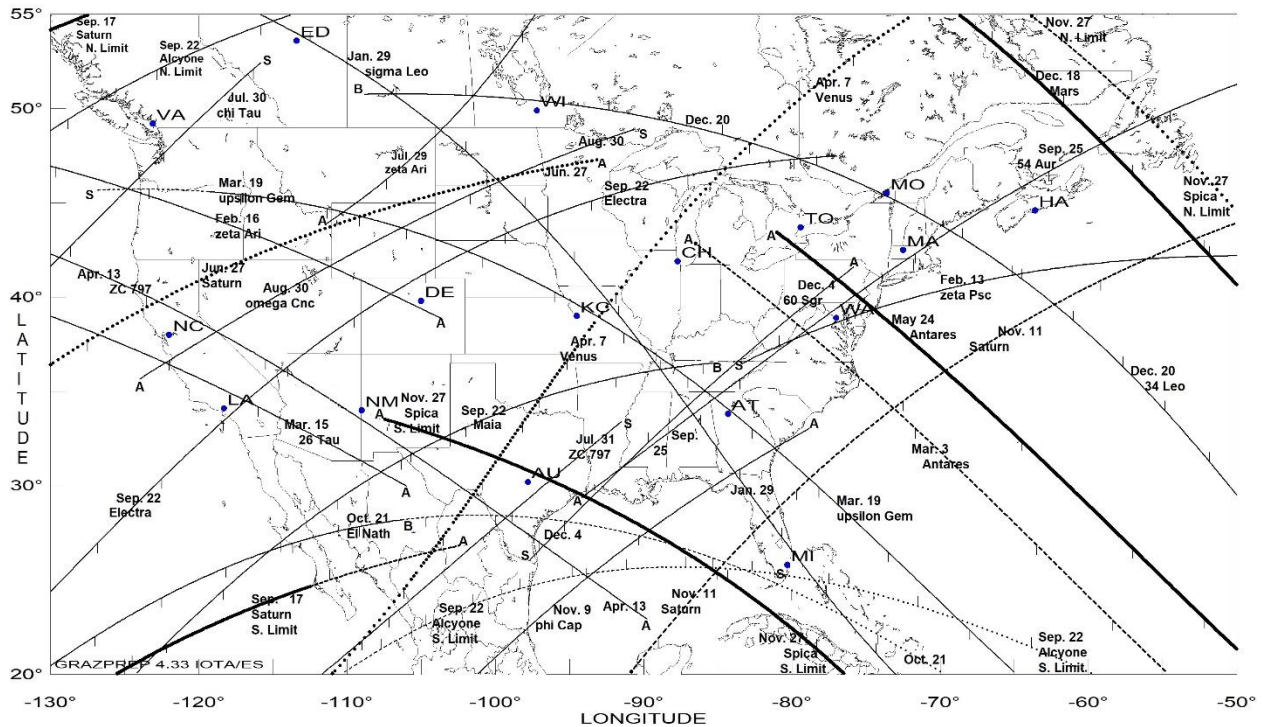


## The Best Lunar Grazing Occultations in North America during 2024

The map below shows the paths of lunar grazing occultations for the 27 brighter stars and planets visible from much of North America in 2024. The events are limited to stars of magnitude 5.5 or brighter that will graze the limb of the Moon when it is at a favorable elongation from the Sun and at least as high above the horizon in degrees as the star's magnitude (e.g., a third-magnitude star is included only if its altitude is at least 3°). Some stars fainter than mag. 5.5 are included, to provide a good geographical distribution of paths. The map is a "false" projection, since the latitude and longitude scales are both linear. This makes it much easier for measuring coordinates or plotting locations with known coordinates than is possible with any other type of projection. The longitude scale is compressed by a factor of  $\cos 50^\circ$ . The maps are not detailed enough for locating oneself in the 2- or 3-km-wide zone where multiple disappearances of the star may occur. You can compute your own detailed predictions for grazing occultations using IOTA's free Occult4 program; for information on how to obtain and use it, see <http://www.lunar-occultations.com/iota/2024iotapredictions.pdf>. If you have trouble calculating your own predictions, detailed predictions of any graze for plotting on larger-scale maps of your region can be obtained by writing to IOTA at PO Box 20313, Fountain Hills, AZ 85268-0313 or better, send an email to [business@occultations.org](mailto:business@occultations.org). For some grazes, IOTA overlays the predicted limit line on the very detailed maps and imagery of maps.google.com, but further corrections are needed based on the predicted lunar profile and the observer's height above sea level. A Web .htm file to do this is generated by IOTA's Occult4 program, see above. The height above sea level in the area where the graze will occur, needs to be specified when generating the .htm file.

The 2024 month and day of month, and the star or planet's name or number are given along each track on the map. Conditions are represented by three different types of lines: solid line = dark limb, night; dashed line = bright limb, night; and dotted line, dark or bright limb, day.

### The best lunar grazing occultations in North America during 2024



Thicker lines are drawn for first-magnitude stars and planets. Many tracks begin and/or end with the letter A, B, or S: A denotes that the Moon is at a low altitude, B that the bright limb interferes, and S that sunlight or twilight interferes. The tick marks along the tracks indicate multiples of 10 min of every hour. For example, if the time for the west end of the track is 3:16.2, the tick marks proceeding eastward correspond

to 3:20, 3:30, etc. Time always increases from west to east along the path. *The time ticks are on the side of the limit with an occultation*, that is north of southern limits and south of northern limits. The locations for the North American standard stations for lunar total occultation predictions given on pages 162-171 of the 2024 *Handbook* are indicated by asterisks on the graze map. 248 grazes are shown on six maps and tables, similar to what we published in the Handbook for previous years, at track on the map.

### Table of the best lunar grazing occultations in North America during 2024

Date	Object Name	ZC No.	d	m	%sl	L	W.U.T.		Lo.	La.
							h	m		
Jan. 29	σ Leonis	ZC 1644		4.0	89-	S	8	55.3	-116	55
Feb. 13	ζ Piscium	ZC 180	B	5.2	21+	S	23	23.6	-84	36
Feb. 16	ζ Arietis	ZC 472	K	4.9	46+	N	7	9.8	-130	47
Mar. 3	Antares	ZC 2366	O	1.1	54-	N	7	34.8	-86	43
Mar. 15	26 Tauri	ZC 559	U	6.5	29+	N	5	41.3	-130	39
Mar. 19	ν Gem	ZC 1149		4.1	69+	N	2	34.4	-127	46
Apr. 7	Venus			-3.3	2-	N	15	43.8	-111	20
Apr. 13		ZC 797	J	6.3	23+	N	3	41.3	-130	42
May 24	Antares	ZC 2366	O	1.1	100-	N	1	53.3	-81	43
June 27	Saturn			1.2	65-	N	16	17.6	-130	36
July 29	ζ Arietis	ZC 472	K	4.9	37-	N	7	8.3	-111	44
July 30	χ Tauri	ZC 647	Y	5.4	25-	N	11	28.1	-130	42
July 31		ZC 797	J	6.3	17-	N	10	46.2	-111	20
Aug. 30	ω Cancrī	ZC 1206		5.9	12-	N	10	49.7	-124	36
Sep. 17	Saturn			0.8	99+	S	11	28.9	-125	20
Sep. 17	Saturn			0.8	99+	N	11	28.5	-130	54
Sep. 22	Electra	ZC 537	U	3.7	76-	N	9	3.2	-130	24
Sep. 22	Maia	ZC 541	V	3.9	76-	N	9	45.1	-124	20
Sep. 22	Alcyone	ZC 552	K	2.9	75-	S	10	41.5	-110	20
Sep. 22	Alcyone	ZC 552	K	2.9	75-	N	10	48.2	-130	49
Sep. 25	54 Aur.	ZC 1022	M	6.0	45-	N	5	55.6	-94	29
Oct. 21	El Nath	ZC 810	Y	1.6	80-	N	9	43.5	-130	20
Nov. 9	φ Cap	ZC 3106		5.2	48+	S	3	40.8	-101	20
Nov. 11	Saturn			1.2	69+	N	2	25.0	-90	20
Nov. 27	Spica	ZC 1925	Z	1.0	13-	S	10	53.5	-108	34
Nov. 27	Spica	ZC 1925	Z	1.0	13-	N	11	23.6	-64	55
Dec. 4	60 Sgr	ZC 2914	V	4.8	13+	S	23	39.0	-97	26
Dec. 18	Mars			-0.9	90-	S	9	36.0	-68	55
Dec. 20	34 Leonis	ZC 1493	O	6.5	74-	S	6	54.5	-127	49

The columns of the table above are explained below:

- Date** ..... The 2024 date
- Object name** .... Planet name, or star's proper name, Bayer Greek letter or Flamsteed number
- ZC/SAO** ..... The star's ZC or Smithsonian Astrophysical Observatory (SAO) catalogue number
- d** ..... Double star code (if the star is double or triple) – see below
- m** ..... The star's visual magnitude
- %sl** ..... the percent of the Moon sunlit (+ for waxing, - for waning, E for lunar eclipse\*)
- L** ..... whether the track is a northern (N) or southern (S) limit
- W.U.T.** ..... the Universal Time at the west end of the track
- Lo., La.** ..... the longitude and latitude of the west end of the track

\*In this case, the number is the % of the Moon's disk that is NOT in the umbral shadow (none in 2024)

### Occulted stars known to be double

In the table below gives data for double stars for which graze predictions are given, either on the map and table above, or on the maps and tables of the 248 grazes portrayed elsewhere on this Web page. The information is from DSFILE, a comprehensive file of zodiacal double-star data compiled by Don Stockbauer, Henk Bulder, Mitsuru Sôma, David Herald, and David Dunham; most of the data for the ZC stars are in the Sato ZC catalogue. The successive columns give the ZC number of the star, the 2024 graze date, the double star code (d), the magnitudes of the brighter (A) and fainter (B) components, the separation in arcseconds, and the position angle (PA) of B from A measured eastward from north. If the star is triple, the third component's magnitude is given under C, and its separation and PA from A are given in the last columns.

The parameters are given for the epoch of the occultation, computed from orbital elements when available or from extrapolations from a long series of observations. If there is little change in the available observations, the last-observed separation and PA are used. Most components fainter than magnitude 12.0 are not listed, and some very close doubles whose parameters are not known, generally with separations less than 0.2", are also not listed. The latter include spectroscopic binaries (code U, or sometimes V) and visual occultation doubles (most codes K and X, and many Vs).

The codes have the following meanings:

- A..... Double listed by Aitken and/or Burnham (ADS, BDS)
- B ..... Triple, with possible close pair discovered by occultation and more distant star visual (A or C)
- C..... Double listed by Innes, Cousteau, or other visual observers
- D..... primary of wide pair; secondary has separate catalogue entry
- H..... triple, with close occultation pair and third visual component; prediction uses a mean position (U, or V & M)
- J..... Single-line spectroscopic binary
- K..... U or V, but duplicity doubtful, only reported "gradual" from a past visual occultation observation
- L..... close triple star (only two stars often listed because inner pair is often spectroscopic; J or U, & V; all V; or all J)
- M..... mean position (centre of light) of a close pair is used by the ZC and/or XZ catalogue
- O..... orbital elements available and used to calculate the separation and PA
- T ..... visual triple star (V and A or C; or all A and/or C)
- U..... Double, separation 0.05" or less, usually a 2-line spectroscopic binary
- V..... Close double discovered by occultation or by interferometry
- W..... Triple, J or U, and A or C
- X..... probable double from occultation (not certain)
- Y ..... triple, K or X (visual A component) and A or C (C component)
- Z ..... triple, O (A/B components) and V (C component) (O and A or C, or V or X or L)

Some close pairs have rapid orbital motion such that the current PA is unknown.

ZC#	2024 Date(s)	d	A	B	Sep. "	PA °	C	Sep. "	PA °
<b>180</b>	<b>Feb. 13</b>	<b>B</b>	<b>6.3</b>	<b>6.3</b>	<b>0.1</b>		<b>6.5</b>	<b>23.0</b>	<b>64</b>
181	Feb. 13	W	6.7	8.7	.001		12.2	1.0	90
485	Jan. 20	M	7.0	10.8	0.6	338			
486	Jan. 20	H	5.4	7.9	0.2	38	8.2	0.8	227
487	Jan. 20	M	5.3	8.5	0.5	289			
567	Mar. 15, Aug. 26	H	6.9	8.9	.004		10.2	3.3	235
598	Feb. 17, Dec. 13	T	6.4	6.4	0.1	214	12.2	25.5	257
<b>647</b>	<b>see Note 1</b>	<b>Y</b>	<b>6.3</b>	<b>6.3</b>	<b>0.1</b>	<b>90</b>	<b>7.6</b>	<b>19.4</b>	<b>24</b>
701	Sep. 23	H	8.0	8.0	0.1		7.4	4.5	9
746	Feb. 18, Aug. 26	A	6.8	8.3	20.5	205			
750	Feb. 18	O	7.1	8.4	0.2	162			
771	Aug. 27	T	6.1	9.1	0.2		8.6	11.8	27
773	Apr. 12, Oct. 21	C	7.1	8.7	14.0	352			
885	Mar. 17, May 11	Y	5.9	7.2	0.01	270	12.0	15.0	232
<b>1022</b>	<b>Mar. 18, Sep. 25</b>	<b>M</b>	<b>6.2</b>	<b>7.8</b>	<b>0.9</b>	<b>36</b>			
1026	Mar. 18, Sep. 25	C	6.5	11.7	30.7	46	10.4	55.9	57
1093	Oct. 23	Z	7.2	7.2	0.7	295	12.3	15.6	94
1181	May 13, Sep. 26	M	7.0	10.1	0.4	208			

1211	May 13, Nov. 20	C	6.2	11.0	45.5	23			
1263	Mar. 20	D	7.1	7.6	5.8	49			
1493	Dec. 20	O	6.8	7.6	0.02	285			
1609	Sep. 30	C	4.7	11.0	5.2	276	9.0	49.3	310
1712	Feb. 26	C	3.8	8.8	105.0	267			
1814	May 19	C	7.0	9.7	57.9	111			
<b>1925</b>	<b>Sep. 6, Nov. 27</b>	<b>Z</b>	<b>1.3</b>	<b>4.5</b>		<b>220</b>	<b>7.5</b>	<b>0.5</b>	<b>180</b>
1971	Jan. 5	M	5.6	8.4	1.1	305	11.9	26.9	164
2134	Nov. 29	D	6.2	8.5	27.1	318			
2287	Sep. 9	W	3.4	4.6	.0003		12.2	50.4	132
<b>2366</b>	<b>Mar. 3, May 24</b>	<b>O</b>	<b>1.2</b>	<b>5.5</b>	<b>2.3</b>	<b>274</b>			
2405	Jul. 18	M	6.6	10.1	2.0	13			
3514	Jan. 16	C	6.9	6.9	0.1	196			

Note 1: For ZC 647, the 2024 dates are April 12, July 30, and Oct. 20

Note 2: For ZC 1925 (Spica), the 2024 dates are Sep. 6 and Nov. 27, but the Sep. 6<sup>th</sup> graze path does not cross our map and thus, is not shown.

The lines in the double star table in bold type are for grazes shown on the map on the first page of this document.

### Names of occulted stars

The stars that are occulted by the Moon are stars that lie along the zodiac; hence they are known by their number in the Zodiacal Catalogue (ZC) compiled by James Robertson and published in the *Astronomical Papers Prepared for the Use of the American Ephemeris and Nautical Almanac, Vol. 10, Part 2* (U.S. Government Printing Office, Washington, 1940). Robertson's ZC has been out of print for many years. In 1986, Isao Sato, a member of the Lunar Occultation Observers Group in Japan, republished the ZC. This new edition is based on the epoch J2000 and includes much new data, particularly on double stars. Since stars are not usually recognized by their ZC numbers, the Bayer designations or Flamsteed numbers of the stars occulted during 2024 are given in the table below. The ZC and larger XZ (now version XZ80Q) catalogues, updated in 2018 by D. Herald using Gaia data, are available through IOTA's website.

ZC Name	ZC Name	ZC/XZ Name
50	44 Psc	1971 86 Vir
146	ε Psc	2029 ET Vir
180	ζ Psc	2237 42 Lib
326	19 Ari	2268 2 Sco
415	40 Ari	2270 V1040 Sco
472	ζ Ari	2286 V913 Sco
486	τ Ari	2287 π Sco
487	63 Ari	2349 σ Sco (Alniyat)
521	9 Tau	2366 α Sco (Antares)
536	16 Tau (Celaeno)	2505 43 Oph
537	17 Tau (Electra)	2910 ω Sgr
539	19 Tau (Taygeta)	2912 59 Sgr (Terebellum)
541	20 Tau (Maia)	2914 60 Sgr
542	21 Tau (Asterope)	3089 χ Cap
543	22 Tau (Sterope II)	3106 φ Cap
545	23 Tau (Merope)	3164 ε Cap
549	24 Tau	3175 κ Cap
552	η Tau (Alcyone)	3288 50 Aqr
559	26 Tau	3339 LQ Aqr
560	27 Tau (Atlas)	3347 70 Aqr
561	28 Tau (Pleione)	3421 χ Aqr
598	36 Tau	3505 20 Psc
647	χ Tau	3514 24 Psc
771	V1156 Tau	X21397 GG Lib
810	β Tau (El Nath)	1925 α Vir (Spica)

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