

SOLAR ECLIPSES

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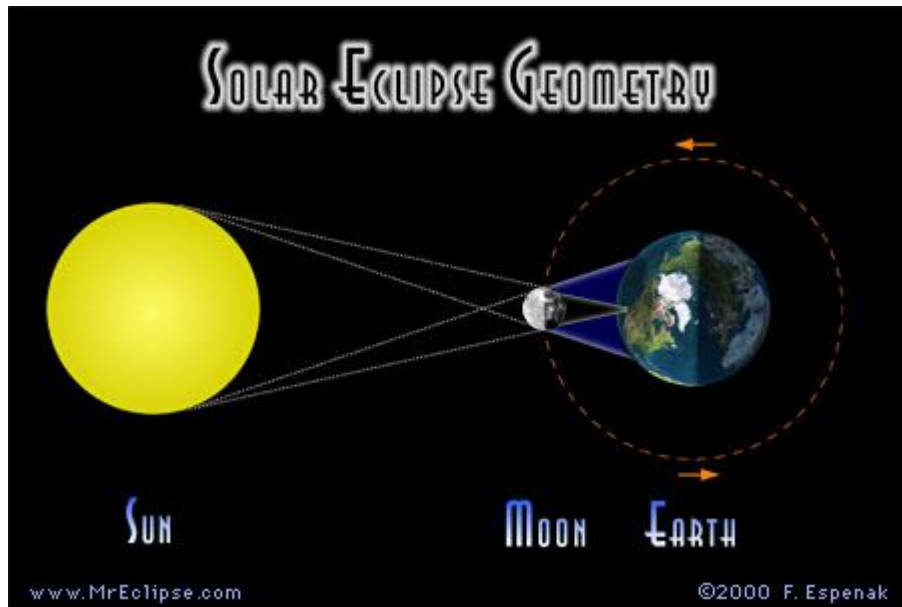
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How they happen

The Moon which is about 3,476 km in diameter orbits the earth once in 29.5 days. As it circles our planet, the moon changes position with respect to the Sun, thus going through a series of phases:

- *New Moon* > New Crescent > First Quarter > Waxing Gibbous > Full Moon > Waning Gibbous > Last Quarter > Old Crescent > *New Moon* (again)

A solar eclipse can only occur at new moon when the moon comes between the Sun and the earth.

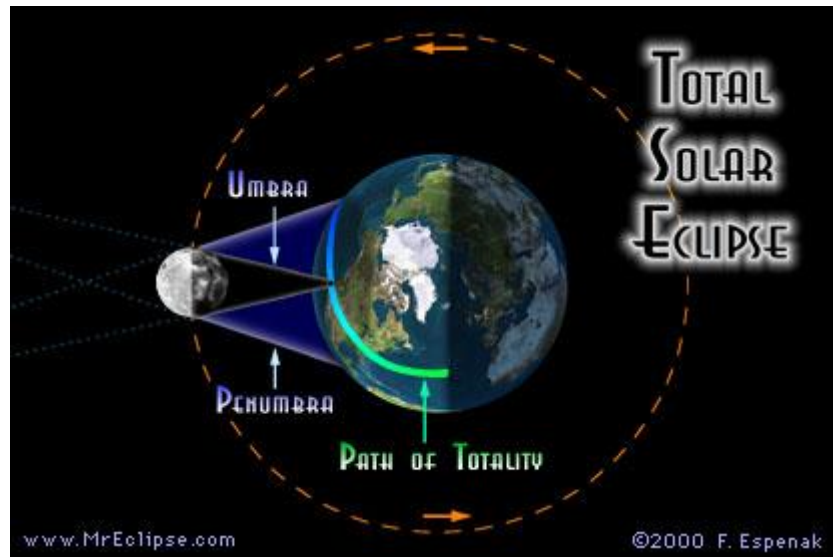


Geometry of the Sun, Earth and Moon During an Eclipse of the Sun

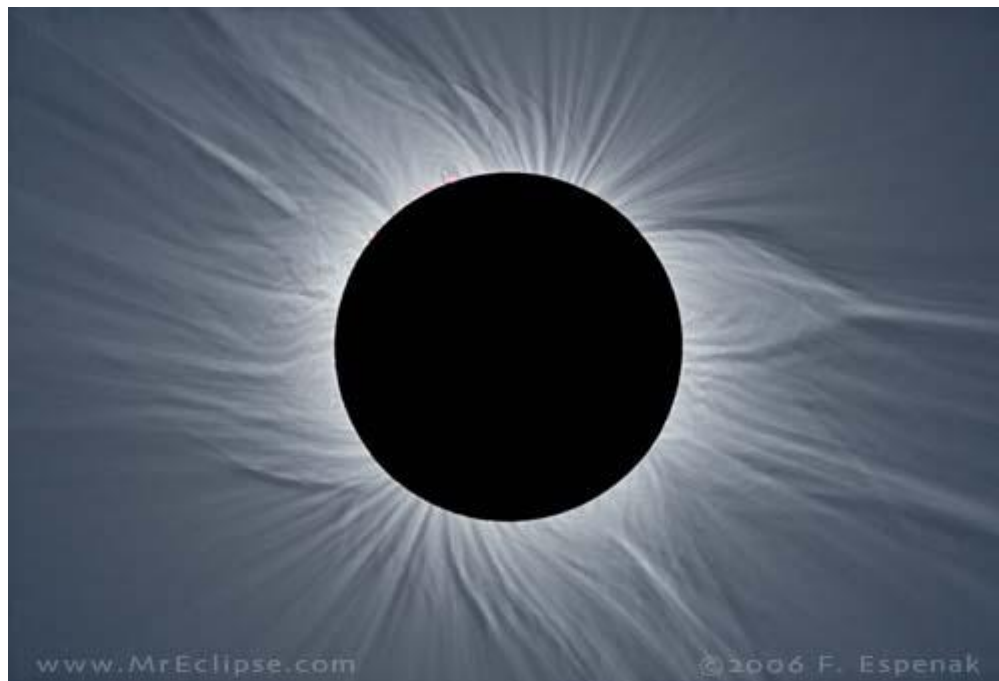
The Moon's two shadows are the penumbra and the umbra.

(Sizes and distances not to scale)

During a solar eclipse, the Moon's shadow falls upon Earth's surface and some portion of the Sun's disk gets covered or 'eclipsed' by the Moon. Since New Moon occurs every 29 1/2 days, one might expect that a solar eclipse should occur once every month but, this doesn't happen because the Moon's orbit around Earth is tilted by about 5 degrees to Earth's orbit around the Sun. The consequence of this is that, the Moon's shadow usually misses Earth as it passes above or below our planet at New Moon. In practice, however, at least twice a year, the geometry lines up just right so that some part of the Moon's shadow falls on Earth's surface and an eclipse of the Sun is seen from that region of the earth.



Total Solar Eclipse and Path of Totality



2006 Total Solar Eclipse

Types of Eclipses

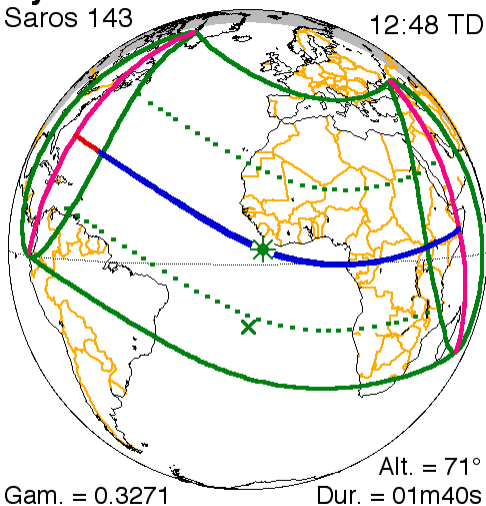
There are four types of solar eclipses:

- A **total eclipse** occurs when the dark silhouette of the Moon completely obscures the intensely bright light of the Sun, allowing the much fainter solar

corona to be visible. During any one eclipse, totality occurs at best only in a narrow track on the surface of Earth and when the Moon is near its closest distance to Earth (*i.e.*, near its **perigee**). The Moon will appear to be large enough to completely cover the Sun's bright disk, or **photosphere**.

- An **annular eclipse** occurs when the Sun and Moon are exactly in line, but the apparent size of the Moon is smaller than that of the Sun. Hence the Sun appears as a very bright ring, or **annulus**, surrounding the dark disk of the Moon. These eclipses occur when the Moon is near its farthest distance from Earth (*i.e.*, near its **apogee**) and it will appear to be slightly smaller than the Sun
- A **hybrid eclipse** (also called **annular/total eclipse**) shifts between a total and annular eclipse. At certain points on the surface of Earth it appears as a total eclipse, whereas at other points it appears as annular. Hybrid eclipses are comparatively rare. The solar eclipse on 3rd November 2013 will be a classic example of this.

Hybrid **2013 Nov 03**
Saros 143 12:48 TD



Five Millennium Canon of Solar Eclipses (Espenak & Meeus)

It is one of the rare hybrid or annular/total eclipses in which some sections of the path are annular while other parts are total. It will be visible from within a thin corridor, which traverses the North Atlantic and equatorial Africa. It will sweep over northern Kenya, crossing Lake Turkana where the central line duration will be about 14 seconds at 14:25 UT (5.25 pm). In its final 2 1/2 minutes, the lunar shadow will race across southern Ethiopia before leaving Earth's surface in Somalia where a 1 second total eclipse will be observed at sunset.

- A **partial eclipse** occurs when the Sun and Moon are not exactly in line and the Moon only partially obscures the Sun. This phenomenon can usually be seen from a large part of Earth outside of the track of an annular or total eclipse. However, some eclipses can only be seen as a partial eclipse, because the **umbra** passes above the Earth's polar regions and never intersects.

Predictions of Solar Eclipses

Here, we use The Eclipse Explorer based on the **JavaScript Solar Eclipse Calculator** created by Chris O'Byrne and Stephen McCann. The original calculator predicts the local circumstances for any single eclipse over the period 1970 to 2039 for a geographic position supplied by the user. (see [Instructions below- from NASA eclipses website](#)).

Instructions

The JavaScript Solar Eclipse Explorer can compute the local circumstances for every solar eclipse visible from a city for any century from -1499 to 3000 (1500 BCE to 3000 CE). Just follow these instructions:

- Section 1 - Select a city from the drop-down menu or manually enter the geographic coordinates and time zone.
 - Section 2 - Choose the desired century by clicking the button.
- Section 3 - A table will be generated giving the local circumstances for every eclipse visible from the city.

All times are displayed in local time using the value from the *Time Zone* field in Section 1 (add 1 hour for Daylight Saving Time). A time followed by "(r)" means the event is already in progress at sunrise. Similarly, a time followed by "(s)" means the event is still in progress at sunset. In such cases, the times and circumstances given are for sunrise or sunset, respectively. The times of sunrise and sunset are calculated when the Sun's lower limb touches the horizon. For more information about the local circumstances table, see **Key to Solar Eclipse Explorer**.

Section 1: City Coordinates (e.g Nairobi)

Choose city, or enter coordinates:

Nairobi, KENYA

Name: Nairobi, KENYA

Latitude: 1 deg 17 min 0 sec S

Longitude: 36 deg 49 min 0 sec E

Altitude: 1820 meters

Time Zone: 03 00 E

Section 2: Century Selection

Choose
century:

2000

Section 3: Eclipse Predictions

Solar Eclipses visible from Nairobi, KENYA

Latitude: 1° 17' 00" S

Longitude: 36° 49' 00" E

Altitude: 1820m

Time Zone: 03:00 E

Calendar Date	Eclipse Type	Partial Eclipse Begins	Sun Alt	A or T Eclipse Begins	Maximum Eclipse	Sun Alt	Sun Azi	A or T Eclipse Ends	Partial Eclipse Ends	Sun Alt	Eclipse Mag.	Eclipse Obs.	A or T Eclipse Duration
2001-Jun-21	P	15:15:23	44	-	16:25:24	29	298	-	17:26:21	15	0.524	0.423	-
2002-Dec-04	P	08:02:50	24	-	08:56:15	36	117	-	09:56:12	49	0.374	0.26	-
2005-Oct-03	P	12:39:11	85	-	14:22:13	60	264	-	15:55:52	36	0.879	0.832	-

2006-Mar-29	P	12:42:17	85	-	12:56:10	83	315	-	13:10:10	81	0.013	0.002	-
2010-Jan-15	A	07:06:28	06	08:26:11	08:29:37	25	113	08:33:04	10:14:51	49	0.912	0.832	6m53s
2013-Nov-03	P	16:16:27	29	-	17:26:55	12	255	-	18:18(s)	0(s)	0.847	0.807	-
2016-Sep-01	P	10:00:27	51	-	11:46:59	75	050	-	13:38:41	71	0.76	0.691	-
2017-Feb-26	P	18:40:05	02	-	18:47(s)	0(s)	262	-	18:47(s)	0(s)	0.12(s)	0.049(s)	-
2019-Dec-26	P	06:29(r)	0(r)	-	06:37:01	01	113	-	07:04:11	08	0.095	0.034	-
2020-Jun-21	P	06:46:06	02	-	07:47:41	16	065	-	08:58:57	32	0.671	0.586	-
2027-Aug-02	P	12:52:19	71	-	14:01:20	62	314	-	15:04:10	50	0.416	0.308	-
2030-Nov-25	P	07:33:33	18	-	08:08:24	26	113	-	08:45:51	34	0.162	0.077	-
2031-May-21	P	07:19:50	11	-	08:36:05	29	066	-	10:09:20	50	0.81	0.746	-
2034-Mar-20	P	12:21:37	85	-	13:28:10	78	276	-	14:32:58	62	0.288	0.18	-
2038-Jan-05	P	17:48:07	12	-	18:27:49	03	247	-	18:41(s)	0(s)	0.202	0.104	-
2038-Jul-02	P	17:20:01	17	-	18:26:19	02	293	-	18:36(s)	0(s)	0.813	0.757	-
2041-Apr-30	P	14:31:54	56	-	16:02:11	35	289	-	17:19:52	17	0.94	0.927	-
2046-Aug-02	P	12:44:40	71	-	13:48:45	64	319	-	14:48:47	53	0.308	0.198	-
2049-May-31	P	17:46:54	10	-	18:29(s)	0(s)	292	-	18:29(s)	0(s)	0.593(s)	0.488(s)	-
2049-Nov-25	P	06:16(r)	0(r)	-	06:52:37	08	111	-	07:41:26	20	0.338	0.223	-
2053-Sep-12	P	11:45:57	78	-	12:58:08	81	305	-	14:07:11	65	0.311	0.2	-
2055-Jul-24	P	12:17:10	68	-	13:06:25	68	343	-	13:54:25	62	0.133	0.057	-

2059- Nov-05	P	10:35 :21	61	-	12:13: 16	76	17 7	-	13:56 :16	61	0.562	0.452	-
2060- Oct-24	P	10:16 :18	58	-	11:34: 57	75	13 7	-	13:02 :28	74	0.318	0.2	-
2064- Feb-17	P	07:04 :53	05	-	08:25: 07	24	10 3	-	10:02 :43	48	0.795	0.716	-
2067- Dec-06	P	17:55 :29	07	-	18:27(s)	0(s)	24 7	-	18:27 (s)	0(s)	0.34(s)	0.225 (s)	-
2070- Oct-04	P	07:24 :19	16	-	08:30: 20	32	09 4	-	09:46 :50	51	0.516	0.405	-
2074- Jan-27	P	06:59 :02	04	-	08:03: 24	19	10 9	-	09:18 :49	37	0.64	0.547	-
2081- Sep-03	P	12:02 :49	79	-	12:27: 06	81	00 8	-	12:51 :04	80	0.042	0.01	-
2086- Jun-11	P	14:02 :18	57	-	15:02: 57	46	30 6	-	15:57 :38	35	0.231	0.129	-
2092- Aug-03	P	11:27 :35	64	-	13:28: 32	68	32 7	-	15:14 :44	47	0.878	0.838	-
2095- Jun-02	P	11:47 :46	64	-	13:19: 50	64	33 4	-	14:49 :45	49	0.615	0.527	-
2100- Sep-04	P	09:56 :31	50	-	11:22: 24	71	06 4	-	12:51 :15	80	0.871	0.846	-

A time followed by "(r)" means the event is already in progress at sunrise, while a time followed by "(s)" means the event is still in progress at sunset. In such cases, the times and circumstances given are for sunrise or sunset, respectively.

One can predict eclipses many centuries top occur.

NB: Solar filters are available with me (Department of Technical and Applied Phjysics, Technical University of Kenya) for viewing the November 3 solar eclipse . Remember the time is 5.25 pm on Sunday