Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
Astronomical time converted to conventional BC/AD years.											
B.C. 1615 Apr 02	23:05	T	6	-0.307	2.323	1.297	107m	39m	11.8	11.89	0.4
A.D. 2004 Oct 28	03:04	T	136	0.285	2.390	1.313	110m	41m	2.5	2.18	13.4
A.D. 0033 Apr 03	14:47	P	71	-0.679	1.671	0.586	86m	-	12.7	12.69	-5.2

1615 BC, April 2 - 11:15 pm = Nisan 15; first contact – Moon contacts umbra
1615 BC, Apr 3 - 12:26 am = Nisan 15; second contact (totality begins)
1615 BC, Apr 3 - 1:05 am = Nisan 15; Moon at deepest eclipse
1615 BC, Apr 3 - 1:44 am = Nisan 15; third contact (totality ends)
1615 BC, Apr 3 - 2:55 am = Nisan 15; fourth contact – Moon leaves umbra

http://sunearth.gsfc.nasa.gov/eclipse/LEcat/LEcatalog.html

Lunar Eclipses: -1699 to -1600

(1700 BCE to 1601 BCE)

Fred Espenak

During the 17th century BCE[1], Earth experienced 247 lunar eclipses as follows:

All Eclipses =	247	= 100.0%
Penumbral (N) =	93	= 37.7%
Partial (P) =	87	= 35.2%
Total (T) =	67	= 27.1%

Eclipses in which some portion of the Moon passes into Earth 's umbral shadow are classified as umbral eclipses . All total and partial lunar eclipses are umbral eclipses. Statistics for umbral eclipses during the century are as follows:

Umbral (P&T) =	154	= 62.3%
Central[2] (T±) =	46	= 18.6%
Non-Central (T) =	21	= 8.5%

There are two to five lunar eclipses in each calendar year. The distribution of eclipses each year during this century are as follows:

Number of Years with 2 Eclipses:	63
Number of Years with 3 Eclipses:	27
Number of Years with 4 Eclipses:	10

When four consecutive lunar eclipses are all *total* eclipses, the group is known as a tetrad. The following tetrads occur during this century:

```
Tetrad (Four Consecutive Total Eclipses):  -1661 - -1660
Tetrad (Four Consecutive Total Eclipses):  -1643 - -1642
Tetrad (Four Consecutive Total Eclipses):  -1625 - -1624
```

During any given century, old Saros series end while new ones begin. The year and Saros number of these events are as follows:

```
    3 Saros Series' begin (Year/Saros):  -1691/ 32 -1662/ 33 -1633/ 34
    6 Saros Series' end   (Year/Saros):  -1685/-12 -1677/ -8 -1670/-14 -1641/-13 -
1630/ -7 -1619/ -6
```

The longest and shortest lunar eclipses of the century and other eclipse extrema are listed below.

```
    Longest  Total  Lunar Eclipse:   -1646 Jun 24    Duration = 01h46m48s
   Shortest  Total  Lunar Eclipse:   -1660 Sep 24    Duration = 00h22m24s
    Longest Partial Lunar Eclipse:   -1690 May 02    Duration = 03h28m04s
   Shortest Partial Lunar Eclipse:   -1687 Aug 24    Duration = 00h36m41s
    Largest  Total  Lunar Eclipse:   -1617 Jun 03    Umbra Magnitude = 1.8596
   Smallest  Total  Lunar Eclipse:   -1660 Sep 24    Umbra Magnitude = 1.0191
    Largest Partial Lunar Eclipse:   -1690 May 02    Umbra Magnitude = 0.9843
   Smallest Partial Lunar Eclipse:   -1687 Aug 24    Umbra Magnitude = 0.0234
  Largest Penumbral Lunar Eclipse:   -1699 May 11     Pen. Magnitude = 1.0844
 Smallest Penumbral Lunar Eclipse:   -1691 Jun 12     Pen. Magnitude = 0.0070
```

Total penumbral eclipses are lunar eclipses in which the entire Moon passes through the penumbra but misses the umbral shadow. Total penumbral eclipses (and magnitudes) for the century are:

```
Total Penumbral Eclipse:   -1699 May 11     Pen. Magnitude = 1.0844
Total Penumbral Eclipse:   -1669 Sep 05     Pen. Magnitude = 1.0454
Total Penumbral Eclipse:   -1651 Sep 15     Pen. Magnitude = 1.0046
Total Penumbral Eclipse:   -1604 Mar 13     Pen. Magnitude = 1.0748
```

Description of Lunar Eclipse Catalog

Local circumstances at greatest eclipse[3] for every event during the century are presented in the following catalog. The calendar date and Universal Time of the instant of greatest eclipse are found in the first two columns. The eclipse type is given (T=Total, P=Partial, or N=Penumbral) along with the Saros series. Gamma is the distance of the Moon's center from the shadow axis of Earth at greatest eclipse (in Earth radii). The penumbral and umbral magnitudes of the eclipse are defined as the fractions of the Moon's diameter obscured by each shadow at greatest eclipse. The semi-durations of the partial and total phases of the eclipse are given to the nearest minute. Finally, the Greenwich Sidereal Time at 00:00 U.T., along with the Moon's Geocentric Right Ascension and Declination at greatest eclipse complete each record. For a detailed key and additional information about the catalog, see: Key to Catalog of Lunar Eclipses.

For any eclipse in the catalog, the start and end times of the partial eclipse phases can be calculated by respectively subtracting and adding the semi-duration of the partial phase (S.D. Par) to the instant of greatest eclipse. Similarly, the start and end times of the total eclipse can be calculated by either subtracting or adding the semi-duration of the total phase (S.D. Tot) to the instant of greatest eclipse. For a detailed example, see Contact - Key to Lunar Eclipse Catalogs.

To determine whether an eclipse is visible from a specific geographic location, it is simply a matter of calculating the Moon's altitude and azimuth during each phase of the eclipse. The calculations can be

performed on any pocket calculator having trigonometric functions (SIN, COS, TAN). Armed with the latitude and longitude of the location, the lunar eclipse catalog provides all the additional information needed to make the calculations. For the equations and an example of how to calculate the Moon's altitude for a specific location, see Altitude - Key to Lunar Eclipse Catalogs.

Footnotes

[1]The terms BCE and CE are abbreviations for "Before Common Era" and "Common Era," respectively. They are the secular equivalents to the BC and AD dating conventions. (See: Year Dating Conventions)

[2]Central lunar eclipses are eclipses in which some portion of the Moon passes the central axis of Earth's umbral shadow. All penumbral and partial lunar eclipses are non-central eclipses since the Moon misses the shadow axis. However, total eclipses may be either non-central (frequently) or central (occasionally). Central total eclipses are longer and usually darker than non-central total eclipses.

[3]Greatest eclipse is defined as the instant when the Moon passes closest to the axis of Earth's shadow. The instant of greatest eclipse corresponds to the maximum phase of the eclipse.

Lunar Eclipses: -1699 to -1600

(1700 BCE to 1601 BCE)

Local Circumstances at Greatest Eclipse: -1699 to -1600

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
-1619 Jun 25	01:02	Ne	-6	-1.566	0.048	-1.046	-	-	17.2	17.11	-24.7
-1619 Jul 24	16:28	N	32	1.305	0.525	-0.567	-	-	19.2	19.17	-21.7
-1619 Dec 19	12:38	P	-1	0.813	1.378	0.386	64m	-	4.9	4.92	23.9
-1618 Jun 14	02:16	P	4	-0.799	1.443	0.373	70m	-	16.5	16.34	-22.6
-1618 Dec 09	02:35	T-	9	0.149	2.615	1.583	108m	48m	4.2	4.14	21.5
-1617 Jun 03	09:29	T-	14	0.003	2.875	1.860	111m	52m	15.8	15.62	-19.8
-1617 Nov 28	10:27	P	19	-0.567	1.880	0.788	94m	-	3.5	3.38	18.4
-1616 May 22	23:31	P	24	0.753	1.476	0.507	73m	-	15.1	14.94	-16.3
-1616 Nov 16	11:17	N	29	-1.269	0.609	-0.520	-	-	2.8	2.63	14.5
-1615 Apr 13	09:50	N	-4	-1.033	0.965	-0.010	-	-	12.5	12.50	-4.5
-1615 May 12	16:46	N	34	1.466	0.163	-0.797	-	-	14.4	14.30	-12.5
-1615 Oct 06	17:38	N	1	1.066	0.957	-0.123	-	-	0.1	23.97	0.9
-1614 Apr 02	23:05	T	6	-0.307	2.323	1.297	107m	39m	11.8	11.89	0.4
-1614 Sep 26	02:47	T	11	0.320	2.296	1.277	103m	37m	23.3	23.32	-4.2
-1613 Mar 23	05:13	P	16	0.469	2.054	0.972	103m	-	11.1	11.26	5.3
-1613 Sep 15	17:34	T	21	-0.373	2.180	1.197	99m	31m	22.7	22.67	-9.0
-1612 Mar 11	05:48	N	26	1.217	0.691	-0.409	-	-	10.3	10.60	10.2
-1612 Sep 04	09:33	N	31	-1.066	0.914	-0.079	-	-	22.0	22.01	-13.5
-1611 Jan 29	18:28	P	-2	-0.915	1.218	0.170	47m	-	7.6	7.93	20.3
-1611 Jul 26	09:22	P	3	0.910	1.235	0.174	49m	-	19.3	19.31	-21.8

-1610 Jan 19	06:23	T+	8	-0.168	2.564	1.565	106m	47m	6.9	7.17	22.7
-1610 Jul 15	12:05	T-	13	0.176	2.598	1.503	116m	49m	18.6	18.53	-23.5
-1609 Jan 08	22:07	P	18	0.514	1.922	0.937	91m	-	6.2	6.40	24.3
-1609 Jul 04	12:35	P	23	-0.573	1.865	0.782	96m	-	17.8	17.74	-24.4
-1609 Nov 30	00:14	N	-10	-1.563	0.031	-1.020	-	-	3.6	3.52	17.9
-1609 Dec 29	13:04	N	28	1.217	0.650	-0.367	-	-	5.5	5.61	25.0
-1608 May 24	08:29	N	-5	1.331	0.431	-0.569	-	-	15.2	15.05	-16.3
-1608 Jun 22	18:07	N	33	-1.294	0.514	-0.517	-	-	17.1	16.96	-24.3
-1608 Nov 18	05:55	P	0	-0.944	1.196	0.088	36m	-	2.9	2.75	15.4
-1607 May 13	23:53	P	5	0.546	1.853	0.891	90m	-	14.5	14.37	-13.9
-1607 Nov 07	05:32	T	10	-0.280	2.425	1.296	113m	41m	2.1	1.99	12.2
-1606 May 03	17:10	T+	15	-0.195	2.498	1.532	105m	46m	13.8	13.71	-11.1
-1606 Oct 27	05:58	T	20	0.404	2.180	1.083	105m	23m	1.4	1.25	8.5
-1605 Apr 23	07:40	P	25	-0.982	1.077	0.066	29m	-	13.1	13.05	-7.9
-1605 Oct 16	13:15	N	30	1.066	0.935	-0.101	-	-	0.7	0.54	4.7
-1604 Mar 13	01:07	N	-3	1.006	1.075	-0.019	-	-	10.4	10.72	9.3
-1604 Sep 05	17:09	P	2	-0.951	1.119	0.139	40m	-	22.0	22.11	-12.9
-1603 Mar 02	01:14	T-	7	0.272	2.423	1.325	113m	42m	9.7	10.01	12.7
-1603 Aug 26	08:44	T+	12	-0.270	2.380	1.377	104m	41m	21.3	21.41	-15.8
-1602 Feb 19	04:53	P	17	-0.471	2.037	0.981	100m	-	9.0	9.29	15.6
-1602 Aug 15	19:39	P	22	0.476	2.028	0.973	100m	-	20.6	20.68	-18.2
-1601 Jan 10	05:32	N	-11	1.484	0.146	-0.846	-	-	6.3	6.52	25.2
-1601 Feb 08	15:38	N	27	-1.160	0.746	-0.258	-	-	8.3	8.56	18.0
-1601 Aug 04	23:28	N	32	1.247	0.633	-0.464	-	-	19.9	19.92	-20.1
-1601 Dec 30	21:28	P	-1	0.821	1.363	0.372	63m	-	5.6	5.73	24.7
-1600 Jun 24	08:58	P	4	-0.876	1.300	0.231	56m	-	17.2	17.09	-24.1
-1600 Dec 19	11:17	T-	9	0.153	2.610	1.576	108m	48m	4.9	4.94	23.2

Calendar Dates

The Julian calendar is used for all dates up to 1582 Oct 04. After that date, the Gregorian calendar is used. Due to the Gregorian Calendar reform, the day after 1582 Oct 04 (Julian calendar) is 1582 Oct 15 (Gregorian calendar). Note that Great Britian did not adopt the Gregorian calendar until 1752. For more information, see Calendars.

The Julian calendar does not include the year 0, so the year 1 BCE is followed by the year 1 CE. This is awkward for arithmetic calculations. In this catalog, dates are counted using the astronomical numbering system which recognizes the year 0. Historians should note the numerical difference of one year between astronomical dates and BCE dates. Thus, the year 0 corresponds to 1 BCE, and the year -100 corresponds to 101 BCE, etc.. (See: Year Dating Conventions)

There is some historical uncertainty as to which years from 43 BCE to 8 CE were counted as leap years. For the purposes of this catalog, we will assume that *all* Julian years divisible by 4 will be counted as leap years.

Predictions

Eclipse predictions presented here are based on j=2 ephemerides for the Sun (Newcomb, 1895) and Moon (Brown, 1919, and Eckert, Jones and Clark, 1954). A revised value used for the Moon's secular acceleration is n-dot = -26 arc-sec/cy*cy, as deduced by Morrison and Ward (1975) from 250 years of Mercury transit observations.

The largest uncertainty in the eclipse predictions is caused by fluctuations in Earth's rotation due primarily to tidal friction of the Moon. The resultant drift in apparent clock time is expressed as *delta-T*. The value for *delta-T* was determined as follows:

1) pre-1600: delta T was calculated from empirical fits to historical records derived by Stephenson (1997)
2) 1600-present: delta T was obtained from published observations
3) future: delta-T was extrapolated from current values and a model of tidal effects

Acknowledgments

All eclipse calculations are by Fred Espenak, and he assumes full responsibility for their accuracy. Some of the information presented in these tables is based on *Fifty Year Canon of Lunar Eclipses: 1986 - 2035*.

Lunar Eclipses: 0001 to 0100

(1 CE to 100 CE)

Fred Espenak

During the 1st century CE[1], Earth experienced 255 lunar eclipses as follows:

All Eclipses =	255	= 100.0%
Penumbral (N) =	96	= 37.6%
Partial (P) =	101	= 39.6%
Total (T) =	58	= 22.7%

Eclipses in which some portion of the Moon passes into Earth 's umbral shadow are classified as umbral eclipses . All total and partial lunar eclipses are umbral eclipses. Statistics for umbral eclipses during the century are as follows:

```
Umbral (P&T) =  159  =  62.4%

Central[2] (T±) =   50  =  19.6%
Non-Central (T) =    8  =   3.1%
```

There are two to five lunar eclipses in each calendar year. The distribution of eclipses each year during this century are as follows:

```
                Number of Years with 2 Eclipses: 65
                Number of Years with 3 Eclipses: 16
                Number of Years with 4 Eclipses: 18
                Number of Years with 5 Eclipses:  1  (   74)
Two eclipses in same month:    0019 Dec 01  &   0019 Dec 30
Two eclipses in same month:    0074 Jan 02  &   0074 Jan 31
```

During any given century, old Saros series end while new ones begin. The year and Saros number of these events are as follows:

```
    3 Saros Series' begin (Year/Saros):      9/ 87    38/ 88    67/ 89
    5 Saros Series' end   (Year/Saros):     12/ 46    30/ 41    59/ 42    70/ 43
81/ 49
```

The longest and shortest lunar eclipses of the century and other eclipse extrema are listed below.

```
 Longest  Total  Lunar Eclipse:    0054 Aug 07    Duration = 01h46m43s
Shortest  Total  Lunar Eclipse:    0087 May 06    Duration = 00h06m26s
 Longest Partial Lunar Eclipse:    0010 Jun 15    Duration = 03h22m01s
Shortest Partial Lunar Eclipse:    0012 May 24    Duration = 00h20m00s
 Largest  Total  Lunar Eclipse:    0007 Aug 17    Umbra Magnitude = 1.8582
Smallest  Total  Lunar Eclipse:    0087 May 06    Umbra Magnitude = 1.0015
 Largest Partial Lunar Eclipse:    0075 Jun 17    Umbra Magnitude = 0.9951
Smallest Partial Lunar Eclipse:    0012 May 24    Umbra Magnitude = 0.0082
Largest Penumbral Lunar Eclipse:   0096 Apr 26     Pen. Magnitude = 1.0477
Smallest Penumbral Lunar Eclipse:  0070 Mar 15     Pen. Magnitude = 0.0157
```

Total penumbral eclipses are lunar eclipses in which the entire Moon passes through the penumbra but misses the umbral shadow. Total penumbral eclipses (and magnitudes) for the century are:

```
Total Penumbral Eclipse:    0096 Apr 26     Pen. Magnitude = 1.0477
```

Description of Lunar Eclipse Catalog

Local circumstances at greatest eclipse[3] for every event during the century are presented in the following catalog. The calendar date and Universal Time of the instant of greatest eclipse are found in the first two columns. The eclipse type is given (T=Total, P=Partial, or N=Penumbral) along with the Saros series. Gamma is the distance of the Moon's center from the shadow axis of Earth at greatest eclipse (in Earth radii). The penumbral and umbral magnitudes of the eclipse are defined as the fractions of the Moon's diameter obscured by each shadow at greatest eclipse. The semi-durations of the partial and total phases of the eclipse are given to the nearest minute. Finally, the Greenwich Sidereal Time at 00:00 U.T., along with the Moon's Geocentric Right Ascension and Declination at greatest eclipse complete each record. For a detailed key and additional information about the catalog, see: Key to Catalog of Lunar Eclipses.

For any eclipse in the catalog, the start and end times of the partial eclipse phases can be calculated by respectively subtracting and adding the semi-duration of the partial phase (S.D. Par) to the instant of greatest

eclipse. Similarly, the start and end times of the total eclipse can be calculated by either subtracting or adding the semi-duration of the total phase (S.D. Tot) to the instant of greatest eclipse. For a detailed example, see Contact - Key to Lunar Eclipse Catalogs.

To determine whether an eclipse is visible from a specific geographic location, it is simply a matter of calculating the Moon's altitude and azimuth during each phase of the eclipse. The calculations can be performed on any pocket calculator having trigonometric functions (SIN, COS, TAN). Armed with the latitude and longitude of the location, the lunar eclipse catalog provides all the additional information needed to make the calculations. For the equations and an example of how to calculate the Moon's altitude for a specific location, see Altitude - Key to Lunar Eclipse Catalogs.

Footnotes

[1]The terms BCE and CE are abbreviations for "Before Common Era" and "Common Era," respectively. They are the secular equivalents to the BC and AD dating conventions. (See: Year Dating Conventions)

[2]Central lunar eclipses are eclipses in which some portion of the Moon passes the central axis of Earth's umbral shadow. All penumbral and partial lunar eclipses are non-central eclipses since the Moon misses the shadow axis. However, total eclipses may be either non-central (frequently) or central (occasionally). Central total eclipses are longer and usually darker than non-central total eclipses.

[3]Greatest eclipse is defined as the instant when the Moon passes closest to the axis of Earth's shadow. The instant of greatest eclipse corresponds to the maximum phase of the eclipse.

Lunar Eclipses: 0001 to 0100

(1 CE to 100 CE)

Local Circumstances at Greatest Eclipse: 0001 to 0100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
0001 Jun 24	09:12	P	78	0.963	1.148	0.066	31m	-	18.0	17.96	-22.8
0001 Nov 19	16:35	N	45	1.379	0.367	-0.680	-	-	3.8	3.56	20.8
0001 Dec 19	05:26	N	83	-1.399	0.316	-0.702	-	-	5.7	5.71	22.2
0002 May 15	04:28	P	50	-0.976	1.085	0.080	32m	-	15.4	15.22	-19.1
0002 Nov 08	22:42	P	55	0.743	1.562	0.459	77m	-	3.0	2.81	17.1
0003 May 04	19:26	T+	60	-0.196	2.496	1.530	105m	46m	14.7	14.56	-15.4
0003 Oct 28	22:37	T-	65	0.067	2.814	1.688	118m	52m	2.3	2.07	12.8
0004 Apr 23	12:35	P	70	0.538	1.870	0.903	91m	-	14.0	13.92	-11.3
0004 Oct 16	23:02	P	75	-0.620	1.784	0.690	90m	-	1.6	1.37	8.1
0005 Mar 14	16:11	N	42	-1.379	0.368	-0.681	-	-	11.3	11.48	2.0
0005 Apr 13	03:17	N	80	1.317	0.463	-0.549	-	-	13.3	13.29	-6.9
0005 Sep 06	19:03	N	47	1.417	0.272	-0.727	-	-	22.9	22.84	-5.9

0005 Oct 06	06:08	N	85	-1.278	0.545	-0.489	-	-	0.8	0.70	3.2
0006 Mar 03	20:22	P	52	-0.691	1.655	0.555	84m	-	10.6	10.83	6.9
0006 Aug 27	10:57	P	57	0.697	1.581	0.608	78m	-	22.2	22.21	-10.5
0007 Feb 20	20:08	T-	62	0.024	2.883	1.775	118m	53m	9.9	10.14	11.6
0007 Aug 17	03:03	Tm	67	-0.010	2.850	1.858	108m	50m	21.5	21.55	-14.7
0008 Feb 09	23:00	P	72	0.734	1.560	0.493	77m	-	9.1	9.44	16.0
0008 Aug 05	14:45	P	77	-0.784	1.456	0.414	71m	-	20.8	20.87	-18.6
0008 Dec 30	22:00	N	44	-1.306	0.476	-0.522	-	-	6.5	6.61	22.1
0009 Jan 29	08:59	N	82	1.387	0.336	-0.678	-	-	8.4	8.72	19.8
0009 Jun 26	04:20	N	49	1.271	0.587	-0.504	-	-	18.1	18.10	-22.5
0009 Jul 25	19:24	Nb	87	-1.580	0.019	-1.069	-	-	20.1	20.14	-21.8
0009 Dec 20	13:41	P	54	-0.644	1.688	0.694	82m	-	5.8	5.83	23.0
0010 Jun 15	05:34	P	59	0.499	1.992	0.922	101m	-	17.4	17.33	-22.9
0010 Dec 10	03:34	T-	64	0.025	2.844	1.811	109m	50m	5.1	5.03	23.0
0011 Jun 04	12:41	T	69	-0.292	2.345	1.329	107m	41m	16.7	16.57	-22.5
0011 Nov 29	11:24	P	74	0.749	1.546	0.453	76m	-	4.4	4.23	22.1
0012 Apr 24	19:44	N	41	1.472	0.154	-0.809	-	-	14.1	14.04	-11.0
0012 May 24	02:38	P	79	-1.025	0.978	0.008	10m	-	16.0	15.83	-21.4
0012 Oct 18	17:06	Ne	46	-1.589	0.018	-1.103	-	-	1.7	1.51	8.1
0012 Nov 17	12:17	N	84	1.455	0.267	-0.861	-	-	3.6	3.41	20.2
0013 Apr 14	12:37	P	51	0.774	1.443	0.465	71m	-	13.4	13.38	-8.0
0013 Oct 07	19:05	P	56	-0.858	1.338	0.261	59m	-	0.9	0.80	4.3
0014 Apr 04	01:47	T-	61	0.037	2.821	1.791	112m	51m	12.7	12.71	-4.6
0014 Sep 27	04:24	T+	66	-0.109	2.682	1.666	108m	49m	0.2	0.11	0.6
0015 Mar 24	07:49	P	71	-0.742	1.554	0.469	78m	-	11.9	12.04	-1.0
0015 Sep 16	19:23	P	76	0.587	1.785	0.805	87m	-	23.5	23.44	-3.0
0016 Feb 11	15:24	N	43	1.460	0.246	-0.856	-	-	9.2	9.58	16.0
0016 Mar 12	08:15	N	81	-1.479	0.213	-0.892	-	-	11.2	11.35	2.8
0016 Aug 07	02:18	N	48	-1.326	0.442	-0.561	-	-	20.9	21.00	-18.6
0016 Sep 05	11:36	N	86	1.288	0.505	-0.484	-	-	22.8	22.77	-6.5
0017 Jan 30	20:03	P	53	0.700	1.616	0.563	80m	-	8.5	8.83	18.6
0017 Jul 27	12:14	P	58	-0.625	1.754	0.698	90m	-	20.2	20.26	-20.6
0018 Jan 20	07:45	T+	63	-0.030	2.820	1.817	107m	50m	7.8	8.07	20.6
0018 Jul 16	15:11	T-	68	0.129	2.683	1.591	117m	51m	19.5	19.49	-22.0
0019 Jan 09	23:20	P	73	-0.701	1.582	0.594	77m	-	7.1	7.30	21.8
0019 Jul 05	15:47	P	78	0.880	1.300	0.219	56m	-	18.7	18.72	-22.5
0019 Dec 01	01:12	N	45	1.385	0.358	-0.692	-	-	4.5	4.35	23.1
0019 Dec 30	14:10	N	83	-1.398	0.318	-0.701	-	-	6.4	6.52	22.1

Lunar Eclipses: 0001 to 0100

(1 CE to 100 CE)

Local Circumstances at Greatest Eclipse: 0001 to 0100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
0020 May 25	11:39	N	50	-1.047	0.952	-0.048	-	-	16.1	15.94	-21.7
0020 Nov 19	06:55	P	55	0.749	1.552	0.445	76m	-	3.8	3.57	20.1

0021	May 15	02:54	T+	60	-0.269	2.362	1.398	103m	42m	15.4	15.25	-18.6
0021	Nov 08	06:35	T-	65	0.077	2.797	1.669	118m	52m	3.0	2.80	16.4
0022	May 04	20:07	T	70	0.469	1.996	1.028	95m	13m	14.7	14.59	-14.9
0022	Oct 28	07:08	P	75	-0.606	1.809	0.715	91m	-	2.3	2.07	12.1
0023	Mar 25	23:37	N	42	-1.436	0.263	-0.786	-	-	12.0	12.14	-2.4
0023	Apr 24	10:36	N	80	1.256	0.576	-0.437	-	-	14.0	13.95	-10.8
0023	Sep 18	03:14	N	47	1.445	0.222	-0.777	-	-	23.6	23.51	-1.6
0023	Oct 17	14:33	N	85	-1.260	0.579	-0.455	-	-	1.6	1.38	7.5
0024	Mar 14	03:34	P	52	-0.743	1.559	0.461	78m	-	11.3	11.49	2.6
0024	Sep 06	19:07	P	57	0.736	1.510	0.534	74m	-	22.9	22.88	-6.4
0025	Mar 03	03:28	Tm	62	-0.019	2.890	1.787	118m	53m	10.6	10.82	7.6
0025	Aug 27	10:55	T-	67	0.037	2.805	1.807	108m	50m	22.2	22.24	-11.0
0026	Feb 20	06:50	P	72	0.701	1.618	0.558	81m	-	9.9	10.14	12.3
0026	Aug 16	22:07	P	77	-0.730	1.559	0.510	78m	-	21.5	21.58	-15.3
0027	Jan 11	06:46	N	44	-1.311	0.465	-0.530	-	-	7.2	7.40	20.9
0027	Feb 09	17:20	N	82	1.362	0.378	-0.630	-	-	9.1	9.46	16.6
0027	Jul 07	10:49	N	49	1.353	0.438	-0.656	-	-	18.9	18.85	-21.9
0027	Aug 06	02:13	N	87	-1.515	0.139	-0.953	-	-	20.8	20.87	-19.2
0027	Dec 31	22:32	P	54	-0.650	1.678	0.685	82m	-	6.5	6.64	22.7
0028	Jun 25	12:11	P	59	0.581	1.841	0.773	95m	-	18.1	18.08	-23.2
0028	Dec 20	12:16	T-	64	0.023	2.849	1.813	110m	50m	5.8	5.85	23.7
0029	Jun 14	19:45	T+	69	-0.212	2.490	1.477	109m	46m	17.4	17.32	-23.6
0029	Dec 09	19:44	P	74	0.747	1.550	0.455	76m	-	5.1	5.03	23.7
0030	May 06	03:18	Ne	41	1.537	0.032	-0.928	-	-	14.8	14.72	-14.3
0030	Jun 04	10:03	P	79	-0.949	1.115	0.148	41m	-	16.7	16.57	-23.2
0030	Nov 28	20:20	N	84	1.450	0.279	-0.850	-	-	4.4	4.20	22.7
0031	Apr 25	20:11	P	51	0.841	1.319	0.340	62m	-	14.1	14.04	-11.7
0031	Oct 19	03:13	P	56	-0.872	1.311	0.235	56m	-	1.7	1.48	8.5
0032	Apr 14	09:05	T-	61	0.102	2.701	1.670	112m	51m	13.4	13.37	-8.7
0032	Oct 07	12:47	T+	66	-0.130	2.643	1.627	108m	48m	1.0	0.78	5.0
0033	Apr 03	14:47	P	71	-0.679	1.671	0.586	86m	-	12.7	12.69	-5.2
0033	Sep 27	03:49	P	76	0.560	1.837	0.855	89m	-	0.3	0.11	1.3
0034	Feb 21	22:53	N	43	1.494	0.180	-0.917	-	-	10.0	10.28	12.2
0034	Mar 23	15:12	N	81	-1.419	0.321	-0.780	-	-	11.9	12.00	-1.4
0034	Aug 18	09:59	N	48	-1.382	0.343	-0.666	-	-	21.6	21.70	-15.4
0034	Sep 16	19:48	N	86	1.257	0.563	-0.430	-	-	23.6	23.44	-2.3
0035	Feb 11	04:07	P	53	0.723	1.570	0.523	78m	-	9.2	9.56	15.4
0035	Aug 07	19:21	P	58	-0.692	1.635	0.573	83m	-	20.9	20.99	-18.0
0036	Jan 31	16:17	T+	63	-0.012	2.850	1.851	107m	50m	8.5	8.82	17.9
0036	Jul 26	21:49	Tm	68	0.053	2.825	1.729	118m	53m	20.2	20.23	-20.0
0037	Jan 20	08:04	P	73	-0.690	1.601	0.615	78m	-	7.8	8.08	19.9
0037	Jul 15	22:26	P	78	0.799	1.448	0.368	70m	-	19.4	19.46	-21.4
0037	Dec 11	09:50	N	45	1.389	0.352	-0.701	-	-	5.2	5.16	24.5
0038	Jan 09	22:50	N	83	-1.395	0.323	-0.697	-	-	7.1	7.31	21.1
0038	Jun 05	18:50	N	50	-1.119	0.819	-0.178	-	-	16.8	16.69	-23.5
0038	Jul 05	04:19	Nb	88	1.506	0.125	-0.903	-	-	18.7	18.70	-21.9
0038	Nov 30	15:08	P	55	0.755	1.544	0.434	75m	-	4.5	4.35	22.4
0039	May 26	10:23	T	60	-0.341	2.227	1.266	100m	36m	16.1	15.97	-21.1

(1 CE to 100 CE)

Local Circumstances at Greatest Eclipse: 0001 to 0100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
0039 Nov 19	14:37	Tm	65	0.084	2.784	1.656	117m	52m	3.7	3.55	19.5
0040 May 15	03:37	T	70	0.399	2.126	1.157	99m	29m	15.4	15.29	-18.0
0040 Nov 07	15:21	P	75	-0.596	1.827	0.734	92m	-	3.0	2.79	15.7
0041 Apr 05	06:54	N	42	-1.499	0.148	-0.902	-	-	12.8	12.78	-6.6
0041 May 04	17:50	N	80	1.190	0.697	-0.317	-	-	14.7	14.62	-14.3
0041 Sep 28	11:35	N	47	1.466	0.184	-0.816	-	-	0.3	0.18	2.8
0041 Oct 27	23:04	N	85	-1.246	0.604	-0.429	-	-	2.3	2.08	11.5
0042 Mar 25	10:34	P	52	-0.804	1.448	0.351	69m	-	12.0	12.14	-1.7
0042 Sep 18	03:25	P	57	0.768	1.453	0.474	70m	-	23.7	23.55	-2.1
0043 Mar 14	10:38	T+	62	-0.070	2.793	1.696	117m	52m	11.3	11.48	3.3
0043 Sep 07	18:55	T-	67	0.077	2.734	1.731	108m	50m	23.0	22.92	-6.9
0044 Mar 02	14:32	P	72	0.660	1.690	0.636	85m	-	10.6	10.83	8.2
0044 Aug 27	05:35	P	77	-0.682	1.650	0.595	83m	-	22.2	22.27	-11.6
0045 Jan 21	15:26	N	44	-1.322	0.444	-0.548	-	-	7.9	8.18	18.9
0045 Feb 20	01:33	N	82	1.330	0.433	-0.569	-	-	9.9	10.17	12.9
0045 Jul 17	17:21	N	49	1.432	0.294	-0.801	-	-	19.6	19.60	-20.6
0045 Aug 16	09:08	N	87	-1.456	0.251	-0.847	-	-	21.5	21.58	-16.0
0046 Jan 11	07:20	P	54	-0.659	1.661	0.668	81m	-	7.2	7.44	21.5
0046 Jul 06	18:54	P	59	0.660	1.696	0.629	87m	-	18.8	18.84	-22.6
0046 Dec 31	20:54	T-	64	0.018	2.858	1.821	110m	51m	6.5	6.66	23.4
0047 Jun 26	02:53	T+	69	-0.135	2.631	1.620	110m	49m	18.1	18.08	-23.8
0047 Dec 21	04:03	P	74	0.746	1.554	0.457	76m	-	5.8	5.84	24.4
0048 Jun 14	17:28	P	79	-0.873	1.255	0.288	57m	-	17.4	17.33	-24.3
0048 Dec 09	04:26	N	84	1.445	0.286	-0.843	-	-	5.1	5.00	24.3
0049 May 06	03:39	P	51	0.913	1.187	0.208	49m	-	14.8	14.72	-15.1
0049 Oct 29	11:28	P	56	-0.881	1.294	0.219	54m	-	2.4	2.19	12.5
0050 Apr 25	16:15	T-	61	0.174	2.570	1.538	111m	48m	14.1	14.04	-12.4
0050 Oct 18	21:18	T+	66	-0.145	2.615	1.599	107m	48m	1.7	1.47	9.2
0051 Apr 14	21:38	P	71	-0.609	1.797	0.713	93m	-	13.4	13.35	-9.2
0051 Oct 08	12:21	P	76	0.537	1.879	0.895	90m	-	1.0	0.78	5.7
0052 Mar 04	06:17	N	43	1.534	0.105	-0.986	-	-	10.7	10.96	8.2
0052 Apr 02	22:04	N	81	-1.354	0.437	-0.659	-	-	12.6	12.65	-5.6
0052 Aug 28	17:46	N	48	-1.432	0.254	-0.761	-	-	22.3	22.40	-11.7
0052 Sep 27	04:06	N	86	1.232	0.612	-0.387	-	-	0.3	0.11	2.1
0053 Feb 21	12:04	P	53	0.753	1.512	0.472	74m	-	10.0	10.26	11.7
0053 Aug 18	02:34	P	58	-0.753	1.527	0.459	76m	-	21.6	21.69	-14.7
0054 Feb 11	00:41	T-	63	0.012	2.848	1.855	107m	50m	9.3	9.55	14.7
0054 Aug 07	04:36	T+	68	-0.017	2.892	1.792	118m	53m	20.9	20.96	-17.4
0055 Jan 31	16:40	P	73	-0.672	1.632	0.648	80m	-	8.6	8.83	17.2
0055 Jul 27	05:14	P	78	0.724	1.585	0.504	80m	-	20.2	20.20	-19.5
0055 Dec 22	18:24	N	45	1.396	0.341	-0.715	-	-	5.9	5.98	25.0
0056 Jan 21	07:23	N	83	-1.388	0.338	-0.683	-	-	7.9	8.09	19.1
0056 Jun 16	02:03	N	50	-1.190	0.687	-0.308	-	-	17.5	17.44	-24.6
0056 Jul 15	11:28	N	88	1.430	0.262	-0.764	-	-	19.4	19.45	-20.8

0056 Dec 10	23:21	P	55	0.760	1.536	0.424	75m	-	5.2	5.16	23.9
0057 Jun 05	17:50	T	60	-0.416	2.090	1.129	97m	26m	16.8	16.71	-22.9
0057 Nov 29	22:42	T-	65	0.089	2.775	1.647	117m	52m	4.5	4.33	21.8
0058 May 26	11:01	T	70	0.325	2.262	1.293	102m	37m	16.1	16.01	-20.5
0058 Nov 18	23:39	P	75	-0.590	1.836	0.745	92m	-	3.7	3.54	18.8
0059 Apr 16	14:02	Ne	42	-1.568	0.021	-1.029	-	-	13.5	13.44	-10.8

Lunar Eclipses: 0001 to 0100

(1 CE to 100 CE)

Local Circumstances at Greatest Eclipse: 0001 to 0100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
0059 May 16	00:58	N	80	1.121	0.826	-0.191	-	-	15.4	15.32	-17.4
0059 Oct 09	20:03	N	47	1.481	0.156	-0.845	-	-	1.1	0.86	7.2
0059 Nov 08	07:41	N	85	-1.237	0.620	-0.411	-	-	3.0	2.80	15.1
0060 Apr 04	17:26	P	52	-0.870	1.325	0.231	57m	-	12.8	12.79	-6.0
0060 Sep 28	11:51	P	57	0.794	1.407	0.425	67m	-	0.4	0.22	2.3
0061 Mar 24	17:40	T+	62	-0.129	2.684	1.591	116m	51m	12.0	12.13	-1.0
0061 Sep 18	03:02	T-	67	0.110	2.675	1.666	108m	49m	23.7	23.59	-2.6
0062 Mar 13	22:07	P	72	0.613	1.773	0.726	90m	-	11.3	11.49	4.0
0062 Sep 07	13:10	P	77	-0.640	1.730	0.667	88m	-	23.0	22.94	-7.5
0063 Feb 02	00:00	N	44	-1.337	0.413	-0.575	-	-	8.7	8.93	16.1
0063 Mar 03	09:39	N	82	1.293	0.499	-0.497	-	-	10.6	10.85	8.8
0063 Jul 29	00:00	N	49	1.504	0.164	-0.934	-	-	20.3	20.33	-18.4
0063 Aug 27	16:12	N	87	-1.404	0.349	-0.753	-	-	22.2	22.27	-12.2
0064 Jan 22	16:02	P	54	-0.671	1.637	0.645	80m	-	8.0	8.21	19.5
0064 Jul 17	01:43	P	59	0.734	1.559	0.493	79m	-	19.6	19.58	-21.2
0065 Jan 11	05:27	T-	64	0.011	2.873	1.835	110m	51m	7.3	7.46	22.2
0065 Jul 06	10:06	T+	69	-0.061	2.766	1.758	110m	51m	18.8	18.84	-23.2
0065 Dec 31	12:16	P	74	0.740	1.564	0.466	77m	-	6.5	6.66	24.1
0066 Jun 26	00:56	P	79	-0.799	1.390	0.424	67m	-	18.1	18.10	-24.5
0066 Dec 20	12:29	N	84	1.439	0.297	-0.831	-	-	5.8	5.82	25.0
0067 May 17	11:03	P	51	0.988	1.051	0.070	29m	-	15.5	15.42	-17.9
0067 Jun 15	18:12	Nb	89	-1.517	0.072	-0.892	-	-	17.4	17.35	-24.9
0067 Nov 09	19:49	P	56	-0.887	1.283	0.209	52m	-	3.1	2.91	16.0
0068 May 05	23:19	T-	61	0.250	2.431	1.397	109m	44m	14.8	14.72	-15.7
0068 Oct 29	05:56	T+	66	-0.155	2.596	1.582	107m	47m	2.4	2.18	13.2
0069 Apr 25	04:19	P	71	-0.532	1.939	0.855	99m	-	14.1	14.01	-13.0
0069 Oct 18	21:01	P	76	0.522	1.909	0.922	91m	-	1.7	1.47	9.9
0070 Mar 15	13:32	Ne	43	1.581	0.016	-1.069	-	-	11.4	11.63	4.0
0070 Apr 14	04:47	N	81	-1.282	0.568	-0.524	-	-	13.4	13.31	-9.6
0070 Sep 09	01:41	N	48	-1.474	0.178	-0.843	-	-	23.1	23.07	-7.6
0070 Oct 08	12:33	N	86	1.214	0.647	-0.356	-	-	1.0	0.79	6.4
0071 Mar 04	19:53	P	53	0.790	1.441	0.408	70m	-	10.7	10.94	7.7
0071 Aug 29	09:54	P	58	-0.806	1.432	0.357	68m	-	22.4	22.38	-11.0
0072 Feb 22	08:59	T-	63	0.041	2.791	1.803	107m	50m	10.0	10.26	11.0

0072 Aug 17	11:29	T+	68	-0.082	2.775	1.671	118m	52m	21.6	21.66	-14.2
0073 Feb 11	01:10	P	73	-0.650	1.672	0.690	82m	-	9.3	9.56	14.0
0073 Aug 06	12:09	P	78	0.654	1.714	0.632	88m	-	20.9	20.92	-16.9
0074 Jan 02	02:55	N	45	1.405	0.325	-0.732	-	-	6.6	6.80	24.6
0074 Jan 31	15:49	N	83	-1.375	0.361	-0.659	-	-	8.6	8.84	16.5
0074 Jun 27	09:19	N	50	-1.259	0.559	-0.433	-	-	18.2	18.21	-24.9
0074 Jul 26	18:44	N	88	1.360	0.391	-0.634	-	-	20.2	20.18	-18.9
0074 Dec 22	07:33	P	55	0.766	1.525	0.412	74m	-	5.9	5.97	24.4
0075 Jun 17	01:19	P	60	-0.489	1.955	0.995	94m	-	17.5	17.47	-24.0
0075 Dec 11	06:46	T-	65	0.094	2.765	1.637	117m	51m	5.2	5.13	23.2
0076 Jun 05	18:26	T-	70	0.251	2.399	1.427	104m	43m	16.8	16.74	-22.3
0076 Nov 29	08:01	P	75	-0.586	1.843	0.754	92m	-	4.4	4.32	21.1
0077 May 26	08:02	N	80	1.048	0.960	-0.060	-	-	16.1	16.03	-19.9
0077 Oct 20	04:40	N	47	1.491	0.138	-0.863	-	-	1.8	1.55	11.4
0077 Nov 18	16:22	N	85	-1.230	0.631	-0.399	-	-	3.7	3.55	18.1
0078 Apr 16	00:10	P	52	-0.942	1.191	0.098	38m	-	13.5	13.44	-10.1

Lunar Eclipses: 0001 to 0100

(1 CE to 100 CE)

Local Circumstances at Greatest Eclipse: 0001 to 0100

Date	U.T. Greatest Eclipse	Saros Type	#	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
0078 Oct 09	20:25	P	57	0.814	1.373	0.388	64m	-	1.1	0.90	6.7
0079 Apr 05	00:34	T+	62	-0.194	2.562	1.474	115m	48m	12.7	12.78	-5.3
0079 Sep 29	11:18	T-	67	0.137	2.630	1.615	108m	48m	0.4	0.26	1.8
0080 Mar 24	05:35	P	72	0.558	1.869	0.829	94m	-	12.0	12.14	-0.3
0080 Sep 17	20:52	P	77	-0.606	1.796	0.727	91m	-	23.7	23.61	-3.2
0081 Feb 12	08:27	N	44	-1.359	0.371	-0.613	-	-	9.4	9.65	12.8
0081 Mar 13	17:37	N	82	1.248	0.578	-0.413	-	-	11.3	11.51	4.5
0081 Aug 08	06:47	Ne	49	1.569	0.045	-1.056	-	-	21.0	21.04	-15.6
0081 Sep 06	23:25	N	87	-1.358	0.435	-0.672	-	-	23.0	22.94	-8.2
0082 Feb 02	00:36	P	54	-0.691	1.601	0.610	79m	-	8.7	8.96	16.7
0082 Jul 28	08:40	P	59	0.802	1.434	0.369	69m	-	20.3	20.32	-19.1
0083 Jan 22	13:54	T+	64	-0.002	2.890	1.851	110m	51m	8.0	8.24	20.1
0083 Jul 17	17:25	T-	69	0.010	2.859	1.852	110m	51m	19.6	19.59	-21.9
0084 Jan 11	20:25	P	74	0.732	1.580	0.481	78m	-	7.3	7.46	22.8
0084 Jul 06	08:27	P	79	-0.727	1.522	0.556	75m	-	18.9	18.86	-23.9
0084 Dec 30	20:30	N	84	1.432	0.311	-0.816	-	-	6.5	6.64	24.7
0085 May 27	18:23	N	51	1.066	0.909	-0.074	-	-	16.2	16.14	-20.1
0085 Jun 26	01:39	N	89	-1.448	0.200	-0.766	-	-	18.2	18.12	-25.1
0085 Nov 20	04:16	P	56	-0.888	1.279	0.208	52m	-	3.8	3.67	18.9
0086 May 17	06:17	T	61	0.329	2.288	1.251	107m	37m	15.5	15.42	-18.6
0086 Nov 09	14:39	Tm	66	-0.161	2.585	1.571	106m	47m	3.1	2.91	16.7
0087 May 06	10:55	T	71	-0.452	2.086	1.002	105m	3m	14.8	14.70	-16.3
0087 Oct 30	05:47	P	76	0.511	1.929	0.941	91m	-	2.4	2.18	13.9
0088 Apr 24	11:26	N	81	-1.205	0.707	-0.382	-	-	14.1	13.98	-13.4

0088 Sep 19	09:41	N	48	-1.512	0.113	-0.914	-	-	23.8	23.74	-3.3
0088 Oct 18	21:05	N	86	1.201	0.674	-0.335	-	-	1.7	1.48	10.7
0089 Mar 15	03:36	P	53	0.833	1.359	0.332	63m	-	11.4	11.60	3.5
0089 Sep 08	17:21	P	58	-0.853	1.349	0.268	60m	-	23.1	23.05	-7.0
0090 Mar 04	17:08	T-	63	0.080	2.719	1.735	106m	49m	10.7	10.94	7.0
0090 Aug 28	18:31	T+	68	-0.139	2.673	1.566	117m	51m	22.3	22.35	-10.6
0091 Feb 22	09:32	P	73	-0.620	1.726	0.746	85m	-	10.0	10.26	10.2
0091 Aug 17	19:14	P	78	0.592	1.829	0.747	94m	-	21.6	21.62	-13.8
0092 Jan 13	11:20	N	45	1.418	0.301	-0.758	-	-	7.4	7.61	23.2
0092 Feb 12	00:06	N	83	-1.355	0.397	-0.623	-	-	9.3	9.56	13.2
0092 Jul 07	16:41	N	50	-1.325	0.438	-0.553	-	-	18.9	18.98	-24.3
0092 Aug 06	02:09	N	88	1.295	0.509	-0.515	-	-	20.9	20.90	-16.3
0093 Jan 01	15:39	P	55	0.775	1.508	0.395	73m	-	6.6	6.79	23.9
0093 Jun 27	08:49	P	60	-0.562	1.822	0.861	89m	-	18.3	18.23	-24.2
0093 Dec 21	14:51	T-	65	0.100	2.753	1.628	117m	51m	5.9	5.95	23.8
0094 Jun 17	01:49	T-	70	0.176	2.537	1.562	106m	47m	17.6	17.49	-23.3
0094 Dec 10	16:24	P	75	-0.582	1.848	0.762	93m	-	5.2	5.12	22.6
0095 Jun 06	15:02	P	80	0.974	1.098	0.075	31m	-	16.9	16.76	-21.6
0095 Oct 31	13:23	N	47	1.496	0.129	-0.872	-	-	2.5	2.26	15.4
0095 Nov 30	01:08	N	85	-1.226	0.637	-0.391	-	-	4.5	4.33	20.4
0096 Apr 26	06:46	N	52	-1.020	1.048	-0.044	-	-	14.2	14.11	-13.9
0096 Oct 20	05:05	P	57	0.828	1.348	0.360	62m	-	1.8	1.59	10.9
0097 Apr 15	07:23	T+	62	-0.264	2.430	1.347	113m	43m	13.5	13.44	-9.4
0097 Oct 09	19:40	T-	67	0.157	2.596	1.575	108m	48m	1.1	0.93	6.2
0098 Apr 04	12:56	P	72	0.498	1.977	0.942	98m	-	12.7	12.79	-4.6
0098 Sep 29	04:42	P	77	-0.578	1.850	0.775	93m	-	0.4	0.28	1.2
0099 Feb 23	16:47	N	44	-1.387	0.319	-0.661	-	-	10.1	10.34	9.0
0099 Mar 25	01:30	N	82	1.199	0.666	-0.319	-	-	12.0	12.17	0.2
0099 Sep 18	06:46	N	87	-1.319	0.510	-0.601	-	-	23.7	23.61	-3.9
0100 Feb 13	09:03	P	54	-0.715	1.555	0.566	76m	-	9.4	9.68	13.3
0100 Aug 07	15:45	P	59	0.864	1.320	0.255	58m	-	21.0	21.03	-16.3

Key to Catalog of Lunar Eclipses

Fred Espenak

Catalogs of lunar eclipse circumstances include the following data. The date and Universal Time [1] of the instant of greatest eclipse[2] are found in the first two columns. The eclipse type is given (T=Total, P=Partial, or N=Penumbral) along with the Saros series. Gamma is the distance of the Moon's center from the shadow axis of Earth at greatest eclipse (in Earth radii). The penumbral and umbral magnitudes of the eclipse are defined as the fractions of the Moon's diameter obscured by each shadow at greatest eclipse. The semi-durations of the partial and total phases of the eclipse are given to the nearest minute. Finally, the Greenwich Sidereal Time at 00:00 U.T., along with the Moon's Geocentric Right Ascension and Declination at greatest eclipse complete each record. A more detailed key is listed below.

[1]For most practical purposes, Universal Time (UT) is equivalent to Greenwich Mean Time (GMT).

[2]Greatest eclipse is defined as the instant when the Moon passes closest to the axis of Earth's shadows. This marks the instant when the Moon is deepest in Earth's shadow(s).

Calculating Eclipse Contact Times

The start and end times, respectively, of the partial phases of any eclipse can be calculated by subtracting or adding the partial semi-duration (S.D. Par) to the instant of greatest eclipse. Similarly, the start and end times, of the total phase of an eclipse can be calculated by subtracting and adding the total semi-duration (S.D. Tot) to the instant of greatest eclipse.

For example, the catalog lists the following record for the total lunar eclipse of 2000 Jan 21:

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
2000 Jan 21	04:43	T	124	-0.296	2.331	1.330	102m	39m	8.0	8.17	19.8

Thus, we have:

```
          Time of Greatest Eclipse:        tm = 04:43 UT
Semi-Duration of Partial Eclipse:   S.D.Par = 102 minutes = 1h 42m
  Semi-Duration of Total Eclipse:   S.D.Tot =  39 minutes = 0h 39m
```

Times of the eclipse phases can then be calculated as:

```
Partial Eclipse Begins:  tm - S.D.Par  =  04:43 - 1h 42m  =  03:01 UT
  Total Eclipse Begins:  tm - S.D.Tot  =  04:43 - 0h 39m  =  04:04 UT
    Total Eclipse Ends:  tm + S.D.Tot  =  04:43 + 0h 39m  =  05:22 UT
  Partial Eclipse Ends:  tm + S.D.Par  =  04:43 + 1h 42m  =  06:25 UT
```

Calculating the Moon's Altitude and Azimuth

To determine whether an eclipse is visible from a specific geographic location, it is simply a matter of calculating the Moon's altitude and azimuth during each phase of the eclipse. The calculations can be performed on any pocket calculator having trig functions (SIN, COS, TAN). Armed with the latitude and longitude of the location, the lunar eclipse catalog provides all the additional information needed to make the calculations. (For those wishing to avoid the tedium of performing of these calculations, several Microsoft Excel spread sheets are available to automate the calculations for any geographic location and for all lunar eclipses from 1951 to 2050. See: Local Visibility of Lunar Eclipses.)

The altitude 'a' and azimuth 'A' of the Moon during any phase of an eclipse depends on the time and the observer's geographic coordinates. Neglecting the effects of atmospheric refraction and lunar parallax, 'a' and 'A' are calculated as follows:

```
h  = 15 * (GST0 + t - ra ) + l
a  =  ArcSin  [ Sin d Sin f + Cos d Cos h Cos f ]
A  =  ArcTan  [ - (Cos d Sin h) / (Sin d Cos f -  Cos d Cos h Sin f) ]
```

where:

```
h  =  Hour Angle of the Moon (in degrees)
a  =  Altitude (in degrees)
A  =  Azimuth (in degrees)
GST0  =  Greenwich Sidereal Time at 00:00 UT
t  =  Universal Time
ra  =  Right Ascension of the Moon (in hours)
d  =  Declination of the Moon (in degrees)
l  =  Observer's Longitude (East +, West -)
f  =  Observer's Latitude (North +, South -)
```

For example, determine whether the Moon will be above the horizon at greatest eclipse during the total lunar eclipse of 2000 Jan 21 (catalog record from previous example) as seen from Washington DC. The geographic coordinates of Washington DC are:

```
Latitude:   f =  38°53´N  =   +38.9°
Longitude:  l = 077°02´W  =  -077.0°
```

From the catalog record, we have:

```
Time of Greatest Eclipse:     t =  04:43 = 4.72
Greenwich Sidereal Time at 00:00 UT:  GST0 =   8.0
Right Ascension of the Moon:    ra =   8.17
Declination of the Moon:     d =  19.8
```

Thus:

```
Hour Angle of the Moon:  h  = 15 * (GST0 + t - ra ) + l
                            = 15 * (8.0 + 4.72 - 8.17) + -077.0
                            = 15 * (4.55) -077.0
                         h  = -9°

Altitude of Moon:   a = ArcSin [Sin d Sin f + Cos d Cos h Cos f]
                      = ArcSin [Sin(19.8) Sin(38.9) + Cos(19.8) Cos(-9) Cos(38.9)]
                      = ArcSin [0.339 * 0.628 + 0.941 * 0.988 * 0.778]
                      = ArcSin [0.213 + 0.723]
                      = ArcSin [0.936]
                      = 69°
```

With an altitude of 69°, the Moon will indeed be visible at greatest eclipse during the total lunar eclipse of 2000 Jan 21 as seen from Washington DC.

The expression for the Moon's azimuth contains the trigonometric function **ArcTan**. The **ArcTan** function results in an angle between -90° and +90°, with an ambiguity of + or - 180°. If the desired calculation has the form **A = ArcTan [x / y]**, then the ambiguity can be resolved using a simple test: if the denominator **y** is negative, then add 180° to the final answer.

In our current example the azimuth of the Moon is then:

```
Azimuth of Moon:  A = ArcTan [-(Cos d Sin h)/(Sin d Cos f - Cos d Cos h Sin f)]
```

```
                        = ArcTan [-(Cos(19.8) Sin(-9))/(Sin(19.8) Cos(38.9) - Cos(19.8)
Cos(-9) Sin(38.9))]
                        = ArcTan [-(0.941 * -0.156) / ((0.339 * 0.778) - (0.941 * 0.988
* 0.628))]
                        = ArcTan [-(-0.147) / ((0.264) - (0.584))]
                        = ArcTan [ +0.147 / (-0.320)]
                        = ArcTan [ -0.459 ]
                        = -24.7°
```

Since the denominator in **ArcTan [+0.147 / (-0.320)]** is negative, we must add 180° to the final answer:

```
                    A = -24.7° + 180°
                    A = 155.3°
```

This places the Moon in the southeast at greatest eclipse during the total lunar eclipse of 2000 Jan 21 as seen from Washington DC.

Key to Catalog of Lunar Eclipses

Column	Heading	Definition/Description
1	Date	Calendar Date (Gregorian) at instant of Greatest Eclipse. (Julian calendar is used before 1582 Oct 15).
2	Greatest Eclipse	Universal Time (UT) of Greatest Eclipse, which is defined as the instant when Moon passes closest to the axis of Earth's shadows.
3	Type	Type of lunar eclipse where: N = Penumbral Eclipse. P = Partial (Umbral) Eclipse. T = Total (Umbral) Eclipse. (Tc = central total eclipse) If the Type ends with: "m" = Middle eclipse of Saros series. "+" = Central eclipse (Moon north of axis). "-" = Central eclipse (Moon south of axis). "b" = Saros series begins (first eclipse in series). "e" = Saros series ends (last eclipse in series).
4	Saros	Saros series of eclipse. (Each eclipse in a Saros is separated by an interval of 18 years 11.3 days.)
5	Gamma	Distance of the Moon from the axis of Earth's shadow cone (units of equatorial radii) at the instant of greatest eclipse.
6	Pen. Mag.	Penumbral eclipse magnitude is the fraction of the Moon's diameter obscured by the penumbra.
7	Umb. Mag.	Umbral eclipse magnitude is the fraction of the Moon's diameter obscured by the umbra.
8	S.D. Par	Semi-duration of partial (umbral) eclipse (minutes).
9	S.D. Tot	Semi-duration of total (umbral) eclipse (minutes).
10	GST0	Greenwich Sidereal Time at 00:00 U.T..
11	Moon RA	Geocentric Right Ascension of the Moon at greatest eclipse (hours).
12	Moon Dec	Geocentric Declination of the Moon at greatest eclipse (degrees).

Eclipses and the Saros

Fred Espenak

The periodicity and recurrence of eclipses is governed by the saros cycle, a period of approximately 6,585.3 days (18 years 11 days 8 hours). It was known to the Chaldeans as a period when lunar eclipses seem to repeat themselves, but the cycle is applicable to solar eclipses as well.

The saros arises from a natural harmony between three of the Moon's orbital periods:

Synodic Month (new moon to new moon)	29.53059 days	= 29d 12h 44m
Draconic Month (node to node)	27.21222 days	= 27d 05h 06m
Anomalistic Month (perigee to perigee)	27.55455 days	= 27d 13h 19m

One saros is equal to 223 synodic months. However, 242 draconic months and 239 anomalistic months are also equal to this same period (to within a couple hours)!

Any two eclipses separated by one saros cycle share very similar geometries. They occur at the same node with the Moon at nearly the same distance from Earth and at the same time of year. Because the saros period is not equal to a whole number of days, its biggest drawback is that subsequent eclipses are visible from different parts of the globe. The extra 1/3 day displacement means that Earth must rotate an additional ~8 hours or ~120º with each cycle. For solar eclipses, this results in the shifting of each successive eclipse path by ~120º westward. Thus, a saros series returns to about the same geographic region every 3 saroses (54 years and 34 days).

A saros series doesn't last indefinitely because the three lunar months are not perfectly commensurate with one another. In particular, the Moon's node shifts eastward by about 0.5º with each cycle. A typical saros series for a solar eclipse begins when new Moon occurs ~18° east of a node. If the first eclipse occurs at the Moon's descending node, the Moon's umbral shadow will pass ~3500 km below Earth and a partial eclipse will be visible from the south polar region. On the following return, the umbra will pass ~300 km closer to Earth and a partial eclipse of slightly larger magnitude will result. After ten or eleven saros cycles (about 200 years), the first central eclipse will occur near the south pole of Earth. Over the course of the next 950 years, a central eclipse occurs every 18.031 years (= saros) but will be displaced northward by an average of ~300 km. Halfway through this period, eclipses of long duration will occur near the equator. The last central eclipse of the series occurs near the north pole. The next approximately ten eclipses will be partial with successively smaller magnitudes. Finally, the saros series will end a dozen or more centuries after it began at the opposite pole. Due to the ellipticity of the orbits of the Earth and Moon, the exact duration and number of eclipses in a complete saros is not constant. A series may last 1226 to 1550 years and is comprised of 69 to 87 eclipses, of which about 40 to 60 are central (i.e. - total or annular).

Solar eclipses that take place near the Moon's ascending node have *odd* saros numbers. Each succeeding eclipse in a series shifts progressively southward with respect to the center of the Earth. On the other hand, solar eclipses occurring near the Moon's descending node have *even* saros numbers. Each succeeding eclipse in a series shifts progressively northward with respect to the center of the Earth. The numbering system used for the saros series was introduced by the Dutch Astronomer G. van den Bergh in his book *Periodicity and Variation of Solar (and Lunar) Eclipses* (Tjeenk Willink, Haarlem, Netherlands, 1955). He assigned the number 1 to a pair of solar and lunar eclipse series that were in progress during the second millennium BC.

Understanding the numbering sequence of the saros is complicated by the fact that it does not depend on when a series either begins or ends. Instead, the numbering is determined by the order in which each series peaks. In this context, the peak of a series occurs when the umbral shadow axis passes closest to the center of the Earth. Since the duration of each series varies up to several hundred years and the numbering is keyed to the order in which each series peaks, this explains why the first eclipse of a series which peaks later can actually preceed the first eclipse of a series that peaks earlier. From the solar eclipse catalogs, the column labeled *Gamma* is the parameter that gives the minimum distance (in Earth radii) of the shadow axis from the center of the Earth during each eclipse. Gamma is positive or negative depending on whether the shadow axis passes north or south of Earth's center. Looking at any of the saros catalogs (e.g. - Saros 145) one can see how the value of gamma changes with each eclipse in a series. When gamma reaches its minimum (absolute) value, the series is then at its peak. In the case of Saros 145, the peak occurs with the eclipse of 2342 Mar 08 (gamma=0.008).

Since there are two to five solar eclipses every year, there are approximately forty different saros series in progress at any one time. For instance, during the later half of the twentieth century, there are 41 individual series and 26 of them are producing central eclipses. As old series terminate, new ones are beginning and take their places.

To illustrate, the ten central solar eclipses of 1891, 1909, 1927, 1945, 1963, 1981, 1999, 2017, 2035 and 2053 are all members of Saros 145. The series began with a partial eclipse near the north pole in 1639. The first central eclipse of the series was an annular eclipse in 1891. It was followed by another annular in 1909. The next event was the first total eclipse in 1927. The total solar eclipse of 1999 August 11 is number 21 of 77 eclipses in Saros 145, and it is the 5th of 41 total eclipses in the series. Each of the subsequent total eclipses shifts southwards. The last total eclipse occurs in 2648 near the south pole. The last eclipse of the series takes place in 3009. Table of Saros 145 gives details for every eclipse in the series.

The saros cycle for lunar eclipses operates analogously with the solar eclipse saros. For lunar eclipses, the parameter *gamma* is the Moon's minimum distance measured with respect to the axis of Earth's shadow (units of Earth radii). Note however, that the saros numbering is opposite to that for solar eclipses. Lunar eclipses occurring near the Moon's ascending node have even saros numbers. Each succeeding eclipse in a series shifts progressively southward with respect to the axis of Earth's shadow. Correspondingly, lunar eclipses occurring near the Moon's descending node have odd saros numbers. Each succeeding eclipse in a series shifts progressively northward with respect to the axis of Earth's shadow.

Lunar Eclipses: 2001 to 2100

(2001 CE to 2100 CE)

Fred Espenak

During the 21st century CE[1], Earth will experience 230 lunar eclipses as follows:

All Eclipses	= 230	= 100.0%
Penumbral (N)	= 87	= 37.8%
Partial (P)	= 58	= 25.2%
Total (T)	= 85	= 37.0%

Eclipses in which some portion of the Moon passes into Earth 's umbral shadow are classified as umbral eclipses . All total and partial lunar eclipses are umbral eclipses. Statistics for umbral eclipses during the century are as follows:

Umbral (P&T)	= 143	= 62.2%
Central[2] (T±)	= 24	= 10.4%
Non-Central (T)	= 61	= 26.5%

There are two to five lunar eclipses in each calendar year. The distribution of eclipses each year during this century are as follows:

Number of Years with 2 Eclipses:	76
Number of Years with 3 Eclipses:	18
Number of Years with 4 Eclipses:	6

When four consecutive lunar eclipses are all *total* eclipses, the group is known as a tetrad. The following tetrads occur during this century:

Tetrad (Four Consecutive Total Eclipses):	2003 - 2004
Tetrad (Four Consecutive Total Eclipses):	2014 - 2015
Tetrad (Four Consecutive Total Eclipses):	2032 - 2033
Tetrad (Four Consecutive Total Eclipses):	2043 - 2044
Tetrad (Four Consecutive Total Eclipses):	2050 - 2051
Tetrad (Four Consecutive Total Eclipses):	2061 - 2062
Tetrad (Four Consecutive Total Eclipses):	2072 - 2073
Tetrad (Four Consecutive Total Eclipses):	2090 - 2091

During any given century, old Saros series end while new ones begin. The year and Saros number of these events are as follows:

3 Saros Series' begin (Year/Saros):	2013/150	2042/156	2096/151
3 Saros Series' end (Year/Saros):	2016/109	2027/110	2092/111

The longest and shortest lunar eclipses of the century and other eclipse extrema are listed below.

```
 Longest  Total  Lunar Eclipse:    2018 Jul 27    Duration = 01h43m35s
Shortest  Total  Lunar Eclipse:    2015 Apr 04    Duration = 00h11m56s
```

(In this year, the calendars of 33 AD and 2015 AD agree exactly. Additionally, the Jewish and Christian holidays correspond exactly as well. Memorial will be celebrated on Thursday, April 2nd, 2018, Good Friday follows the next day, April 3rd, when Jesus was crucified in 33 AD, and the anniversary of the resurrection will take place on Sunday – Easter Sunday, April 5th, as it did in 33 A.D. In 33 AD, this eclipse was only partial and only the last few minutes of its obscuration would have been visible to sharp eyes as the Moon rose. – Brian Kutscher)

```
 Longest Partial Lunar Eclipse:    2021 Nov 19    Duration = 03h29m03s
Shortest Partial Lunar Eclipse:    2042 Sep 29    Duration = 00h11m28s
 Largest  Total  Lunar Eclipse:    2029 Jun 26    Umbra Magnitude = 1.8488
Smallest  Total  Lunar Eclipse:    2015 Apr 04    Umbra Magnitude = 1.0052
 Largest Partial Lunar Eclipse:    2086 Nov 20    Umbra Magnitude = 0.9924
Smallest Partial Lunar Eclipse:    2042 Sep 29    Umbra Magnitude = 0.0028
Largest Penumbral Lunar Eclipse:   2070 Apr 25     Pen. Magnitude = 1.0772
Smallest Penumbral Lunar Eclipse:  2042 Oct 28     Pen. Magnitude = 0.0075
```

Total penumbral eclipses are lunar eclipses in which the entire Moon passes through the penumbra but misses the umbral shadow. Total penumbral eclipses (and magnitudes) for the century are:

```
Total Penumbral Eclipse:    2006 Mar 14     Pen. Magnitude = 1.0565
Total Penumbral Eclipse:    2017 Feb 11     Pen. Magnitude = 1.0140
Total Penumbral Eclipse:    2053 Aug 29     Pen. Magnitude = 1.0453
Total Penumbral Eclipse:    2066 Dec 31     Pen. Magnitude = 1.0033
Total Penumbral Eclipse:    2070 Apr 25     Pen. Magnitude = 1.0772
Total Penumbral Eclipse:    2082 Aug 08     Pen. Magnitude = 1.0272
Total Penumbral Eclipse:    2085 Jan 10     Pen. Magnitude = 1.0187
Total Penumbral Eclipse:    2099 Sep 29     Pen. Magnitude = 1.0599
```

Description of Lunar Eclipse Catalog

Local circumstances at greatest eclipse[3] for every event during the century are presented in the following catalog. The calendar date and Universal Time of the instant of greatest eclipse are found in the first two columns. The eclipse type is given (T=Total, P=Partial, or N=Penumbral) along with the Saros series. Gamma is the distance of the Moon's center from the shadow axis of Earth at greatest eclipse (in Earth radii). The penumbral and umbral magnitudes of the eclipse are defined as the fractions of the Moon's diameter obscured by each shadow at greatest eclipse. The semi-durations of the partial and total phases of the eclipse are given to the nearest minute. Finally, the Greenwich Sidereal Time at 00:00 U.T., along with the Moon's Geocentric Right Ascension and Declination at greatest eclipse complete each record. For a detailed key and additional information about the catalog, see: Key to Catalog of Lunar Eclipses.

For any eclipse in the catalog, the start and end times of the partial eclipse phases can be calculated by respectively subtracting and adding the semi-duration of the partial phase (S.D. Par) to the instant of greatest eclipse. Similarly, the start and end times of the total eclipse can be calculated by either subtracting or adding the semi-duration of the total phase (S.D. Tot) to the instant of greatest eclipse. For a detailed example, see Contact - Key to Lunar Eclipse Catalogs.

To determine whether an eclipse is visible from a specific geographic location, it is simply a matter of calculating the Moon's altitude and azimuth during each phase of the eclipse. The calculations can be performed on any pocket calculator having trigonometric functions (SIN, COS, TAN). Armed with the latitude and longitude of the location, the lunar eclipse catalog provides all the additional information needed

to make the calculations. For the equations and an example of how to calculate the Moon's altitude for a specific location, see Altitude - Key to Lunar Eclipse Catalogs.

Footnotes

[1]The terms BCE and CE are abbreviations for "Before Common Era" and "Common Era," respectively. They are the secular equivalents to the BC and AD dating conventions. (See: Year Dating Conventions)

[2]Central lunar eclipses are eclipses in which some portion of the Moon passes the central axis of Earth's umbral shadow. All penumbral and partial lunar eclipses are non-central eclipses since the Moon misses the shadow axis. However, total eclipses may be either non-central (frequently) or central (occasionally). Central total eclipses are longer and usually darker than non-central total eclipses.

[3]Greatest eclipse is defined as the instant when the Moon passes closest to the axis of Earth's shadow. The instant of greatest eclipse corresponds to the maximum phase of the eclipse.

Lunar Eclipses: 2001 to 2100

(2001 CE to 2100 CE)

Local Circumstances at Greatest Eclipse: 2001 to 2100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
2001 Jan 09	20:21	T	134	0.372	2.187	1.194	99m	31m	7.3	7.42	22.4
2001 Jul 05	14:55	P	139	-0.729	1.573	0.499	80m	-	18.9	18.99	-23.4
2001 Dec 30	10:29	N	144	1.073	0.919	-0.110	-	-	6.6	6.64	24.2
2002 May 26	12:03	N	111	1.176	0.714	-0.283	-	-	16.3	16.23	-20.0
2002 Jun 24	21:27	N	149	-1.444	0.235	-0.787	-	-	18.2	18.22	-24.8
2002 Nov 20	01:47	N	116	-1.113	0.886	-0.222	-	-	3.9	3.71	18.7
2003 May 16	03:40	T	121	0.412	2.100	1.134	97m	26m	15.6	15.51	-18.6
2003 Nov 09	01:19	T	126	-0.432	2.140	1.022	106m	12m	3.2	2.93	16.3
2004 May 04	20:30	T	131	-0.313	2.288	1.309	102m	38m	14.9	14.81	-16.5
2004 Oct 28	03:04	T	136	0.285	2.390	1.313	110m	41m	2.5	2.18	13.4
2005 Apr 24	09:55	N	141	-1.089	0.890	-0.138	-	-	14.2	14.11	-13.9
2005 Oct 17	12:03	P	146	0.980	1.084	0.068	29m	-	1.7	1.47	10.3
2006 Mar 14	23:48	N	113	1.021	1.056	-0.056	-	-	11.5	11.68	3.1
2006 Sep 07	18:51	P	118	-0.926	1.158	0.190	46m	-	23.1	23.11	-6.7
2007 Mar 03	23:21	T	123	0.317	2.345	1.238	111m	37m	10.8	10.96	6.9
2007 Aug 28	10:37	T+	128	-0.214	2.478	1.481	106m	45m	22.4	22.45	-10.0
2008 Feb 21	03:26	T	133	-0.399	2.171	1.111	103m	25m	10.0	10.25	10.5
2008 Aug 16	21:10	P	138	0.565	1.862	0.812	94m	-	21.7	21.76	-12.9
2009 Feb 09	14:38	N	143	-1.064	0.924	-0.083	-	-	9.3	9.53	13.5
2009 Jul 07	09:39	N	110	-1.491	0.182	-0.908	-	-	19.0	19.14	-23.9

2009 Aug 06	00:39	N	148	1.357	0.428	-0.662	-	-	21.0	21.05	-15.6
2009 Dec 31	19:23	P	115	0.977	1.081	0.082	31m	-	6.7	6.76	24.0
2010 Jun 26	11:38	P	120	-0.709	1.603	0.542	82m	-	18.3	18.35	-24.0
2010 Dec 21	08:17	T	125	0.321	2.306	1.261	105m	37m	6.0	5.95	23.7
2011 Jun 15	20:13	T-	130	0.090	2.712	1.705	110m	50m	17.6	17.59	-23.2
2011 Dec 10	14:32	T	135	-0.388	2.212	1.111	106m	26m	5.3	5.14	22.6
2012 Jun 04	11:03	P	140	0.825	1.343	0.376	64m	-	16.9	16.86	-21.7
2012 Nov 28	14:33	N	145	-1.087	0.942	-0.183	-	-	4.5	4.33	20.5
2013 Apr 25	20:07	P	112	-1.012	1.012	0.021	16m	-	14.3	14.21	-14.4
2013 May 25	04:10	Nb	150	1.535	0.040	-0.928	-	-	16.2	16.15	-19.4
2013 Oct 18	23:50	N	117	1.151	0.791	-0.267	-	-	1.8	1.57	11.0
2014 Apr 15	07:46	T	122	-0.302	2.344	1.296	108m	39m	13.6	13.56	-10.0

(This one (2014) is about as close in appearance to the one seen in Egypt in 1615 BC as possible. It will be visible in the US, but not in Egypt or Israel.)

2014 Oct 08	10:55	T	127	0.383	2.171	1.172	100m	30m	1.1	0.92	6.3
2015 Apr 04	12:00	T	132	0.446	2.105	1.005	105m	6m	12.8	12.89	-5.3
2015 Sep 28	02:47	T	137	-0.330	2.254	1.282	100m	36m	0.4	0.29	1.5
2016 Mar 23	11:47	N	142	1.159	0.801	-0.308	-	-	12.1	12.22	-0.3
2016 Aug 18	09:42	Ne	109	1.559	0.017	-0.993	-	-	21.8	21.85	-11.4
2016 Sep 16	18:54	N	147	-1.055	0.933	-0.058	-	-	23.7	23.67	-3.3
2017 Feb 11	00:44	N	114	-1.025	1.014	-0.030	-	-	9.4	9.64	13.1
2017 Aug 07	18:20	P	119	0.867	1.315	0.251	58m	-	21.1	21.18	-15.4
2018 Jan 31	13:30	T	124	-0.301	2.320	1.321	102m	38m	8.7	8.93	17.0
2018 Jul 27	20:22	T-	129	0.117	2.706	1.614	118m	52m	20.4	20.47	-19.0
2019 Jan 21	05:12	T	134	0.369	2.193	1.201	99m	31m	8.0	8.21	20.3
2019 Jul 16	21:31	P	139	-0.643	1.729	0.658	89m	-	19.6	19.73	-21.9
2020 Jan 10	19:10	N	144	1.073	0.921	-0.111	-	-	7.3	7.45	23.0
2020 Jun 05	19:25	N	111	1.240	0.594	-0.399	-	-	17.0	16.97	-21.5
2020 Jul 05	04:30	N	149	-1.364	0.380	-0.638	-	-	18.9	18.99	-24.1
2020 Nov 30	09:43	N	116	-1.131	0.855	-0.257	-	-	4.6	4.48	20.7
2021 May 26	11:19	T	121	0.477	1.979	1.016	94m	9m	16.3	16.24	-20.7
2021 Nov 19	09:03	P	126	-0.455	2.098	0.979	105m	-	3.9	3.67	19.2

(Eclipses that will be visible from Detroit - Brian Kutscher)

Lunar Eclipses: 2001 to 2100

(2001 CE to 2100 CE)

Local Circumstances at Greatest Eclipse: 2001 to 2100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
2022 May 16	04:11	T+	131	-0.253	2.397	1.419	104m	43m	15.6	15.52	-19.3
2022 Nov 08	10:59	T-	136	0.257	2.440	1.363	110m	43m	3.2	2.90	16.9
2023 May 05	17:23	N	141	-1.035	0.989	-0.041	-	-	14.9	14.81	-17.2
2023 Oct 28	20:14	P	146	0.947	1.143	0.127	40m	-	2.5	2.16	14.1
2024 Mar 25	07:13	N	113	1.061	0.982	-0.128	-	-	12.2	12.34	-1.2
2024 Sep 18	02:44	P	118	-0.979	1.062	0.091	32m	-	23.8	23.77	-2.6
2025 Mar 14	06:59	T	123	0.348	2.286	1.183	109m	33m	11.5	11.64	2.7
2025 Sep 07	18:12	T	128	-0.275	2.369	1.368	105m	41m	23.1	23.11	-6.0
2026 Mar 03	11:33	T	133	-0.377	2.210	1.156	104m	30m	10.8	10.94	6.4
2026 Aug 28	04:13	P	138	0.497	1.990	0.935	99m	-	22.4	22.44	-9.3

2027 Feb 20	23:13	N	143	-1.048	0.952	-0.052	-	-	10.0	10.24	9.8
2027 Jul 18	16:03	Ne	110	-1.576	0.028	-1.063	-	-	19.7	19.88	-22.3
2027 Aug 17	07:14	N	148	1.280	0.571	-0.521	-	-	21.7	21.73	-12.4
2028 Jan 12	04:13	P	115	0.982	1.072	0.072	29m	-	7.4	7.56	22.7
2028 Jul 06	18:19	P	120	-0.790	1.453	0.394	71m	-	19.0	19.11	-23.3
2028 Dec 31	16:52	T	125	0.326	2.300	1.252	105m	36m	6.7	6.77	23.3
2029 Jun 26	03:22	T-	130	0.013	2.852	1.849	110m	51m	18.3	18.35	-23.3
2029 Dec 20	22:42	T	135	-0.381	2.227	1.122	107m	27m	6.0	5.95	23.1
2030 Jun 15	18:33	P	140	0.754	1.472	0.508	73m	-	17.6	17.61	-22.6
2030 Dec 09	22:27	N	145	-1.073	0.968	-0.159	-	-	5.2	5.12	21.9
2031 May 07	03:51	N	112	-1.069	0.907	-0.085	-	-	15.0	14.92	-17.8
2031 Jun 05	11:44	N	150	1.473	0.154	-0.814	-	-	16.9	16.89	-21.1
2031 Oct 30	07:45	N	117	1.177	0.742	-0.315	-	-	2.6	2.27	14.8
2032 Apr 25	15:13	T	122	-0.356	2.245	1.197	106m	33m	14.3	14.24	-13.8
2032 Oct 18	19:02	T	127	0.417	2.108	1.108	98m	24m	1.9	1.60	10.4
2033 Apr 14	19:12	T	132	0.396	2.197	1.099	108m	25m	13.6	13.56	-9.4
2033 Oct 08	10:55	T	137	-0.289	2.331	1.355	102m	40m	1.2	0.96	5.8
2034 Apr 03	19:05	N	142	1.115	0.881	-0.223	-	-	12.8	12.88	-4.6
2034 Sep 28	02:46	P	147	-1.011	1.016	0.020	16m	-	0.5	0.33	1.0
2035 Feb 22	09:05	N	114	-1.037	0.991	-0.048	-	-	10.1	10.35	9.2
2035 Aug 19	01:11	P	119	0.943	1.177	0.109	39m	-	21.8	21.86	-12.0
2036 Feb 11	22:11	T	124	-0.311	2.300	1.305	101m	38m	9.4	9.67	13.6
2036 Aug 07	02:51	T-	129	0.200	2.553	1.459	116m	48m	21.1	21.18	-16.1
2037 Jan 31	14:00	T	134	0.362	2.205	1.213	99m	32m	8.7	8.97	17.5
2037 Jul 27	04:08	P	139	-0.558	1.884	0.814	97m	-	20.3	20.46	-19.6
2038 Jan 21	03:48	N	144	1.071	0.925	-0.109	-	-	8.0	8.24	20.9
2038 Jun 17	02:43	N	111	1.308	0.467	-0.522	-	-	17.7	17.72	-22.1
2038 Jul 16	11:34	N	149	-1.284	0.525	-0.490	-	-	19.6	19.74	-22.5
2038 Dec 11	17:43	N	116	-1.145	0.831	-0.285	-	-	5.4	5.27	22.0
2039 Jun 06	18:53	P	121	0.546	1.852	0.891	90m	-	17.0	16.99	-22.1
2039 Nov 30	16:55	P	126	-0.472	2.068	0.947	103m	-	4.6	4.45	21.3
2040 May 26	11:45	T+	131	-0.187	2.519	1.540	106m	46m	16.3	16.26	-21.5
2040 Nov 18	19:03	T-	136	0.236	2.478	1.402	111m	44m	3.9	3.65	19.7
2041 May 16	00:41	P	141	-0.975	1.100	0.070	30m	-	15.6	15.53	-20.0
2041 Nov 08	04:33	P	146	0.921	1.191	0.175	46m	-	3.2	2.89	17.5
2042 Apr 05	14:28	N	113	1.108	0.894	-0.213	-	-	12.9	13.01	-5.4
2042 Sep 29	10:44	P	118	-1.026	0.978	0.003	6m	-	0.6	0.43	1.6
2042 Oct 28	19:33	Nb	156	1.557	0.008	-0.974	-	-	2.5	2.17	14.8
2043 Mar 25	14:30	T	123	0.385	2.216	1.119	108m	27m	12.2	12.31	-1.6
2043 Sep 19	01:50	T	128	-0.332	2.269	1.261	103m	36m	23.9	23.77	-1.9

Lunar Eclipses: 2001 to 2100

(2001 CE to 2100 CE)

Local Circumstances at Greatest Eclipse: 2001 to 2100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °

2044 Mar 13	19:37	T	133	-0.350	2.256	1.208	105m	34m	11.5	11.61	2.1
2044 Sep 07	11:19	T	138	0.432	2.111	1.050	103m	18m	23.1	23.10	-5.4
2045 Mar 03	07:42	N	143	-1.028	0.987	-0.012	-	-	10.8	10.93	5.7
2045 Aug 27	13:53	N	148	1.206	0.708	-0.388	-	-	22.4	22.40	-8.8
2046 Jan 22	13:01	P	115	0.988	1.060	0.059	27m	-	8.1	8.35	20.5
2046 Jul 18	01:04	P	120	-0.869	1.307	0.251	58m	-	19.7	19.86	-21.8
2047 Jan 12	01:24	T	125	0.332	2.291	1.239	105m	35m	7.4	7.57	22.0
2047 Jul 07	10:34	T+	130	-0.063	2.757	1.757	110m	51m	19.0	19.11	-22.6
2048 Jan 01	06:52	T	135	-0.375	2.240	1.132	107m	28m	6.7	6.76	22.7
2048 Jun 26	02:01	P	140	0.680	1.607	0.644	80m	-	18.3	18.37	-22.6
2048 Dec 20	06:26	N	145	-1.063	0.988	-0.140	-	-	6.0	5.92	22.5
2049 May 17	11:25	N	112	-1.134	0.789	-0.203	-	-	15.7	15.64	-20.6
2049 Jun 15	19:12	N	150	1.407	0.276	-0.693	-	-	17.6	17.64	-21.9
2049 Nov 09	15:50	N	117	1.196	0.707	-0.350	-	-	3.3	3.00	18.2
2050 May 06	22:30	T	122	-0.418	2.131	1.082	103m	22m	15.0	14.94	-17.2
2050 Oct 30	03:20	T	127	0.443	2.060	1.060	97m	18m	2.6	2.30	14.2
2051 Apr 26	02:14	T	132	0.337	2.303	1.206	111m	35m	14.3	14.24	-13.2
2051 Oct 19	19:10	T+	137	-0.254	2.395	1.417	102m	42m	1.9	1.63	9.9
2052 Apr 14	02:16	N	142	1.063	0.972	-0.126	-	-	13.5	13.55	-8.7
2052 Oct 08	10:44	P	147	-0.973	1.089	0.087	33m	-	1.2	0.99	5.3
2053 Mar 04	17:20	N	114	-1.053	0.958	-0.075	-	-	10.9	11.03	5.1
2053 Aug 29	08:04	N	119	1.016	1.045	-0.028	-	-	22.5	22.53	-8.2
2054 Feb 22	06:49	T	124	-0.324	2.275	1.283	101m	37m	10.2	10.38	9.8
2054 Aug 18	09:24	T	129	0.280	2.407	1.311	114m	42m	21.8	21.86	-12.7
2055 Feb 11	22:44	T	134	0.353	2.222	1.230	100m	33m	9.5	9.71	14.1
2055 Aug 07	10:51	P	139	-0.477	2.032	0.964	102m	-	21.1	21.17	-16.8
2056 Feb 01	12:24	N	144	1.068	0.931	-0.105	-	-	8.8	9.00	18.1
2056 Jun 27	10:01	N	111	1.377	0.340	-0.646	-	-	18.4	18.48	-21.9
2056 Jul 26	18:41	N	149	-1.205	0.669	-0.344	-	-	20.3	20.47	-20.3
2056 Dec 22	01:47	N	116	-1.156	0.812	-0.306	-	-	6.1	6.07	22.4
2057 Jun 17	02:24	P	121	0.617	1.722	0.762	85m	-	17.7	17.75	-22.8
2057 Dec 11	00:51	P	126	-0.485	2.044	0.923	102m	-	5.3	5.24	22.6
2058 Jun 06	19:14	T+	131	-0.118	2.646	1.667	107m	49m	17.0	17.01	-22.8
2058 Nov 30	03:14	T-	136	0.221	2.506	1.431	111m	45m	4.6	4.42	21.9
2059 May 27	07:53	P	141	-0.910	1.220	0.188	49m	-	16.3	16.26	-22.2
2059 Nov 19	12:59	P	146	0.900	1.229	0.213	50m	-	3.9	3.64	20.4
2060 Apr 15	21:35	N	113	1.162	0.794	-0.311	-	-	13.7	13.68	-9.3
2060 Oct 09	18:51	N	118	-1.067	0.905	-0.074	-	-	1.3	1.09	5.8
2060 Nov 08	04:02	N	156	1.533	0.052	-0.932	-	-	3.2	2.90	18.2
2061 Apr 04	21:52	T	123	0.430	2.131	1.039	105m	16m	12.9	12.97	-5.8
2061 Sep 29	09:36	T	128	-0.381	2.181	1.168	102m	30m	0.6	0.43	2.4
2062 Mar 25	03:32	T	133	-0.315	2.316	1.275	106m	38m	12.2	12.28	-2.2
2062 Sep 18	18:32	T	138	0.374	2.221	1.154	107m	30m	23.9	23.75	-1.2
2063 Mar 14	16:04	P	143	-1.001	1.034	0.039	22m	-	11.5	11.61	1.5
2063 Sep 07	20:39	N	148	1.138	0.836	-0.264	-	-	23.1	23.06	-4.9
2064 Feb 02	21:47	P	115	0.997	1.045	0.044	23m	-	8.9	9.11	17.6
2064 Jul 28	07:50	P	120	-0.947	1.162	0.109	39m	-	20.5	20.58	-19.6
2065 Jan 22	09:57	T	125	0.337	2.282	1.228	105m	35m	8.2	8.36	19.8
2065 Jul 17	17:46	Tm	130	-0.140	2.615	1.618	108m	49m	19.7	19.85	-21.1
2066 Jan 11	15:02	T	135	-0.369	2.252	1.142	108m	29m	7.4	7.56	21.4

Lunar Eclipses: 2001 to 2100

(2001 CE to 2100 CE)

Local Circumstances at Greatest Eclipse: 2001 to 2100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
2066 Jul 07	09:28	P	140	0.606	1.742	0.781	86m	-	19.0	19.12	-21.9
2066 Dec 31	14:28	N	145	-1.054	1.003	-0.124	-	-	6.7	6.73	22.1
2067 May 28	18:54	N	112	-1.201	0.666	-0.327	-	-	16.4	16.38	-22.8
2067 Jun 27	02:39	N	150	1.340	0.400	-0.570	-	-	18.4	18.39	-22.0
2067 Nov 21	00:02	N	117	1.211	0.680	-0.376	-	-	4.0	3.76	21.0
2068 May 17	05:40	P	122	-0.485	2.009	0.959	100m	-	15.7	15.65	-20.0
2068 Nov 09	11:44	T	127	0.464	2.022	1.021	95m	11m	3.3	3.02	17.6
2069 May 06	09:07	T-	132	0.272	2.422	1.327	113m	43m	15.0	14.94	-16.5
2069 Oct 30	03:33	T+	137	-0.226	2.448	1.467	103m	44m	2.6	2.33	13.7
2070 Apr 25	09:19	N	142	1.005	1.077	-0.017	-	-	14.2	14.23	-12.5
2070 Oct 19	18:49	P	147	-0.941	1.151	0.143	42m	-	1.9	1.67	9.4
2071 Mar 16	01:29	N	114	-1.076	0.913	-0.114	-	-	11.6	11.71	0.8
2071 Sep 09	15:03	N	119	1.083	0.925	-0.153	-	-	23.3	23.19	-4.2
2072 Mar 04	15:21	T	124	-0.343	2.238	1.250	100m	35m	10.9	11.07	5.6
2072 Aug 28	16:03	T	129	0.356	2.269	1.171	110m	33m	22.5	22.53	-8.9
2073 Feb 22	07:22	T	134	0.339	2.247	1.256	100m	35m	10.2	10.42	10.3
2073 Aug 17	17:40	T	139	-0.400	2.173	1.106	106m	26m	21.8	21.85	-13.4
2074 Feb 11	20:53	N	144	1.061	0.944	-0.092	-	-	9.5	9.74	14.7
2074 Jul 08	17:19	N	111	1.446	0.212	-0.771	-	-	19.1	19.22	-20.9
2074 Aug 07	01:53	N	149	-1.129	0.806	-0.204	-	-	21.1	21.18	-17.4
2075 Jan 02	09:52	N	116	-1.164	0.798	-0.323	-	-	6.8	6.88	21.8
2075 Jun 28	09:53	P	121	0.690	1.587	0.628	79m	-	18.4	18.50	-22.5
2075 Dec 22	08:53	P	126	-0.494	2.027	0.906	102m	-	6.1	6.05	23.0
2076 Jun 17	02:37	Tm	131	-0.045	2.780	1.800	108m	50m	17.7	17.77	-23.4
2076 Dec 10	11:32	T-	136	0.210	2.524	1.450	111m	46m	5.3	5.22	23.2
2077 Jun 06	14:57	P	141	-0.839	1.351	0.317	63m	-	17.0	17.02	-23.5
2077 Nov 29	21:33	P	146	0.886	1.256	0.241	53m	-	4.6	4.42	22.5
2078 Apr 27	04:33	N	113	1.222	0.682	-0.420	-	-	14.4	14.36	-13.0
2078 Oct 21	03:05	N	118	-1.102	0.842	-0.140	-	-	2.0	1.78	9.8
2078 Nov 19	12:37	N	156	1.515	0.086	-0.899	-	-	3.9	3.65	21.1
2079 Apr 16	05:08	P	123	0.480	2.036	0.950	102m	-	13.6	13.65	-9.8
2079 Oct 10	17:28	T	128	-0.424	2.104	1.085	100m	22m	1.3	1.09	6.5
2080 Apr 04	11:21	T	133	-0.275	2.386	1.351	107m	41m	12.9	12.95	-6.4
2080 Sep 29	01:50	T	138	0.321	2.322	1.249	109m	37m	0.6	0.41	3.0
2081 Mar 25	00:19	P	143	-0.969	1.090	0.100	34m	-	12.2	12.28	-2.9
2081 Sep 18	03:32	N	148	1.075	0.953	-0.151	-	-	23.8	23.72	-0.8
2082 Feb 13	06:26	P	115	1.010	1.021	0.019	15m	-	9.6	9.85	14.1
2082 Aug 08	14:44	N	120	-1.020	1.027	-0.024	-	-	21.2	21.29	-16.8
2083 Feb 02	18:24	T	125	0.346	2.266	1.211	105m	34m	8.9	9.11	16.9
2083 Jul 29	01:03	T+	130	-0.214	2.478	1.483	107m	46m	20.5	20.58	-18.9
2084 Jan 22	23:10	T	135	-0.361	2.267	1.155	108m	31m	8.2	8.34	19.2

2084 Jul 17	16:56	P	140	0.531	1.878	0.917	91m	-	19.8	19.86	-20.4
2085 Jan 10	22:29	N	145	-1.046	1.019	-0.108	-	-	7.4	7.52	20.8
2085 Jun 08	02:15	N	112	-1.274	0.532	-0.462	-	-	17.1	17.13	-24.2
2085 Jul 07	10:02	N	150	1.270	0.529	-0.442	-	-	19.1	19.14	-21.2
2085 Dec 01	08:22	N	117	1.219	0.665	-0.390	-	-	4.7	4.54	23.1
2086 May 28	12:41	P	122	-0.558	1.875	0.824	95m	-	16.4	16.39	-22.1
2086 Nov 20	20:17	P	127	0.480	1.994	0.992	94m	-	4.0	3.78	20.4
2087 May 17	15:52	T-	132	0.200	2.553	1.460	116m	48m	15.7	15.65	-19.3
2087 Nov 10	12:02	T+	137	-0.204	2.490	1.506	104m	45m	3.3	3.06	17.1

Lunar Eclipses: 2001 to 2100

(2001 CE to 2100 CE)

Local Circumstances at Greatest Eclipse: 2001 to 2100

Date	U.T. Greatest Eclipse	Type	Saros #	Gamma	Pen. Mag.	Umb. Mag.	S.D. Par	S.D. Tot	GST (0 UT) h	Moon RA h	Moon Dec °
2088 May 05	16:14	P	142	0.939	1.195	0.106	39m	-	15.0	14.92	-15.8
2088 Oct 30	03:00	P	147	-0.915	1.201	0.188	47m	-	2.6	2.37	13.2
2089 Mar 26	09:31	N	114	-1.104	0.859	-0.162	-	-	12.3	12.37	-3.6
2089 Sep 19	22:08	N	119	1.145	0.816	-0.269	-	-	24.0	23.84	0.1
2090 Mar 15	23:45	T	124	-0.367	2.191	1.207	99m	32m	11.6	11.74	1.3
2090 Sep 08	22:49	T	129	0.425	2.143	1.043	107m	17m	23.2	23.18	-4.8
2091 Mar 05	15:55	T	134	0.322	2.278	1.288	101m	37m	10.9	11.11	6.1
2091 Aug 29	00:35	T	139	-0.327	2.306	1.240	109m	37m	22.5	22.52	-9.6
2092 Feb 23	05:18	N	144	1.051	0.963	-0.074	-	-	10.2	10.45	10.8
2092 Jul 19	00:39	Ne	111	1.513	0.087	-0.893	-	-	19.9	19.95	-19.2
2092 Aug 17	09:11	N	149	-1.057	0.938	-0.071	-	-	21.8	21.87	-14.0
2093 Jan 12	17:57	N	116	-1.173	0.782	-0.340	-	-	7.5	7.67	20.4
2093 Jul 08	17:21	P	121	0.763	1.452	0.493	71m	-	19.2	19.25	-21.5
2094 Jan 01	16:57	P	126	-0.502	2.012	0.892	101m	-	6.8	6.85	22.4
2094 Jun 28	09:59	T-	131	0.029	2.812	1.829	108m	51m	18.5	18.53	-23.2
2094 Dec 21	19:53	T-	136	0.202	2.539	1.467	111m	46m	6.1	6.03	23.6
2095 Jun 17	21:57	P	141	-0.766	1.487	0.451	74m	-	17.8	17.78	-24.1
2095 Dec 11	06:12	P	146	0.874	1.276	0.262	55m	-	5.4	5.22	23.9
2096 May 07	11:21	N	113	1.290	0.557	-0.542	-	-	15.1	15.06	-16.1
2096 Jun 06	02:40	Nb	151	-1.573	0.030	-1.054	-	-	17.0	17.00	-24.1
2096 Oct 31	11:27	N	118	-1.131	0.792	-0.195	-	-	2.7	2.48	13.5
2096 Nov 29	21:19	N	156	1.502	0.111	-0.876	-	-	4.7	4.44	23.2
2097 Apr 26	12:15	P	123	0.538	1.928	0.847	98m	-	14.4	14.33	-13.4
2097 Oct 21	01:27	T	128	-0.461	2.041	1.015	98m	10m	2.0	1.78	10.5
2098 Apr 15	19:01	T+	133	-0.227	2.471	1.442	108m	45m	13.6	13.62	-10.4
2098 Oct 10	09:16	T	138	0.275	2.409	1.329	111m	42m	1.3	1.08	7.1
2099 Apr 05	08:27	P	143	-0.931	1.158	0.173	45m	-	12.9	12.95	-7.1
2099 Sep 29	10:33	N	148	1.018	1.060	-0.047	-	-	0.6	0.38	3.4
2100 Feb 24	15:02	N	115	1.027	0.990	-0.011	-	-	10.3	10.55	10.2
2100 Aug 19	21:41	N	120	-1.090	0.898	-0.152	-	-	21.9	21.98	-13.4

Calendar Dates

The Julian calendar is used for all dates up to 1582 Oct 04. After that date, the Gregorian calendar is used. Due to the Gregorian Calendar reform, the day after 1582 Oct 04 (Julian calendar) is 1582 Oct 15 (Gregorian calendar). Note that Great Britian did not adopt the Gregorian calendar until 1752. For more information, see Calendars.

The Julian calendar does not include the year 0, so the year 1 BCE is followed by the year 1 CE. This is awkward for arithmetic calculations. In this catalog, dates are counted using the astronomical numbering system which recognizes the year 0. Historians should note the numerical difference of one year between astronomical dates and BCE dates. Thus, the year 0 corresponds to 1 BCE, and the year -100 corresponds to 101 BCE, etc.. (See: Year Dating Conventions)

There is some historical uncertainty as to which years from 43 BCE to 8 CE were counted as leap years. For the purposes of this catalog, we will assume that *all* Julian years divisible by 4 will be counted as leap years.

Predictions

Eclipse predictions presented here are based on j=2 ephemerides for the Sun (Newcomb, 1895) and Moon (Brown, 1919, and Eckert, Jones and Clark, 1954). A revised value used for the Moon's secular acceleration is n-dot = -26 arc-sec/cy*cy, as deduced by Morrison and Ward (1975) from 250 years of Mercury transit observations.

The largest uncertainty in the eclipse predictions is caused by fluctuations in Earth's rotation due primarily to tidal friction of the Moon. The resultant drift in apparent clock time is expressed as *delta-T*. The value for *delta-T* was determined as follows:

1) pre-1600: delta T was calculated from empirical fits to historical records derived by Stephenson (1997)
2) 1600-present: delta T was obtained from published observations
3) future: delta-T was extrapolated from current values and a model of tidal effects

Acknowledgments

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