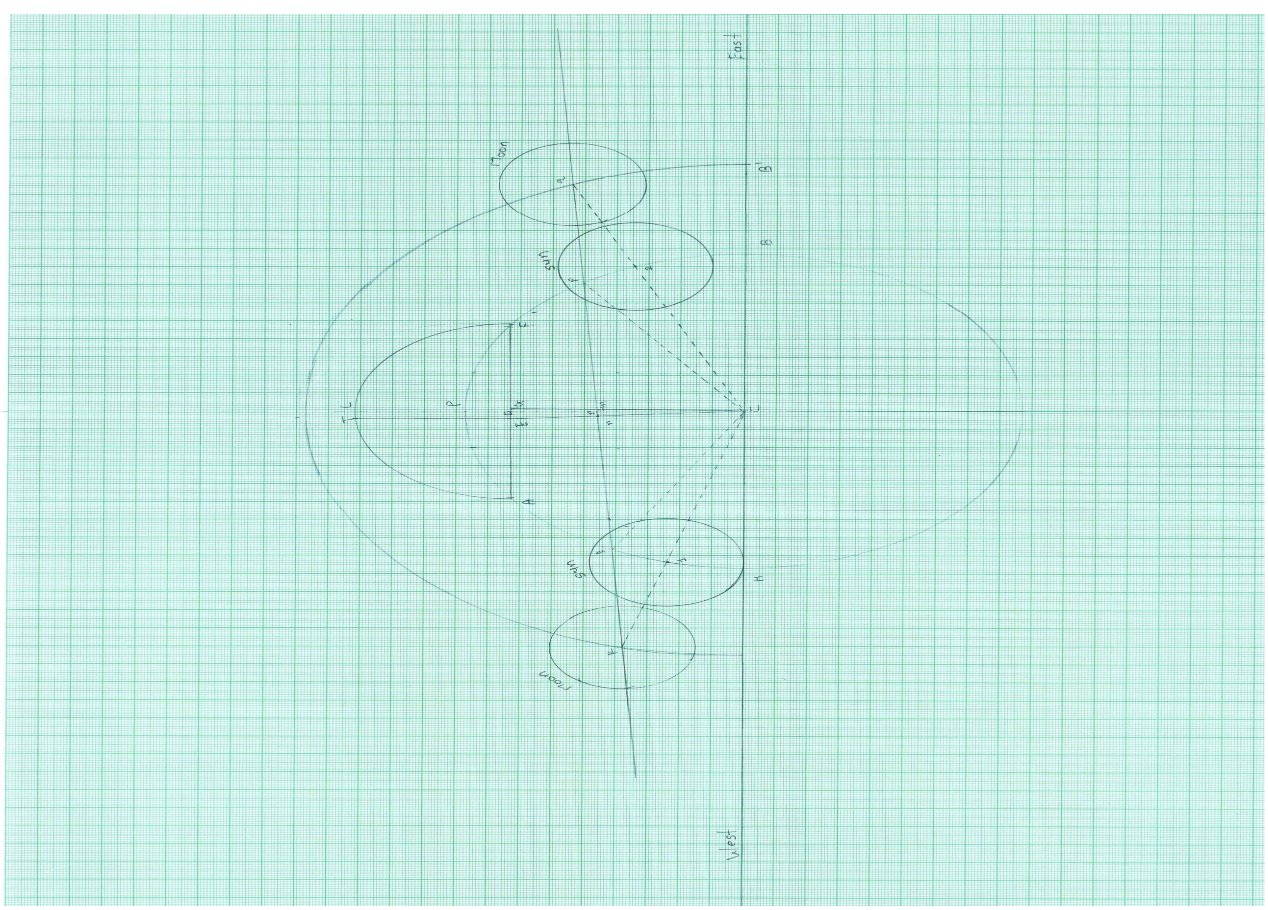
Moon's hourly motion – Sun's hourly motion = $0^\circ 30' 24.8'' = 45.61$mm

III. ELEMENTS FOR COMPUTATIONS

The arguments which are required for plotting (projecting) the annular solar eclipses of 26th December 2019 at the time of new moon are…

Sr no.	Observations	Degree(˚)	Minitues(ˈ)	Seconds(″)
1	Longitude of sun	274	6	55.1
2	Declination of sun	23	22	25.4
3	Sun's hourly motion in longitude	0	2	32.9
4	Sun's horiontal parallax	0	0	8.5
5	Sun's semi diameter	0	16	15.5
6	Longitude of moon	274	7	31.2
7	Moon's hourly motion in longitude	0	32	57.7
8	Moon's horizontal parallax	0	58	44
9	Moon's semi diameter	0	15	33
10	Moon's latitude	0	23	36
11	Moon's hourly motion in latitude	0	3	2.35
12	Angle of moon's path with ecliptic	5	8	42
13	Node of moon	Decending node		

IV. GRAPH



V. OBSERVATION FROM THE PROJECTION

kl = 54mm	1h 6m 3s
Kr = 122mm	2h 42m 35s
Km = 133mm	2h 43m 49s
Kn = 129mm	2h 38m 53s
Kp = 203mm	4h 10m 3s
Kq = 258mm	5h 17m 47s

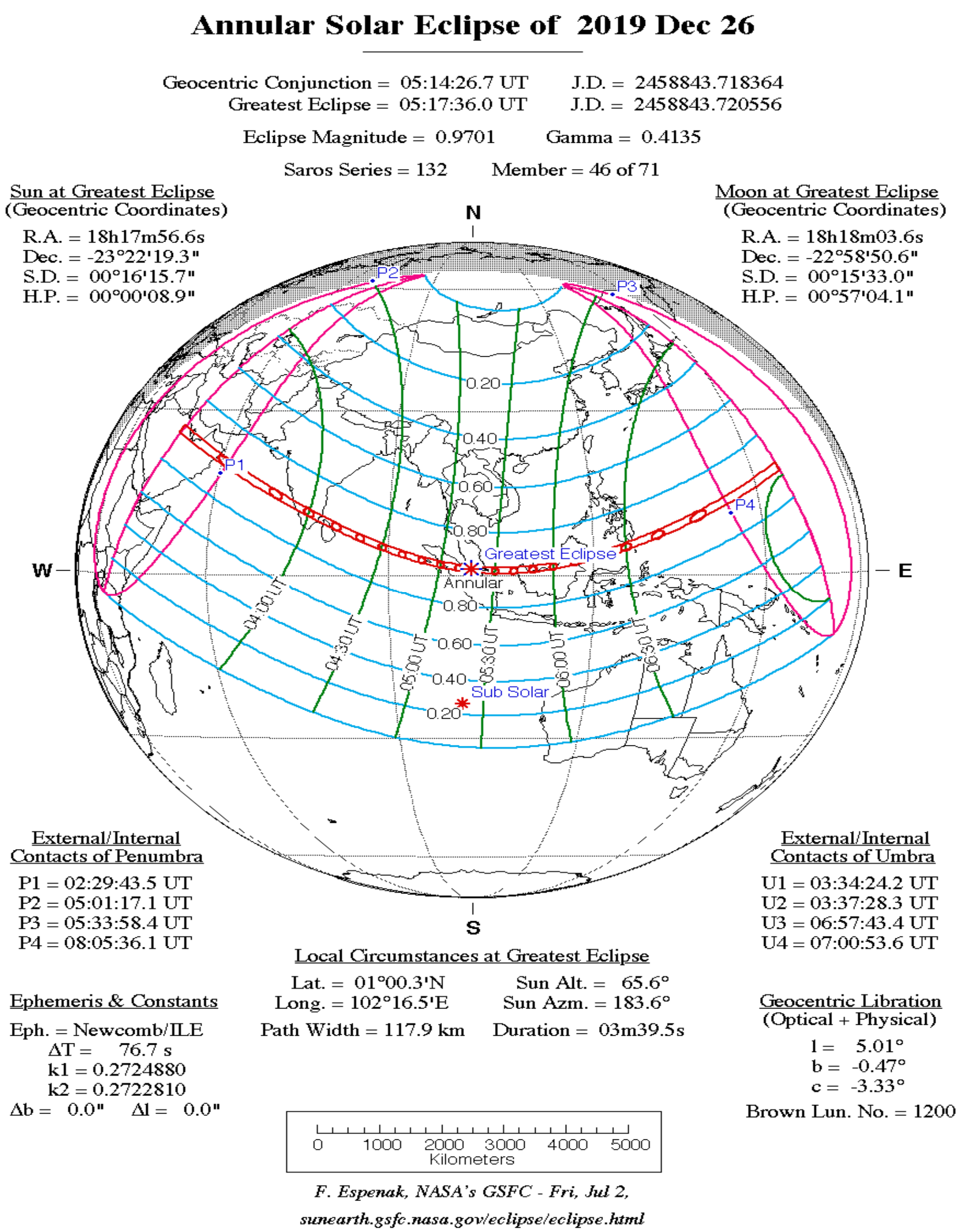
kl = 54mm	1h 6m 3s
lr = 75mm	1h 32m 23s
rm = 1mm	0h 43m 49s
mn = 4mm	2h 1m 13.9s
np = 74mm	0h 4m 55s
pq = 55mm	1h 7m 44s

$\angle kCH = 16^\circ$
$\angle lCH = 28^\circ$
$\angle pCB = 35^\circ$
$\angle qCB = 24^\circ$

VI. RESULTS FROM GRAPH

A. Time Of Conjuction At Greenwich: 5h 15m 29s

-k to n	5H 15M 29S 2H 38M 53S	2H 36M 36S	FIRST PENUBRAL CONTACT(P1)
+k to l	2H 36M 36S 1H 6M 3S	3H 42M 39S	FIRST UMBRAL CONTACT(U1)
+l to r	3H 42M 39S 1H 32M 23S	4H 74M 62S	GEOCENTRIC CONJUCTION
+r to m	4H 74M 62S 0H 1M 13.9S	5H 16M 16S	GREATEST ECLIPSE
+m to p (mn + np)	5H 16M 16S 0H 4M 55S 1H 31M 8.8S	6H 52M 19.8S	LAST UMBRAL CONTACT(U4)
+p to q	6H 52M 19.8S 1H 7M 44S	8H 0M 3.8S	LAST PENUBRAL CONTACT(P4)



B. Comparison

Contact Points	Calculated	According to NASA's Eclipse page
FIRST PENUBRAL CONTACT(P1)	2H 36M 36S	2H 29M 43.5S
LAST PENUBRAL CONTACT(P4)	8H 0M 3.8S	8H 5M 36S
FIRST UMBRAL CONTACT(U1)	3H 42M 39S	3H 34M 24.2S
LAST UMBRAL CONTACT(U4)	6H 52M 19.8S	7H 00M 53.6S

VII.CONCLUSION

A. The experiment for the determination of values of Penumbra and Umbra has been successfully carried out.

B. The results of the experiment performed by geometrical method are in good agreement with the data which are published on website of NASA.

VIII. ACKNOWLEDGMENTS

I am highly thankful to my project guide professor B.Y. Thakor, P.G. department of physics, Vallabh Vidhyanagar for providing me necessary guidance and help towards the successful completion of the project. He was always helpful throughout my project and guided me about ways to analyze problems. I am grateful to him for giving me an opportunity to learn something in astronomy during my final year.

My thank are also due to professor P.C Vinodkumar, Head of physics P.G. department, Sardar Patel university, Vallabh Vidhyanagar for assigning project work in the final year.

Last but not the least I would like to thank all those who helped me directly or indirectly in completion of my project.

REFERENCES

[1] Fred Espenak, NASA's GSFC

[2] Prof. Brijmohan Y Thakor – P.G.Department of Physics, Vallabh Vidhyanagar