

ECLIPSES, 2024

In the year 2024, there are two eclipses of the Sun and one eclipse of the Moon.

I	April	8	Total eclipse of the Sun	320–323
II	October	2	Annular eclipse of the Sun	324–327
III	September	18	Partial eclipse of the Moon	328

In addition, there is one Penumbral eclipse of the Moon	March 25	329
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I- Total eclipse of the Sun, 8 April, 2024, Monday.

Not visible in India.

Area of Visibility

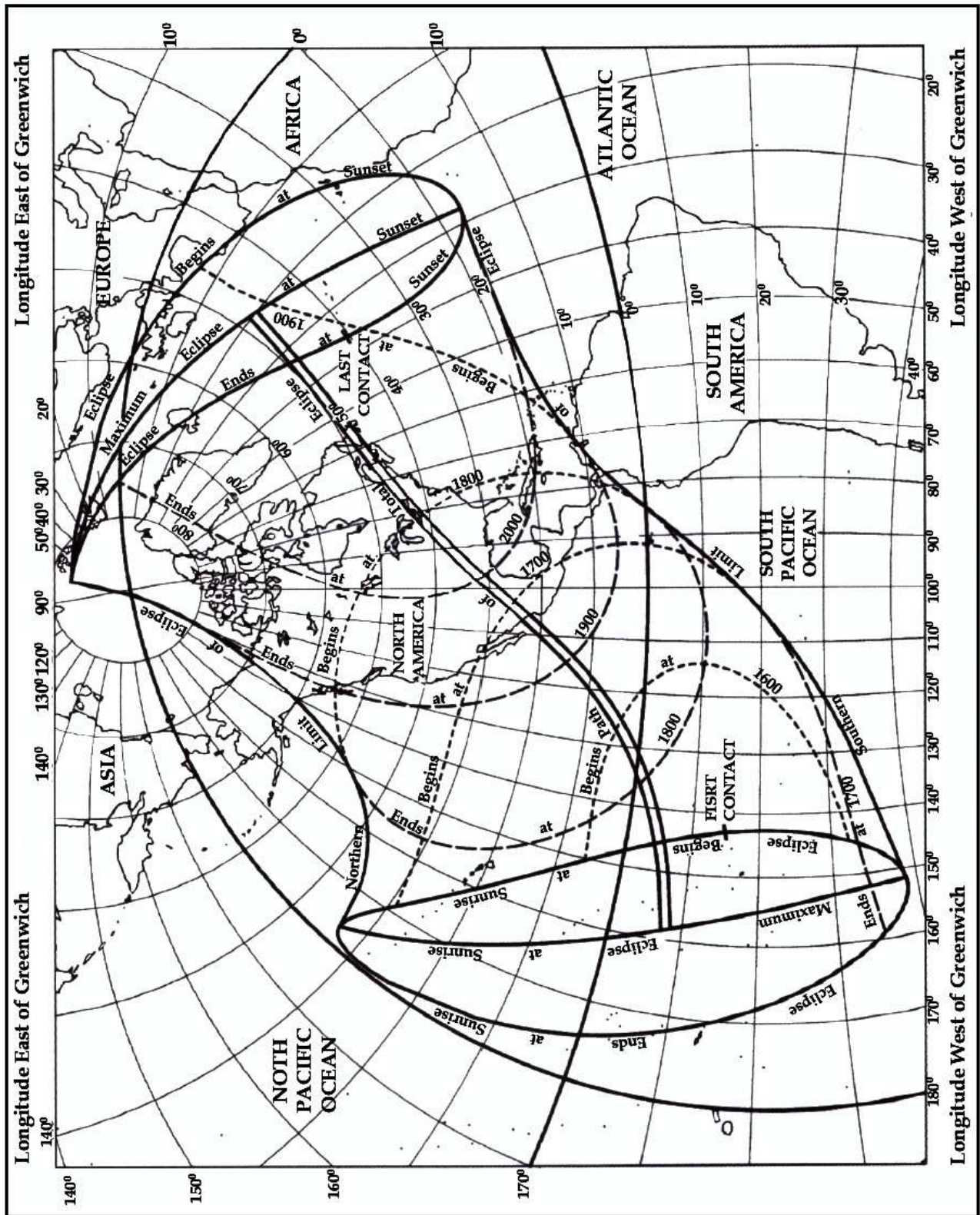
The eclipse will be visible in the region covering Polynesia (inc. Hawaii), most of North America (except Alaska), Central America, Greenland, Iceland, Azores.

ELEMENTS OF THE ECLIPSE						
Universal Time of Conjunction in Right Ascension : April 8 ^d 18 ^h 36 ^m 07 ^s .01						
	MOON			SUN		
	h	m	s	h	m	s
Right Ascension	1	11	39.77	1	11	39.77
Hourly Motion			134.82			9.18
	°	'	"	°	'	"
Declination	7	59	22.39	7	35	46.89
Hourly Motion		17	23.91			55.81
Equatorial Horizontal Parallax		60	56.35			08.78
True Semi-diameter		16	35.94		15	58.19

CIRCUMSTANCES OF THE ECLIPSE										
	Universal Time			Indian Standard Time			Latitude		Longitude	
	d	h	m	d	h	m	°	'	°	'
Eclipse begins	8	15	42.3	8	21	12.3	-14	57.3	-143	07.9
Central eclipse begins	8	16	40.0	8	22	10.0	-7	49.3	-158	32.3
Greatest eclipse*	8	18	17.3	8	23	47.3	+25	17.4	-104	08.7
Central eclipse ends	8	19	54.5	9	01	24.5	+47	37.1	-19	47.6
Eclipse ends	8	20	52.3	9	02	22.3	+40	33.4	-36	05.1

*Magnitude of the eclipse = 1.0561, Duration of eclipse = 5h10 m.
Duration of Central eclipse = 3h14 m, Maximum duration of Annular phase = 4 m 32s.

TOTAL SOLAR ECLIPSE OF APRIL 8, 2024



The timing of beginning and ending are expressed in UT

ECLIPSES, 2024

BESSELIAN ELEMENTS OF THE TOTAL ECLIPSE OF THE SUN
APRIL 8

Terrestrial Time (TT)		Co-ordinates of the Centre of Shadow on the Fundamental Plane		Direction of the Axis of Shadow *				Radius of Penumbra and Umbra on the Fundamental Plane			
h	m	x	y	sin d	cos d	°	μ	'	''	l ₁	l ₂
15	40	-1.511968	-0.412741	+0.131418	+0.991327	54	34	54.0		+0.534733	-0.010288
	50	-1.426730	-0.367550	+0.131461	+0.991321	57	04	56.4		+0.534753	-0.010269
16	00	-1.341488	-0.322360	+0.131504	+0.991316	59	34	58.9		+0.534772	-0.010250
	10	-1.256241	-0.277172	+0.131546	+0.991310	62	05	01.3		+0.534790	-0.010231
	20	-1.170990	-0.231986	+0.131589	+0.991304	64	35	03.8		+0.534808	-0.010214
	30	-1.085735	-0.186802	+0.131632	+0.991299	67	05	06.2		+0.534825	-0.010197
	40	-1.000476	-0.141620	+0.131675	+0.991293	69	35	08.7		+0.534841	-0.010180
	50	-0.915214	-0.096441	+0.131718	+0.991287	72	05	11.1		+0.534856	-0.010165
17	00	-0.829948	-0.051264	+0.131761	+0.991282	74	35	13.6		+0.534871	-0.010150
	10	-0.744679	-0.006090	+0.131803	+0.991276	77	05	16.0		+0.534885	-0.010136
	20	-0.659408	+0.039082	+0.131846	+0.991270	79	35	18.4		+0.534899	-0.010123
	30	-0.574133	+0.084250	+0.131889	+0.991264	82	05	20.9		+0.534911	-0.010110
	40	-0.488857	+0.129416	+0.131932	+0.991259	84	35	23.3		+0.534923	-0.010098
	50	-0.403578	+0.174578	+0.131975	+0.991253	87	05	25.8		+0.534934	-0.010087
18	00	-0.318297	+0.219738	+0.132017	+0.991247	89	35	28.2		+0.534945	-0.010076
	10	-0.233014	+0.264893	+0.132060	+0.991242	92	05	30.7		+0.534955	-0.010066
	20	-0.147731	+0.310046	+0.132103	+0.991236	94	35	33.1		+0.534964	-0.010057
	30	-0.062445	+0.355194	+0.132146	+0.991230	97	05	35.5		+0.534972	-0.010049
	40	+0.022841	+0.400339	+0.132189	+0.991225	99	35	38.0		+0.534980	-0.010041
	50	+0.108128	+0.445480	+0.132231	+0.991219	102	05	40.4		+0.534987	-0.010034
19	00	+0.193415	+0.490616	+0.132274	+0.991213	104	35	42.9		+0.534993	-0.010028
	10	+0.278703	+0.535749	+0.132317	+0.991207	107	05	45.3		+0.534999	-0.010022
	20	+0.363991	+0.580877	+0.132360	+0.991202	109	35	47.7		+0.535004	-0.010018
	30	+0.449278	+0.626001	+0.132403	+0.991196	112	05	50.2		+0.535008	-0.010013
	40	+0.534565	+0.671120	+0.132445	+0.991190	114	35	52.6		+0.535011	-0.010010
	50	+0.619852	+0.716235	+0.132488	+0.991185	117	05	55.1		+0.535014	-0.010007
20	00	+0.705138	+0.761344	+0.132531	+0.991179	119	35	57.5		+0.535016	-0.010005
	10	+0.790422	+0.806449	+0.132574	+0.991173	122	05	59.9		+0.535017	-0.010004
	20	+0.875705	+0.851548	+0.132617	+0.991167	124	36	02.4		+0.535018	-0.010003
	30	+0.960987	+0.896642	+0.132659	+0.991162	127	06	04.8		+0.535018	-0.010004
	40	+1.046267	+0.941731	+0.132702	+0.991156	129	36	07.2		+0.535017	-0.010004
	50	+1.131545	+0.986815	+0.132745	+0.991150	132	06	09.7		+0.535015	-0.010006
21	00	+1.216820	+1.031892	+0.132788	+0.991144	134	36	12.1		+0.535013	-0.010008

tanf1= 0.00467585

tanf2= 0.00465259

TT hr	d ° ' "			Variations per minute		
				x	y	μ ' "
16	7	33	23	+0.008 525	0.004 519	15 00
17	7	34	17	+0.008 527	0.004 517	15 00
18	7	35	10	+0.008 529	0.004 513	15 00
19	7	36	04	+0.008 529	0.004 513	15 00
20	7	36	57	+0.008 528	0.004 510	15 00

$$\xi' = 0.004364\rho\cos\phi' \cos(\mu+\lambda) \quad \eta' = 0.004364\xi\text{sin}d$$

*d stands for declination and μ stands for hourangle

ECLIPSES, 2024

PATH OF CENTRAL PHASE DURING THE ECLIPSE OF THE SUN
APRIL 8

Terrestrial Time (TT) h m	Northern Limit		Central Line		Southern Limit		Central Line
	Latitude ° ' "	Longitude ° ' "	Latitude ° ' "	Longitude ° ' "	Latitude ° ' "	Longitude ° ' "	Duration of Totality m s
Limit	-7 10.6	-158 44.5	-7 49.3	-158 32.2	-8 27.8	-158 20.2	- -
16 40	- -	- -	-7 43.8	-157 52.1	-7 35.9	-152 58.8	2 05
16 50	-1 37.6	-138 00.6	-2 03.6	-137 01.4	-2 30.1	-136 03.5	2 53
17 00	+2 10.5	-130 34.1	+1 42.4	-129 42.4	+1 14.1	-128 51.4	3 16
17 10	+5 36.3	-125 26.1	+5 07.0	-124 37.1	+4 37.7	-123 48.6	3 34
17 20	+8 50.3	-121 24.2	+8 20.2	-120 36.6	+7 50.1	-119 49.3	3 48
17 30	+11 57.0	-118 00.3	+11 26.2	-117 13.5	+10 55.4	-116 27.1	3 59
17 40	+14 58.6	-114 59.4	+14 27.0	-114 13.4	+13 55.5	-113 27.6	4 09
17 50	+17 56.8	-112 12.1	+17 24.3	-111 26.7	+16 51.9	-110 41.6	4 16
18 00	+20 52.4	-109 31.4	+20 18.9	-108 46.7	+19 45.5	-108 02.3	4 21
18 10	+23 46.3	-106 51.6	+23 11.7	-106 07.7	+22 37.1	-105 24.1	4 24
18 20	+26 38.9	-104 07.3	+26 03.0	-103 24.5	+25 27.2	-102 41.9	4 25
18 30	+29 30.8	-101 13.0	+28 53.4	-100 31.6	+28 16.1	-99 50.5	4 23
18 40	+32 22.0	-98 02.5	+31 42.9	-97 23.2	+31 04.0	-96 44.0	4 20
18 50	+35 12.6	-94 28.4	+34 31.7	-93 51.7	+33 51.1	-93 15.3	4 15
19 00	+38 02.2	-90 20.5	+37 19.5	-89 47.8	+36 36.9	-89 15.1	4 07
19 10	+40 50.1	-85 24.8	+40 05.3	-84 57.7	+39 20.9	-84 30.4	3 56
19 20	+43 34.1	-79 19.6	+42 47.5	-79 00.7	+42 01.3	-78 41.4	3 43
19 30	+46 10.1	-71 27.8	+45 22.2	-71 21.6	+44 34.7	-71 14.3	3 26
19 40	+48 27.8	-60 31.9	+47 40.0	-60 47.2	+46 52.4	-61 00.1	3 05
19 50	+49 48.7	-42 09.3	+49 06.7	-43 17.8	+48 24.1	-44 18.5	2 35
Limit	+48 14.7	-19 29.1	+47 37.2	-19 47.4	+46 59.8	-20 05.2	-

II-Annular eclipse of the Sun, 2 October, 2024, wednesday.

Not Visible in India

Area of Visibility

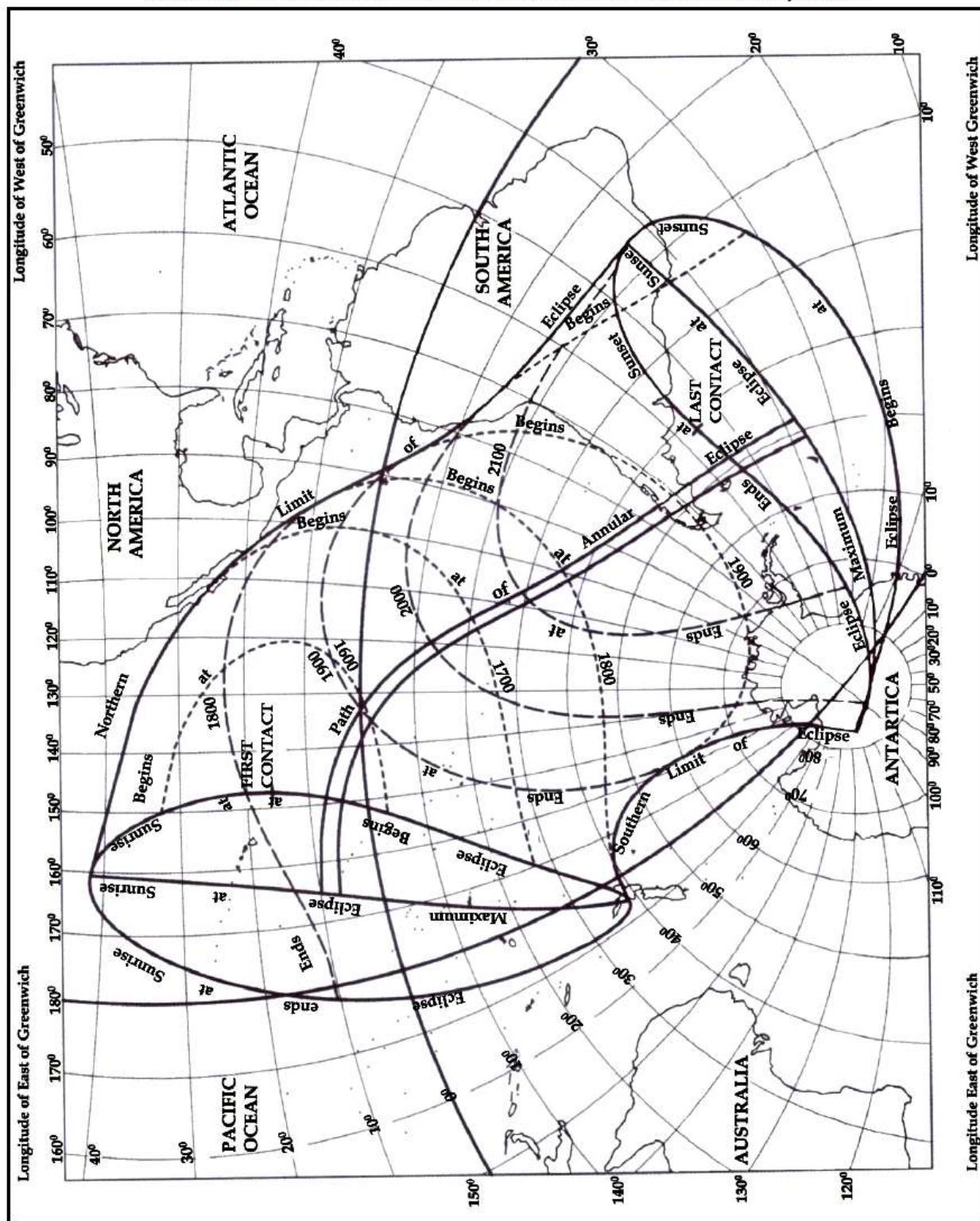
The eclipse will be visible in the region covering Polynesia (including Hawaii), parts of western Mexico, Galapagos Islands, southern half of South America, parts of Antarctica, south Georgia.

ELEMENTS OF THE ECLIPSE						
Universal Time of Conjunction in Right Ascension :October 2 ^d 19 ^h 08 ^m 04 ^s .36						
	MOON			SUN		
	h	m	s	h	m	s
Right Ascension	12	37	02.37	12	37	02.37
Hourly Motion			104.39			09.08
	°	'	"	°	'	"
Declination	-4	20	59.26	-3	59	26.15
Hourly Motion		-14	3.73			-57.98
Equatorial Horizontal Parallax		53	56.38			08.79
True Semi-diameter		14	41.91		15	58.96

CIRCUMSTANCES OF THE ECLIPSE										
	Universal Time			Indian Standard Time			Latitude		Longitude	
	d	h	m	d	h	m	°	'	°	'
Eclipse begins	2	15	43.1	2	21	13.1	+16	02.0	-147	21.3
Central eclipse begins	2	16	53.6	2	22	23.6	+8	22.8	-165	33.0
Greatest eclipse*	2	18	45.0	3	00	15.0	-21	56.9	-114	31.1
Central eclipse ends	2	20	36.2	3	02	06.2	-49	28.8	-37	05.0
Eclipse ends	2	21	46.9	3	03	16.9	-41	51.8	-55	50.1

*Magnitude of the eclipse = 0.932, Duration of eclipse = 6h04 m.
Duration of Central eclipse = 3h43 m, Maximum duration of Annular phase = 7 m 21s.

ANNULAR SOLAR ECLIPSE OF OCTOBER 2, 2024



The timing of beginning and ending are expressed in UT

BESSELIAN ELEMENTS OF THE ANNULAR ECLIPSE OF THE SUN
OCTOBER 2

Terrestrial Time (TT)		Co-ordinates of the Centre of Shadow on the Fundamental Plane		Direction of the Axis of Shadow *					Radius of Penumbra and Umbra on the Fundamental Plane	
h	m	x	y	sin d	cos d	μ			l ₁	l ₂
						°	'	"		
15	40	-1.539773	+0.448982	-0.068634	+0.997642	57	42	59.8	+0.569257	+0.024236
	50	-1.466212	+0.408366	-0.068679	+0.997639	60	13	02.4	+0.569268	+0.024247
16	00	-1.392647	+0.367751	-0.068724	+0.997636	62	43	05.0	+0.569278	+0.024257
	10	-1.319079	+0.327137	-0.068769	+0.997633	65	13	07.6	+0.569287	+0.024266
	20	-1.245508	+0.286522	-0.068814	+0.997630	67	43	10.2	+0.569296	+0.024275
	30	-1.171934	+0.245909	-0.068859	+0.997626	70	13	12.8	+0.569304	+0.024283
	40	-1.098357	+0.205295	-0.068904	+0.997623	72	43	15.4	+0.569312	+0.024291
	50	-1.024777	+0.164683	-0.068949	+0.997620	75	13	18.0	+0.569319	+0.024298
17	00	-0.951194	+0.124071	-0.068994	+0.997617	77	43	20.6	+0.569326	+0.024305
	10	-0.877610	+0.083460	-0.069039	+0.997614	80	13	23.2	+0.569332	+0.024311
	20	-0.804022	+0.042850	-0.069084	+0.997611	82	43	25.8	+0.569337	+0.024316
	30	-0.730433	+0.002241	-0.069129	+0.997608	85	13	28.4	+0.569342	+0.024321
	40	-0.656841	-0.038367	-0.069174	+0.997605	87	43	31.0	+0.569346	+0.024325
	50	-0.583248	-0.078974	-0.069219	+0.997601	90	13	33.6	+0.569350	+0.024329
18	00	-0.509652	-0.119580	-0.069264	+0.997598	92	43	36.2	+0.569353	+0.024332
	10	-0.436055	-0.160184	-0.069309	+0.997595	95	13	38.8	+0.569356	+0.024335
	20	-0.362456	-0.200787	-0.069354	+0.997592	97	43	41.4	+0.569358	+0.024336
	30	-0.288856	-0.241389	-0.069399	+0.997589	100	13	44.0	+0.569359	+0.024338
	40	-0.215254	-0.281989	-0.069444	+0.997586	102	43	46.6	+0.569360	+0.024339
	50	-0.141650	-0.322588	-0.069489	+0.997583	105	13	49.2	+0.569360	+0.024339
19	00	-0.068046	-0.363185	-0.069534	+0.997580	107	43	51.7	+0.569360	+0.024338
	10	+0.005559	-0.403781	-0.069579	+0.997576	110	13	54.3	+0.569358	+0.024337
	20	+0.079166	-0.444374	-0.069624	+0.997573	112	43	56.9	+0.569357	+0.024336
	30	+0.152773	-0.484966	-0.069669	+0.997570	115	13	59.5	+0.569355	+0.024333
	40	+0.226381	-0.525556	-0.069714	+0.997567	117	44	02.1	+0.569352	+0.024331
	50	+0.299989	-0.566143	-0.069759	+0.997564	120	14	04.7	+0.569348	+0.024327
20	00	+0.373598	-0.606729	-0.069804	+0.997561	122	44	07.3	+0.569344	+0.024323
	10	+0.447207	-0.647313	-0.069849	+0.997557	125	14	09.9	+0.569340	+0.024318
	20	+0.520817	-0.687894	-0.069894	+0.997554	127	44	12.5	+0.569334	+0.024313
	30	+0.594426	-0.728473	-0.069939	+0.997551	130	14	15.0	+0.569328	+0.024307
	40	+0.668036	-0.769050	-0.069984	+0.997548	132	44	17.6	+0.569322	+0.024301
	50	+0.741645	-0.809624	-0.070029	+0.997545	135	14	20.2	+0.569315	+0.024294
21	00	+0.815254	-0.850196	-0.070074	+0.997542	137	44	22.8	+0.569307	+0.024286
	10	+0.888863	-0.890765	-0.070119	+0.997538	140	14	25.4	+0.569299	+0.024277
	20	+0.962471	-0.931331	-0.070164	+0.997535	142	44	28.0	+0.569290	+0.024268
	30	+1.036079	-0.971895	-0.070209	+0.997532	145	14	30.6	+0.569280	+0.024259
	40	+1.109686	-1.012456	-0.070254	+0.997529	147	44	33.1	+0.569270	+0.024249
	50	+1.183292	-1.053014	-0.070299	+0.997526	150	14	35.7	+0.569259	+0.024238
22	00	+1.256897	-1.093569	-0.070344	+0.997523	152	44	38.3	+0.569247	+0.024226

tanf1= 0.00469570

tanf2= 0.00467234

TT	d			Variations per minute		
				x'	y'	μ'
hr	°	'	"			"
16	-3	56	26	+0.007 357	-0.004 061	15 00
17	-3	57	22	+0.007 360	-0.004 060	15 00
18	-3	58	18	+0.007 360	-0.004 060	15 00
19	-3	59	14	+0.007 361	-0.004 060	15 00
20	-4	00	10	+0.007 361	-0.004 058	15 00
21	-4	01	06	+0.007 361	-0.004 057	15 00

$$\xi' = 0.004364\rho\cos\phi'\cos(\mu+\lambda) \quad \eta' = 0.004364\xi\sin d$$

*d stands for declination and μ stands for hour angle

ECLIPSES, 2024

PATH OF CENTRAL PHASE DURING THE ANNULAR ECLIPSE OF THE SUN
OCTOBER 02

Terrestrial Time (TT) h m	Northern Limit		Central Line		Southern Limit		Central Line
	Latitude ° ' "	Longitude ° ' "	Latitude ° ' "	Longitude ° ' "	Latitude ° ' "	Longitude ° ' "	Duration of Annularity m s
Limit	+9 50.1	-165 10.0	+8 22.8	-165 33.0	+6 54.6	-165 57.0	- -
17 00	+6 30.8	-146 48.8	+5 37.8	-148 59.3	+4 43.9	-151 25.3	6 12
17 10	+3 25.1	-139 02.5	+2 34.8	-140 39.3	+1 43.5	-142 21.0	6 31
17 20	+0 34.2	-133 59.7	+0 13.3	-135 24.5	-1 01.9	-136 52.3	6 44
17 30	-2 09.2	-130 11.5	-2 54.5	-131 29.9	-3 40.9	-132 50.3	6 55
17 40	-4 48.0	-127 07.1	-5 31.6	-128 21.1	-6 16.1	-129 -36.9	7 04
17 50	-7 23.7	-124 30.7	-8 05.9	-125 41.8	-8 49.0	-126 54.2	7 11
18 00	-9 57.0	-122 13.2	-10 38.3	-123 22.0	-11 20.6	-124 31.9	7 17
18 10	-12 28.8	-120 08.2	-13 09.6	-121 15.2	-13 51.3	-122 23.3	7 22
18 20	-14 59.5	-118 11.1	-15 40.2	-119 16.6	-16 21.8	-120 -23.2	7 25
18 30	-17 29.6	-116 17.8	-18 -10.6	-117 22.3	-18 52.5	-118 27.6	7 28
18 40	-19 59.4	-114 25.2	-20 41.2	-115 28.7	-21 23.7	-116 33.0	7 30
18 50	-22 29.2	-112 29.8	-23 12.2	-113 32.5	-23 56.0	-114 36.0	7 31
19 00	-24 59.5	-110 28.5	-25 44.1	-111 30.3	-26 29.5	-112 32.8	7 30
19 10	-27 30.3	-108 17.4	-28 17.1	-109 18.2	-29 04.6	-110 19.7	7 29
19 20	-30 02.0	-105 52.1	-30 51.5	-106 51.7	-31 41.7	-107 51.9	7 26
19 30	-32 34.6	-103 07.3	-33 27.5	-104 05.0	-34 21.1	-105 03.3	7 23
19 40	-35 08.4	-99 55.6	-36 05.2	-100 50.5	-37 03.0	-101 45.7	7 17
19 50	-37 43.2	-96 06.7	-38 44.8	-96 57.0	-39 47.6	-97 47.3	7 10
20 00	-40 18.5	-91 24.9	-41 25.9	-92 07.6	-42 34.6	-92 49.6	7 01
20 10	-42 53.2	-85 23.7	-44 -07.3	-85 53.1	-45 23.3	-86 20.2	6 50
20 20	-45 23.9	-77 10.3	-46 46	-77 13.9	-48 10.5	-77 11.2	6 35
20 30	-47 39.8	-64 17	-49 10.1	-63 12.7	-50 43.3	-61 43.7	6 13
Limit	-48 01.9	-37 36.2	-49 28.7	-37 05.2	-50 56.3	-36 32.0	- -

III- Partial eclipse of the Moon, 18 September, 2024, Wednesday

Not Visible in India

Eclipse will be visible in the region covering Parts of Antarctica, Western Indian Ocean, Middle East, Africa, Europe, Atlantic Ocean, Americas (Except western most Alaska), eastern Polynesia.

The places from where the beginning of Umbral phase is visible at the time of moonset are- Crozet Island, Madagascar, Somalia, Most parts of Saudi Arabia, Iraq, Some parts of Iran, Some parts of Russia.

The places from where the ending of Umbral phase is visible at the time of moonrise are- South Pacific Ocean, North Pacific Ocean, Canada..

ELEMENTS OF THE ECLIPSE						
Universal Time of Opposition in Right Ascension :September 18 ^d 01 ^h 48 ^m 28 ^s .36						
	MOON			SUN		
	h	m	s	h	m	s
Right Ascension	23	44	01.42	11	44	01.42
Hourly Motion			134.08			08.96
	°	'	"	°	'	"
Declination	-2	52	23.72	1	43	48.00
Hourly Motion		18	12.98			-58.06
Equatorial Horizontal Parallax		61	20.01			08.75
True Semi-diameter		16	42.38		15	55.06

CIRCUMSTANCES OF THE ECLIPSE											
	Universal Time			Indian Standard Time			Position Angle measured from the North Point of Moon's Limb (N.E.S.W.)	The Moon being in the Zenith in			
	d	h	m	d	h	m		Latitude		Longitude	
							°	°	'	°	'
Moon enters penumbra	18	0	39.3	18	06	09.3	22	-3	13	-11	36
Moon enters umbra	18	2	11.8	18	07	41.8	349	-2	45	-33	57
Middle of the eclipse*	18	2	44.2	18	08	14.2	—	-2	35	-41	46
Moon leaves umbra	18	3	16.6	18	08	46.6	313	-2	26	-49	35
Moon leaves penumbra	18	4	49.2	18	10	19.2	299	-1	57	-71	55

*Magnitude of the eclipse =0.090(Moon's diam =1.0). Distance between the centers at middle 3603".8

Radius of shadow cone at Moon's distance: Penumbra 4730".4, Umbra 2782".1

EASTERN AND WESTERN LIMITS OF VISIBILITY

Eastern Limit Moonset at beginning (2h 11.8m U.T.)				Western Limit Moonrise at ending (3h 16.6m U.T.)							
Latitude	Longitude		Latitude	Longitude		Latitude	Longitude				
°	°	'	°	°	'	°	°	'			
-50	+59	21	+10	+55	34	-50	-142	28	+10	-139	09
-40	+58	22	+20	+55	03	-40	-141	37	+20	-138	42
-30	+57	39	+30	+54	28	-30	-140	59	+30	-138	11
-20	+57	04	+40	+53	44	-20	-140	28	+40	-137	32
-10	+56	32	+50	+52	46	-10	-140	00	+50	-136	41
0	+56	03	+60	+51	16	0	-139	35	+60	-135	22

The eclipse is visible in the region west of the eastern limit and east of the western limit. Here, moonset and moonrise times relate to visibility of the center of the Moon on the horizon.

PENUMBRAL ECLIPSE OF THE MOON, March 25, 2024, Monday

CIRCUMSTANCES OF THE ECLIPSE											
	Universal Time			Indian Standard Time			Position Angle from the North Point of Moon's Limb (N.E.S.W)**	The Moon being in the Zenith in			
	d	h	m	d	h	m		Latitude		Longitude	
	d	h	m	d	h	m	°	°	'	°	'
Moon enters penumbra	25	4	51.0	25	10	21.0	161	+0	38	-71	53
Middle of the eclipse*	25	7	12.8	25	12	42.8	-	-1	12	-105	47
Moon leaves penumbra	25	9	34.7	25	15	04.7	257	-1	46	-140	31

* Penumbral magnitude of eclipse: 0.982

** N.E.S.W stands for North, East, South and West

Note : - A penumbral eclipse of the Moon is not to be taken as an eclipse of the Moon in the ordinary sense, as the Moon is not covered by the real shadow of the Earth during such an eclipse.