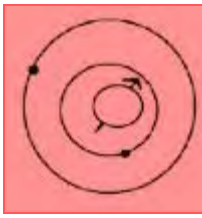

Feature Story

A Preview of the 2019 – 2021 Perihelic Apparition of Mars

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Introduction

The most colorful of planets has begun a perihelic apparition that will be the second best apparition since 2003. Observers all over the world will have good views. You will want to make Mars a priority in your 2020 observing plans.

The Apparition

Salient dates of the apparition, together with magnitude and apparent diameter on those dates, are listed in Table 1. Traditionally, the observing season has been considered to start when the apparent diameter of Mars reaches 6 arc seconds and to end when it declines to that size. The beginning and end of the observing season given in Table 1 reflect that tradition. For many visual observers, 6 arc seconds remains a reasonable limit, but some imagers have been making useful observations of dust storms, clouds, and polar cap changes when Mars is as small as 4 arc seconds in diameter. Furthermore, many modern amateurs use instruments larger than those available to previous generations, so that the 6 arc second limit may seem obsolete.

This is a perihelic apparition, so that Mars will appear bright to the naked eye and large in the eyepiece. The only opposition since 2003 in which Mars appeared this large and bright was the 2018 apparition. As Table 1 indicates, the brightness at opposition will be -2.62 magnitude, while at closest approach to Earth it will be slightly less bright at magnitude -2.57 magnitude. This is slightly less brilliant (0.16 magnitudes fainter) than Mars was when at its brightest during the 2018 apparition. Note that when Jupiter is at opposition on July 14, 2020, the gas giant will be of magnitude -2.8, so Mars will not outshine it in 2020.

Table 1. Important Dates of the 2019 – 2021 Apparition

yyyy-mm-dd*	Event	Mag	Diam**
2019-09-02	Opening conjunction	1.73	3.50
2020-03-19	Observing season begins	0.92	6.00
2020-06-21	Western quadrature***	-0.35	10.72
2020-09-09	Retrograde motion begins	-2.02	20.20
2020-10-06	Closest approach	-2.57	22.57
2020-10-14	Opposition	-2.62	22.33
2020-11-15	Retrograde motion ends	-1.64	17.32
2021-01-22	Eastern quadrature***	0.26	8.50
2021-03-10	Observing season ends	1.05	6.00
2021-10-08	Ending conjunction	1.64	3.56

* Dates are in universal time.
** "Diam" is the apparent subtended diameter in arc-seconds.
*** Quadratures are determined as the dates when the actual separation in the sky is 90 degrees, rather than the separation as measured with reference to the celestial equator.

Online Features

Left-click your mouse on:

- The authors' e-mail addresses in blue text to contact them.
- The hyperlinks and source material references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Table 1 indicates that the closest approach to Earth will occur eight days before opposition. This is due to the opposition's occurrence somewhat after Mars's perihelion. For the same reason, Mars will appear larger and brighter at western quadrature than it will at eastern quadrature.

Figure 1 graphs the Martian apparent diameter and magnitude as they change with the progression of this apparition. At close apparitions such as this one, the observing season is longer than it is at aphelic apparitions — 357 days in 2020 (about as long as the 358 days in 2018), and better than the 341 days in 2016.

Mars in the Sky

During apparitions that have the closest oppositions, such as the 2018 apparition, the planet Mars usually has a southerly declination in Earth's sky for most of the observing season. In contrast, during this apparition Mars will be south of the Celestial Equator until July 12, 2020, when it enters the northern sky, where it will stay throughout the rest of the apparition. Its declination will be +5.3 degrees at its opposition on July 27, 2020, but the most northerly declination of +24.9 degrees will not occur until April 24, 2021. The changes in declination as the

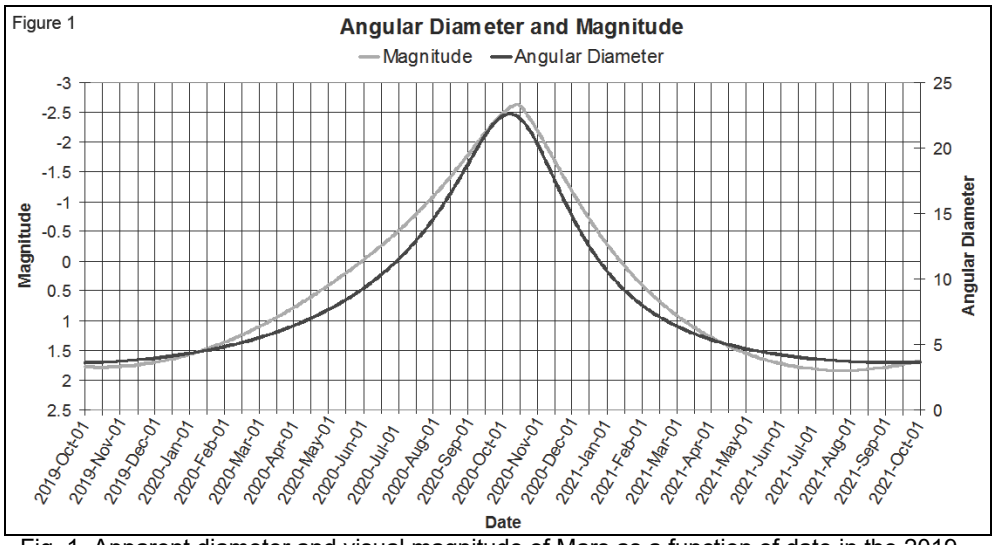


Fig. 1. Apparent diameter and visual magnitude of Mars as a function of date in the 2019-2021 apparition.

Fig. 2. Declination and elongation of Mars as a function of date in the 2019 - 2021 apparition.

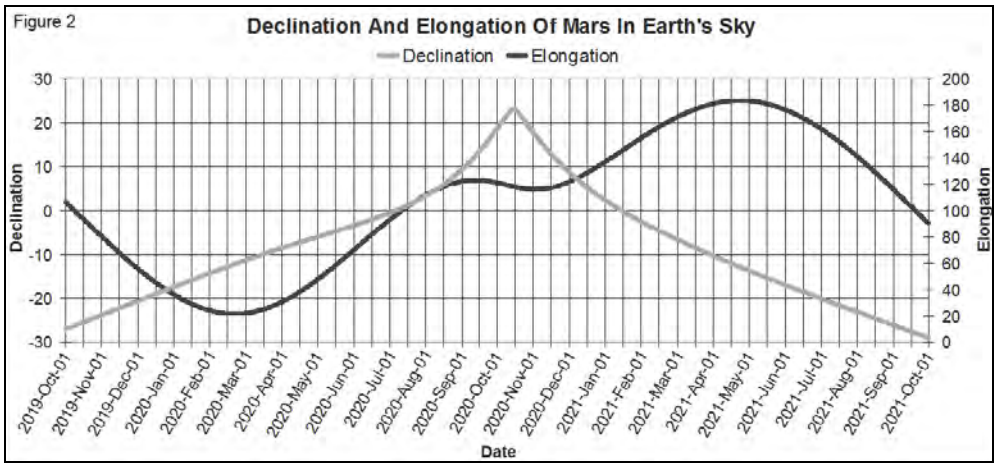
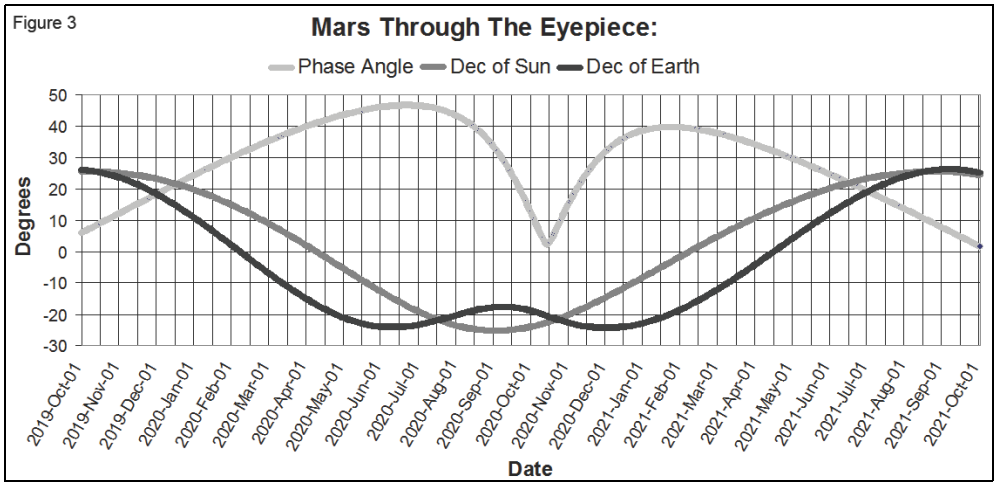


Fig. 3. The phase angle, declination of the Sun and declination of Earth as a function of date in the 2019 - 2021 apparition.



apparition progresses are graphed in Figure 2. Although observers in Earth's Southern Hemisphere are favored during the early months of the apparition and northern observers are favored in the latter months, there will be good views for all observers in the best observing days near opposition, as the planet will be near the Celestial Equator.

Mars in the Telescope

After the apparent size of the planet's disc, the next most important characteristic of the planet's appearance is its oval shape. The phase (Sun-Mars-Earth) angle will peak at 46.6 degrees before opposition on June 21, 2020, and at 39.6 degrees after opposition, on January 22, 2021. This is graphed in Figure 3. The fraction of the planet's disc that appears to be illuminated by the Sun is lowest when the phase angle is highest. The fraction illuminated begins and ends the apparition with values near 1.0 and has a similar value at opposition. The lowest values of fraction illuminated are at quadrature: 0.844 before opposition and 0.885 after opposition. The unilluminated crescent of the planet, called the "illumination defect", is on the preceding side of the planet before opposition and on the following side of the planet after opposition. The unilluminated part of the planet cannot be seen or imaged, though on rare occasions very high clouds have been imaged over it.

Knowledge of the location of the illumination defect helps the observer interpret what he is seeing. The declinations of the Earth and Sun in the Martian sky are graphed in Figure 3 and can be compared to the simulated views in Figure 4. Thoughtful interpretation of these figures will tell the observer whether his view of the polar caps is affected by the location of the illumination defect. For example, on March 18, 2020, the Earth has a southern declination in the Martian sky so that one might see the South Pole if it is illuminated by the Sun. However, the Sun on that date has a northern declination, indicating that the South

Figure 4. Jeff Beish's diagrams of expected appearances of Mars during the observing season of 2019-2021.

Pole is not illuminated, and so cannot be seen, though part of the South Polar Cap will be visible as indicated in Figure 4. Because the areocentric declination of Earth is more negative than that of the Sun for most of the apparition, the illumination defect extends "behind" the South Pole for much of the apparition. Only during a three-month period ending near the time of opposition can one see the actual southern limb of the planet. Thus, the polar caps are often partially obscured by the illumination defect, and may display peculiar shapes that an observer can understand by knowing the location of the illumination defect.

The seasons of Mars are the next important characteristic of the planet that observers should witness. The season of the Martian year can be understood simply by following the areocentric declination of the Sun in Figure 3. At the beginning of the observing season on March 19, 2020, the areocentric declination of the Sun is positive, and it is declining, indicating that Mars is in northern summer and southern winter. The equinox on April 8 marks the beginning of northern autumn, and the next solstice is September 2, which marks the beginning of northern winter and southern summer. Lastly, northern spring and southern autumn will begin on February 7, 2021.

Figure 3 shows that in the beginning and the ending parts of the observing season the North Pole will be tilted toward the Earth. During the central part of the observing season the South Pole will be tilted toward Earth, as indicated by the areocentric declination of the Earth (also shown in Figure 3). This will render the albedo features of the south temperate latitudes readily visible.

The simulated images in Figure 4 show the expected appearance of the planet at intervals during the coming apparition. Celestial south is up and celestial west (the preceding side) is to the left in these depictions. Notice how the apparent axial tilt of the planet changes during the apparition as the Earthly perspective on it changes.

Polar Caps and Surface Frosts

The South Polar Cap (SPC) is large early in the observing season, but is partly hidden by the illumination defect. The SPC will have shrunken to a small size by the time of closest approach, and remains small for the rest of the observing season (Figure 4). As the SPC shrinks, look for Novus Mons, a white frosty area left behind as the SPC recedes, centered at longitude 315 degrees and latitude 72 degrees south. It should be best seen in early August 2020. Novus Mons means "new mountain" and its other name is "the Mountains of Mitchel." These alpine names were given because early observers considered it likely that frost would linger in a mountainous area as the SPC receded. It is now known that the area is not particularly mountainous. Around the time of opposition, observers can detect that the small, residual SPC is not centered exactly on the South Pole. This can be discerned by comparing its visibility from night to night, as it will be nearer the southern limb of the planet on some nights than on others.

Another interesting feature of the Southern Hemisphere is the white frost that is often seen in Hellas and Argyre. Because this is most likely to be seen in early northern summer, the best chance of seeing it during this apparition occurs as you read this, in the very early days of the apparition.

Clouds

Polar hoods are cloud zones that develop over the polar cap during late summer and persist through winter, sometimes into early spring. In the northern Martian hemisphere, it will be interesting to watch the insidious development of the North Polar Hood during the few weeks before and after the northern autumnal equinox on April 8, 2020. It should break up and dissipate in the few weeks before and after the start of northern spring on February 7, 2021. The South Polar Hood forms as the North Polar Hood dissipates, and then breaks up as the North Polar Hood forms.

There are relatively few clouds visible on Mars during southern spring and summer, the seasons that will constitute most of the coming observing season. Nevertheless, a few discreet clouds and occasional morning limb hazes are likely. Clouds are best detected by observing or imaging with a blue filter. Ground hazes and frosts are often best seen with a green filter. (With a red filter, most clouds are hard to see, but surface albedo features stand out strongly.)

Dust Storms

It is exciting to detect a dust storm and to monitor its development. They can be seen at any season of the Martian year. With the improvements in instruments and imaging methods in the last few decades, we have been detecting more

Table 2. Greatest Elongations of Deimos

Date UT	HH:MM UT	Sub-Mars Longitude on Earth at Elong Time*	E or W	PA[×]	Angle Sep[ς]
2020-Sep-08	20:05	98	E	54	69
2020-Sep-09	11:15	130	W	234	70
2020-Sep-10	02:25	2	W	53	70
2020-Sep-10	17:35	134	E	233	70
2020-Sep-11	08:40	93	W	54	71
2020-Sep-11	23:50	39	E	234	71
2020-Sep-12	15:00	171	E	54	71
2020-Sep-13	06:10	58	W	233	71
2020-Sep-13	21:15	76	E	54	72
2020-Sep-14	12:25	153	W	234	72
2020-Sep-15	03:35	21	W	54	72
2020-Sep-15	18:45	111	E	233	73
2020-Sep-16	09:50	116	W	54	73
2020-Sep-17	01:00	16	E	234	73
2020-Sep-17	16:10	148	E	54	74
2020-Sep-18	07:20	81	W	233	74
2020-Sep-18	22:25	53	E	54	74
2020-Sep-19	13:35	176	W	234	74
2020-Sep-20	04:45	44	W	54	74
2020-Sep-20	19:50	89	E	234	75
2020-Sep-21	11:00	139	W	54	75
2020-Sep-22	02:10	7	W	234	75
2020-Sep-22	17:15	126	E	54	75
2020-Sep-23	08:25	103	W	234	76
2020-Sep-23	23:35	29	E	54	76
2020-Sep-24	14:40	162	E	234	76
2020-Sep-25	05:50	66	W	54	76
2020-Sep-25	21:00	66	E	234	76
2020-Sep-26	12:05	161	W	54	77
2020-Sep-27	03:15	30	W	234	77
2020-Sep-27	18:25	102	E	54	77
2020-Sep-28	09:30	125	W	234	77
2020-Sep-29	00:40	7	W	54	77
2020-Sep-29	15:50	139	E	234	77
2020-Sep-30	06:55	89	W	54	77
2020-Sep-30	22:05	43	E	234	78
2020-Oct-01	13:15	175	E	54	78
2020-Oct-02	04:20	52	W	234	78
2020-Oct-02	19:30	80	E	54	78
2020-Oct-03	10:35	148	W	234	78
2020-Oct-04	01:45	16	W	54	78
2020-Oct-04	16:55	116	E	234	78
2020-Oct-05	08:00	111	W	54	78
2020-Oct-05	23:10	21	E	234	78
2020-Oct-06	14:15	154	E	54	78

dust storms than in the past. For example, in the 2007-8 apparition, Earth-based observers not only detected and monitored the great planet-encircling dust storm of that apparition, but also detected seven other dust storms, of which five were well-monitored.

Mars has been well observed since 1893, and the first planet-encircling dust storm was detected 15 years later in 1908. The last such storm was observed during the most recent apparition. A total of 12 global dust storms have been detected over the last 126 years with a 10.5-year mean interval between them. However, there was a 32-year period with no global dust storms (1923 to 1955) and there were four within six years: 1970, 1972, 1974, and 1975 (McKimm, 1999). It remains unclear whether the likelihood of observing another such storm is related to the length of time since the last one.

During each apparition there are some reports of dust storms that are not borne out by follow-up observations. It is important to remember the three cardinal features of dust storms:

- They are bright in red light.
- They obscure the usual albedo features.
- They move, from sol to sol.

Unless all three of these characteristics are seen, one might refer to a suspected dust feature as a "possible" dust storm.

To identify and monitor a dust storm, the use of a red filter is very helpful for both visual observers and imagers. Changes in the storm's obscuration of underlying albedo features should be recorded as the observer studies the region's appearance from night to night.

Occasionally, exceptional dust features can be seen that do not meet these criteria. For example, narrow streaks of dark dust stand out prominently against the polar caps, which can be unambiguously identified as dust

Table 2. Greatest Elongations of Deimos (Continued)

2020-Oct-07	05:25	75	W	234	78
2020-Oct-07	20:35	57	E	54	78
2020-Oct-08	11:40	170	W	234	78
2020-Oct-09	02:50	39	W	54	78
2020-Oct-09	17:55	95	E	235	78
2020-Oct-10	09:05	134	W	54	78
2020-Oct-11	00:10	1	W	235	78
2020-Oct-11	15:20	131	E	55	78
2020-Oct-12	06:30	98	W	235	77
2020-Oct-12	21:35	35	E	55	77
2020-Oct-13	12:45	167	E	235	77
2020-Oct-14	03:50	60	W	55	77
2020-Oct-14	19:00	72	E	235	77
2020-Oct-15	10:10	157	W	55	77
2020-Oct-16	01:15	24	W	235	77
2020-Oct-16	16:25	108	E	55	76
2020-Oct-17	07:30	119	W	235	76
2020-Oct-17	22:40	13	W	55	76
2020-Oct-18	13:50	144	E	235	76
2020-Oct-19	04:55	83	W	55	76
2020-Oct-19	20:05	49	E	235	75
2020-Oct-20	11:10	178	W	55	75
2020-Oct-21	02:20	47	W	235	75
2020-Oct-21	17:30	85	E	55	75
2020-Oct-22	08:35	142	W	235	74
2020-Oct-22	23:45	10	W	55	74
2020-Oct-23	14:55	122	E	235	74
2020-Oct-24	06:00	106	W	55	73
2020-Oct-24	21:10	26	E	235	73
2020-Oct-25	12:15	159	E	56	73
2020-Oct-26	03:25	69	W	236	73
2020-Oct-26	18:35	63	E	55	72
2020-Oct-27	09:40	165	W	236	72
2020-Oct-28	00:50	33	W	56	72
2020-Oct-28	16:00	99	E	236	71
2020-Oct-29	07:05	128	W	56	71
2020-Oct-29	22:15	4	E	236	71
2020-Oct-30	13:25	136	E	56	70
2020-Oct-31	04:30	92	W	236	70
2020-Oct-31	19:40	40	E	56	69

* Sub-Mars longitude is the longitudinal meridian on Earth from which the greatest elongation event will be on the observer's meridian at elongation time, in degrees. E or W is the east or west designator of that Earth longitude (not the designator of the direction from Mars of the elongation).

× PA is the position angle of Deimos with respect to the center of Mars, measured in degrees, with zero as directly north and 90 degrees as directly east, referenced to the sky plane (not in planet-referenced directions).

ς Ang Sep is angular separation from the center of Mars in the sky plane, measured in arc seconds.

deposits. Rarely, a dust storm will be composed of dark dust that is not bright in red light, but can be seen to obscure albedo features and change from sol to sol. Such dark dust storms are generally small and transient (Venable, 2017).

The Moons of Mars

At a favorable apparition such as this one, it is likely than many observers will be able to detect the moons of Mars visually. Detecting Phobos and Deimos is very difficult during unfavorable apparitions. The problem, of course, is not due to the intrinsic faintness of the moons, but rather to the brightness of the nearby planet. There are two ways in which visual observations of the moons are impaired by the brightness of Mars. First, the sky is bright very near the planet, due to scattering in the Earth's atmosphere. Second, the eye's sensitivity to faint light is down-regulated by the bright field of view when it includes the planet. Attempts to image the moons are not affected by the second of these factors, and so we receive more images of them than we do visual reports.

High magnification is essential in order to observe the moons. A motor-driven mounting with a hand controller for fine telescope movements may necessary, in order to accurately place the disc of Mars slightly beyond the edge of the field of view. An occulting bar placed at the focal plane of the eyepiece is another tool that some have used to good advantage.

Generally, success in seeing the moons depends on planning to observe when they are at greatest elongation from the planet. Deimos is far easier to see than Phobos, even though it is intrinsically fainter, as it is farther from the edge of the planet's disc. Deimos is 2.95 Mars-diameters from the edge of the planet's disc when at greatest elongation. It may be detectable for one to three hours before and after the time of greatest elongation, depending on the observing conditions and the telescope aperture. Table 2 gives the UT dates and times of all of the greatest elongations of Deimos that occur during the period around

Mars's opposition in which the planet has an apparent diameter of greater than 20 arc-seconds. Only a fraction of them will be observable from any one longitude of Earth. The table lists the Earth longitude from which each elongation will occur on the local meridian, from where it can be best seen. We recommend that you limit your observation attempts to those Deimos elongations that occur within 45 degrees of your meridian.

Should you wish to try to see Phobos, contact coordinator Roger Venable for information about favorable times for your location, or use the JPL Horizons ephemeris generator (as Roger does) to generate the predictions.

Table of Potential Observational Events

Table 3 of this article, compiled by Jeff Beish, lists the important things to be alert for as you observe the Red Planet during this apparition. *The New Internet Mars Observer's Handbook* (Beish, 2019) provides more details about features that may be observed.

Reporting Your Observations

The ALPO Mars Section is eager to receive your reports of your observations, whether you make images, drawings, or written descriptions. It is easiest for us if you send them directly to coordinator Roger Venable at *rjvmd@hughes.net* , We also encourage you to post them in the ALPO online image gallery by sending them to Theo Ramakers at *mars@alpo-astronomy.org*

There are observing forms available online for those who would benefit from assistance in compiling a report. Find them on the ALPO website, at *www.alpo-astronomy.org* . On that page, click on "Mars Section" in the list of ALPO sections in the left sidebar. Then, on the Mars Section page, look in the list in the right sidebar under "Mars Observing Form."

With your report, be sure to include your name, location, the universal time of your observation (not your local time), brief descriptions of your instrument(s), filters used, and estimates of the quality of seeing and transparency. Your interpretations of your findings are also welcome.

References

Beish, Jeff. (2019). “The New Internet Mars Observer's Handbook” at *https://dustymars.neocities.org/*

McKim, R. “Telescopic Martian Dust Storms: A Narrative and Catalogue” Memoirs of the British Astronomical Society, Vol. 44, 1999. pp. 1-165. *http://www.britastro.org/mars/memoir.htm*

Venable, R. J. (2018). "Report on the Mars Apparition of 2007-2008." Journal of the Assn of Lunar & Planetary Observers; 60 (1): 48-100. *http://alpo-astronomy.org/gallery3/index.php/Publications-Section/ALPO-Journals/DJALPO-2018/JALPO60-1-Winter-2018*

Table 3. Calendar of Events — Mars, 2019-2021

DATE	PHYSICAL	REMARKS
2019 Sep 02	Ls 74.3°	**Conjunction.** Mars is behind the Sun ~2.675 AU.
2019 Oct 08	Ls 90° De 25.0° Ds 24.8° RA 12:10 Dec 0.0° A. Dia 3.6”	**Solstice - Northern Summer/Southern Winter.** Orographic clouds over the Tharsis volcanoes – W-Cloud present? Local seasonal clouds should wrap around Syrtis Major and be prominent in Lybia. White cloud and Ice-fog activity? Discrete clouds? NPC remnant? Lemuria (210° W, 82° N) detached from NPC? Any other detachments (projections at 135° W and 290° W) near NPC remnant, NPC Width ~18° ±4°.
2020 Mar 20	Ls 169.1° De -11.9° Ds 4.5° RA 19:37 Dec -22.3° A.Dia 6”	**Apparition begins** for observers using 4-inch to 8-inch apertures telescopes and up. Begin low-resolution CCD imaging. Views of surface details not well defined. Is the North Polar Hood present? Does SPH or frost cover should begin to clear and darken. Are W-clouds present? South cap emerges from darkness of Winter. SPH thinning and forms "Life Saver Effect"?
2020 May 09	Ls 197.6° De -21.7° Ds -7.3° RA 21:59 Dec -14.2° A.Dia 8”	SPC shrinking. Syrtis Major darkens and continues to shrink. W-clouds possible. Surface details increasing in contrast Hellas the features Zea Locus and dark? SPC Novissima Thyle (300°-330°W) projection present? (SPC width ~52° ±6°).

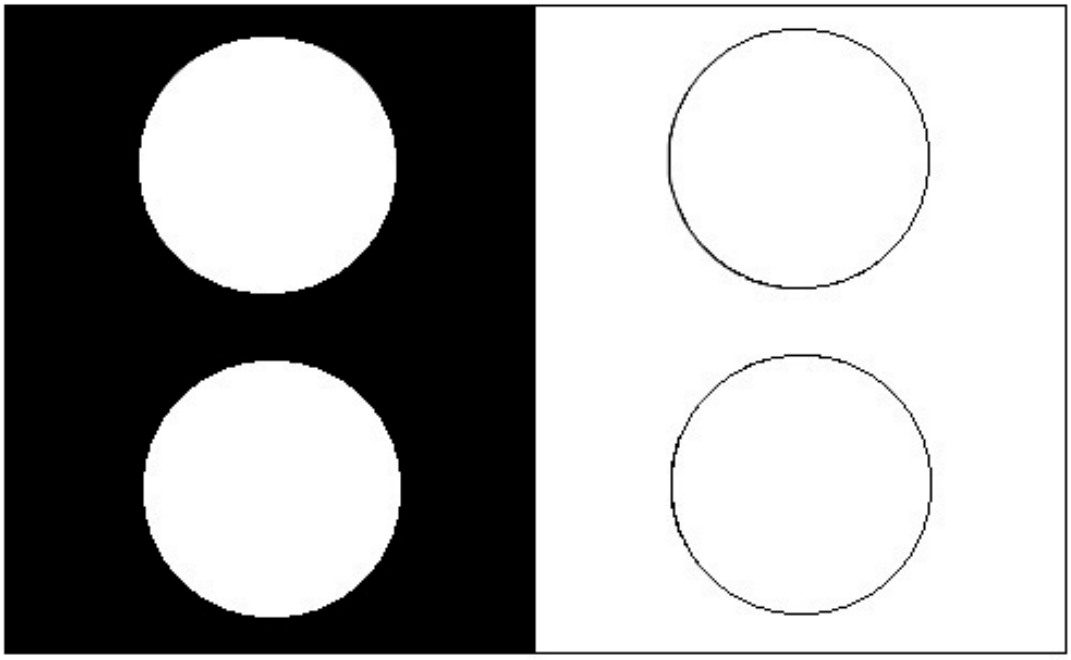
Table 3. Calendar of Events — Mars, 2019-2021 (Continued)

2020 Jun 07	Ls 215.1° De -23.6° Ds -13.9° RA 23:14 Dec -7.6° A.Dia 9.7''	**Mars at quadrature.** Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~44° ±3°).
2020 Jun 12	Ls 218.2° De -23.6° Ds -15.0° RA 23:27 Dec -6.4° A. Dia 10''	Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~44° ±3°).
2020 Jul 07	Ls 172.4° De -12.8° Ds 3.2° RA 19:57 Dec -22.4° A.Dia 12''	SPC rapid retreat. Novus Mons small, bright, and high-contrast. Rima Australis widens. SPC isolated bright spot at 155° longitude? Any white patches near -20° latitude may brighten. Atmosphere of Mars very clear during Ls 240°- 250°. Occasional morning limb hazes. Dust clouds? Note: Several "planet-encircling dust storms have been reported during this season at 24° Ls. (SPC width ~28° ±3°).
2020 Aug 02	Ls 250° De -19.8° Ds -23.2° RA 01:14 Dec 3.7° A.Dia 14.7''	**Mars at Perihelion** . SPC in rapid retreat. Novus Mons smaller. Dust clouds expected over Serpentis-Hellaspontus (Ls 250° - 270°). Syrtis Major beginning to narrow. Frost in bright deserts? Orographic clouds (W-clouds) possible. Elysium and Arsia Mons bright? Note: Several "planet-encircling dust storms have been reported during this season. High probability 255° Ls. (SPC width ~ 24° ±3°).
2020 Sep 03	Ls 270° De -17.3° Ds -24.8° RA 01:49 Dec 6.7° A.Dia 19.2''	**Solstice - Northern Winter/Southern Summer.** W-clouds present? NPH extends 50° N? Decreased number of White clouds. "Syrtis Blue Cloud"? White areas in deserts? Dust clouds in south until 270° Ls? Watch for planetary system clouds bands. Orographic cloud over Arsia Mons? Syrtis Major is narrow. (SPC width ~ 17° ±2°).
2020 Sep 09	Ls 274.2° De -17.5° Ds -25.2° RA 01:50 Dec 6.8° A.Dia 20.1''	**Retrogression Begins.** W-clouds present? NPH extends 50° N? Decreased number of White clouds. "Syrtis Blue Cloud"? White areas in deserts? Dust clouds in south until 270° Ls? Watch for planetary system clouds bands. Orographic cloud over Arsia Mons? Syrtis Major is narrow. (SPC width ~ 17° ±2°).
2020 Oct 06	Ls 291.0° De -19.1° Ds -23.0° RA 01:32 Dec 6.0° A.Dia 22.6''	**Mars at Closest Approach.** Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~10° ±2°).
2020 Oct 13	Ls 295.2° De -20.0° Ds -22.3° RA 01:23 Dec 5.5° A.Dia 22.4''	**Mars at Opposition.** Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~10° ±2°).

Table 3. Calendar of Events — Mars, 2019-2021 (Continued)

2020 Nov 14	Ls 314.1° De -23.7° Ds -17.9° RA 00:57 Dec 5.2° A.Dia 17.7''	**Retrogression Ends.** Bright? Is SPC remnant visible in mid-summer? High probability of dusty storm at 315° Ls. Orographic cloud over Arsia Mons? Topographic cloud over (SPC width ~10° ±2°).
2020 Dec 18	Ls 333.2° De -23.4° Ds -10.9° RA 01:20 Dec 9.0° A.Dia 12'	Hellas Ice-fog activity? Topographic cloud over NPC large hood present. W-Cloud? Orographic cloud over Arsia Mons? (SPC width ~10° ±2°).
2021 Jan 05	Ls 342.9° De -21.9° Ds 7.1° RA 01:47 Dec 12.1° A.Dia 10'	Hellas Ice-fog activity? Topographic cloud over NPC large hood present. W-Cloud? Orographic cloud over Arsia Mons? (SPC width ~10° ±2°).
2021 Jan 30	Ls 355.8° De -18.3° Ds 1.8° RA 02:34 Dec 16.5° A.Dia 8'	NPC large hood (NPH) present. Discrete (white) clouds and white areas should be seen. Syrtis Major begins to expand to its east. Topographic cloud over Libya?
2021 Feb 08	Ls 0° De -16.6° Ds 0.1° RA 02:53 Dec 19.9° A.Dia 7.4'''	**Equinox - Northern Spring/Southern Autumn**. North Polar Hood (NPH) breaking up, North Polar Cap (NPC) should be exposed.
2021 Mar 12	Ls 15.9° De -9.4° Ds 6.6° RA 04:09 Dec 22.5° A.Dia 6'''	North Polar Hood (NPH) breaking up and North Polar Cap (NPC) should be exposed. and Argyre bright?
2021 Oct 08	Ls 109.8°	**Conjunction.** Mars is behind the Sun ~2.629AU.

ALPO Mars Section Observation



Top: **Time (UT):**_____ **Bottom:** **Time (UT):**_____
CM:_____° W **CM:**_____° W
Filter:_____ (W / S) **Filter:**_____ (W / S)

Date (UT):_____ **Observer:**_____
Time (UT):_____ - _____ **Address:**_____
CM: _____° W - _____° W
D_E:_____° - **L_S:**_____° **Observing Station:**_____
Dia. (''):_____ **k (phase):** _____
Telescope:_____ **f/**_____ (in. / cm. ; RL , RR , SC) **E-mail (optional):**_____
Magnification:_____ x _____ x _____ x
Filters:_____ (W / S)
Seeing (0-10):_____ **Antoniadi (I-V):**_____
Transparency (1-6):_____ (Clear / Haze / Int. Clouds)
Blue (Violet) Clearing (0-3):_____

Notes

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(Continue on back if needed)