Introduction to sky maps for observing planets and bright stars at evening and morning mid-twilight

When organizing a first sky watching session for students, we suggest that you begin your outdoor session during evening twilight, so students can experience the joy of discovering and identifying the brighter stars as they first appear. Begin your session no later than one-half hour after sunset, or even earlier if the Moon or a bright planet is visible. You may wish to continue until the sky is dark enough for naked-eye observation of constellations of interest. Binoculars and telescopes can provide inspiring views of Moon, planets, double stars, star clusters such as the Hyades and the Pleiades, the Great Nebula in Orion's sword, the Lagoon Nebula above the spout of the Teapot of Sagittarius, Andromeda Galaxy, and more.

If you also schedule a predawn session, you can start as early as 1¾ to 2 hours before sunrise, before morning twilight begins, to allow enough dark-sky time to observe a selection of constellations and deep sky objects. Continue long enough into twilight to watch some of the brighter stars disappear.

My friend and former colleague at Michigan State University, Mr. Robert D. Miller, has kindly created computer programs and provided us with monthly sky charts tracking daily locations of the five naked-eye planets and the 15 stars of first magnitude or brighter visible from latitude 40° north. Positions of the stars and planets are plotted each day at the moment the Sun is 9° below the horizon, which we have called "mid-twilight". Locations of the planets are plotted as a separate dot for each day, with larger dots plotted weekly on the 1st, 8th, 15th, 22nd, and 29th day of the month. Star positions during the course of the month are plotted as continuous tracks, with all stars drifting westward (left to right on the charts) in the course of the month, owing to the Earth's revolution around the Sun.

For latitude 40° N, the moment of evening mid-twilight during the course of the year occurs 43 to 53 minutes after sunset, and morning mid-twilight occurs a similar interval ahead of sunrise. For locations south of lat. 40° N, the same stage of twilight occurs closer to sunset and sunrise, and for locations farther north, twilights are longer.

Sky in May 2021, evening mid-twilight
(See May evening twilight map in next section, Sky Maps for Observing Planets and Bright Stars at Evening and Morning Mid-twilight, May through July 2021.)

Venus, emerging from the far side of the Sun into the evening sky, first appears above the WNW horizon in mid-twilight in early May 2021. It will ascend to its greatest altitude in evening twilight in late November and early December 2021, and finally disappear below the horizon in early January 2022. The evening twilight chart for May 2021 also shows **Mercury** above WNW horizon all month, and reaching peak altitude at mid-month to upper left of Venus. But the speedy innermost planet won't actually be visible in May's closing days, because it fades sharply when it becomes more backlit during its

pass toward the near side of the Sun. Mars is visible too, to the upper left of the two inner planets.

Also on the May evening chart, four bright stars visible at the start of May, **Rigel** very low in WSW, **Aldebaran** in WNW, **Sirius** in SW, and **Betelgeuse** in west, all depart below the horizon, in that order, in the course of the month. On what date will you last see each star in the first hour after sunset? On what date will you last see fading Mercury? Binoculars can help delay their last dates of visibility.

Sometimes a star or planet is below the horizon at the start of a month, but might appear above the horizon before month's end, for example **Antares** appears low in SE in evening mid-twilight in the last days of May. (It's at *opposition* to the Sun on the night of May 30 and visible all night, from dusk until dawn.)

Sky in May 2021, morning mid-twilight
(See May morning twilight map in next section, Sky Maps for Observing Planets and Bright Stars at Evening and Morning Mid-twilight, May through July 2021.)

Jupiter in SE is the most prominent object, with **Saturn** 15° to 18° to its upper right or right. The brightest stars are golden **Arcturus** getting lower in W to WNW, and blue-white **Vega** nearly overhead. Other bright stars visible each clear morning in May are **Altair** and **Deneb** completing the *Summer Triangle* with Vega, and **Antares** sinking low in SW. **On the morning of Wednesday, May 26,** there will be a brief **total lunar eclipse** visible in western U.S., centered at 4:19 a.m. PDT, low in SW, within 7° to the right of Antares.

Robert C. Victor was Staff Astronomer at Abrams Planetarium, Michigan State University. He is now retired and enjoys providing sky watching sessions for groups in and around Palm Springs.

Robert D. Miller, who provided the twilight charts, did graduate work in Planetarium Science and later astronomy and computer science at Michigan State University and remains active in research and public outreach in astronomy.

Sky Maps for Observing Planets and Bright Stars at Evening and Morning Mid-twilight, May through July 2021

***** May 2021 evening twilight *****

On the map depicting the sky at evening mid-twilight for May 2021, **three planets** appear in WNW to W sky. **Mercury and Mars** are plotted for the entire month. By early in May, **Venus** begins an evening apparition which will last until early in January 2022.

Mars is high enough to remain visible after twilight ends, allowing its motion against background stars to be followed easily. In darker skies later after sunset, watch Mars move in Gemini, passing third magnitude stars Mu and Nu April 28-May 2, Epsilon on May 9, and Delta on May 23. Mars forms an isosceles triangle with Twins Pollux and Castor on May 15, passes south of Pollux on

May 31, and forms a straight line with the Twins on June 7.

Mercury, brightest at start of month, is 9° to upper left of Venus May 8-16, and climbs highest above the evening mid-twilight horizon at mid-month. Although Mercury is plotted for all of May, the rapidly fading planet will be difficult to observe in last week of month. When it passes 0.4° S of Venus on May 28, Mercury will be a dim mag. +2.3. **The Moon** passes the three evening planets, Venus on May 12, Mercury on May 13, and Mars on May 15, and passes Pollux, Regulus, Spica, and Antares on May 16, 19, 23, and 26. For illustrations and details of these events, see the May 2021 Sky Calendar, at www.abramsplanetarium.org/skycalendar/

Bright stars visible in the western sky at dusk at start of May include the entire "Winter Hexagon", comprising, in clockwise order, **Sirius, Procyon, Pollux** (with Castor), **Capella, Aldebaran, Rigel,** and back to Sirius, with **Betelgeuse** inside. During May, in order of departure, Rigel, Aldebaran, Sirius, and Betelgeuse drop below the western horizon, leaving the "Spring Arch" of Procyon, Pollux, Castor, and Capella still in view.

Regulus begins May high in south at dusk, and is still well up in WSW at month's end, to upper left of the Spring Arch.

Golden **Arcturus** opens May well up in eastern sky at dusk. Look for blue-white **Spica** 33° to its lower right. Both stars ascend through the southeastern sky as the month progresses.

Blue-white **Vega** is already present very low in NE at dusk on May 1, as seen from lat. 40° N . Viewers farther south at lat. 34° N can wait until a later stage of twilight to watch it rise, or wait a few days to catch it rising in mid-twilight.

Later in May, two more bright stars appear above the horizon in mid-twilight, **Deneb** in NE to Vega's lower left, and **Antares** in SE. Antares is at opposition to the Sun on the night of May 30.

***** May 2021 morning twilight *****

At morning mid-twilight in May 2021, **Jupiter,** in SE, appears as the brightest "star". **Saturn** is 15° to 18° to its upper right or right. The *Summer Triangle* of **Vega, Altair, and Deneb** is nearly overhead. Other bright stars easily seen all month are **Arcturus** sinking in W to WNW, and **Antares** low in SW. From lat. 40° N, **Fomalhaut** emerges in SE in early May and **Capella** in NNE before mid-month. Seen from farther south, at lat. 34° N, Fomalhaut is already visible low in SE as May opens and rises higher as month progresses. There, Capella's first appearance is delayed until last week of May.

In the morning sky, look for the waning Moon in the same part of the sky as Jupiter and Saturn during May 3-5, and May 31-June 1, as illustrated on the May 2021 *Sky Calendar.*

***** June 2021 evening twilight *****

In June, only planets visible at dusk are bright **Venus** very low in WNW, and faint **Mars** 25° to 7° to its upper left. The two brightest stars visible are golden **Arcturus** very high in SE to SSW, and blue-white **Vega** climbing high in ENE.

In early June, the *Spring Arch* of four stars is still visible: **Procyon** low in west, Twins **Pollux and Castor** in WNW, and **Capella** low in NW. By month's end, the Twins remain, but only with the aid of binoculars.

Watch for these **striking arrangements of planets with Twin stars Pollux and Castor,** as illustrated on the *Sky Calendar* for June 2021: Mars on June 7 (in straight line with Twins); Venus on June 13 (forming isosceles triangle with Twins), June 21 (Venus' least distance from Pollux), and June 24 (Venus in straight line with Twins).

Other stars visible at dusk: **Regulus,** heart of Leo, is in WSW to W, to upper left of Venus and Mars. (Mars closes to within 18° to lower right of Regulus at month's end.) **Spica,** spike of grain in the hand of Virgo, crosses through S into SSW, 33° lower right or below Arcturus. **Antares,** heart of the Scorpion, starts very low in SE and climbs into SSE. Look for **Deneb** to lower left of Vega. Watch the horizon a little more than 10° north of east, to Vega's lower right, for the rising of **Altair,** completing the *Summer Triangle* with Vega and Deneb.

At evening mid-twilight, watch the **Moon** wax from a thin crescent on June 11 to Full on June 24. Watch for its pairings with planets and bright zodiacal stars on evenings of June 11 (Venus), 12 (Pollux), 13 (Mars), 15 (Regulus), 19 (Spica), and 22 (Antares), as illustrated on the *Sky Calendar.*

***** June 2021 morning twilight *****

Look to the southern sky at dawn to see **Jupiter,** the brightest morning "star", and **Saturn,** from 18° to nearly 20° to its right or lower right.

Antares makes its exit in SW in June's morning mid-twilight sky, and **Arcturus** departs in WNW soon after midmonth. The *Summer Triangle* of **Vega, Altair, and Deneb** passes to west of overhead, while **Fomalhaut,** mouth of the Southern Fish, glows low in SE to S, to lower left of Jupiter.

Capella appears very low in NNE at start of June, and rises higher into NE as month progresses. Late in June, look for **Aldebaran,** eye of Taurus, the Bull, very low in ENE, 31° lower right of Capella. On June's last two mornings, use binoculars to spot first-magnitude **Mercury** rising 8° lower left of Aldebaran. Mercury will brighten further, and be easier to spot during the first three weeks of July.

Watch the waning gibbous Moon pass Saturn and Jupiter on the mornings of May 31 and June 1, and on June 27-29, as illustrated on the June 2021 Sky Calendar.

***** July 2021 evening twilight *****

In July 2021 at dusk, watch for a **"celestial traffic jam"** involving two planets and a star, with three near-collisions and a grouping of all three objects in a field just over 5°across. The participants are brilliant **Venus; Regulus,** at mag. +1.4 the faintest of all the first-magnitude stars; and even fainter **Mars** at mag. +1.8, as faint as it gets. Since the gatherings will occur low in bright twilight, binoculars are recommended.

For illustrations of all these events, see the July 2021 *Sky Calendar.*

On July 1, Venus, very low in WNW, is the lowest of the three bodies, with Mars within 7° to its upper left, and Regulus 17° to upper left of Mars. The three objects span 24° on July 1.

Venus moves closer to Mars each evening until July 12. They'll appear about 1.0° apart on July 11; between 0.5° and 0.6° apart on July 12 and 13; and about 1.0° apart again on July 14.

Even the Moon gets into the act! A very thin, 1-percent crescent **Moon,** setting in bright twilight some 16° lower right of Venus on July 10, will be a challenge, but on the next two nights the beautiful waxing crescent Moon will hopscotch past the Venus-Mars pair: On July 11 the 4-percent crescent Moon will appear some 5° to the right or lower right of Venus, and on July 12, the 10-percent Moon will appear 7°-8° to Venus' upper left and 5° to upper right of Regulus.

A 46-percent Moon, nearly at First Quarter phase, will appear in SW near **Spica** on July 16. Next, a waxing gibbous Moon will appear about 8° from **Antares** in the south on the evenings of July 19 and 20.

The second "near-collision" of the "celestial traffic jam" will occur on July 21, as Venus passes 1.1° north (upper right) of Regulus. That evening, Mars will be 5.0° to their lower right, creating the most compact gathering of the three objects. All three bodies should fit within the field of view of most binoculars magnifying no more than 10 times.

On the final evening of the Moon's visibility in mid-twilight, July 23, the Full Moon will appear low in SE, 10° to the right of **Saturn.** On the next night, July 24, wait until about 1½ hours after sunset to see the Moon 7° lower left of Saturn, and **Jupiter,** just risen, 5° lower left of the Moon. On July 25, look about two hours after sunset to catch the Moon, just risen, within 5° lower right of Jupiter.

The final "near-collision", the faintest, lowest, and most difficult to observe, will be the conjunction of Mars with Regulus on July 29. Using binoculars, look within 10° lower right of Venus. Faint Mars will appear just over 0.6° to the upper right of Regulus. Observers at lower latitudes, where the pair sets longer after sunset in a darker sky, will have an advantage.

Other stars not yet mentioned so far in this account of July's evening sky: **Castor and Pollux,** very low in WNW to NW twilight glow at start of July, require binoculars and very clear skies. They'll be in conjunction, on far side of the Sun, July 12-15. **Arcturus** is very high in southwestern sky at dusk. The *Summer Triangle* of **Vega, Altair, and Deneb,** climbing higher in eastern sky, is visible all night throughout July.

***** July 2021 morning twilight *****

Planets: Bright **Jupiter,** in south to southwest at morning mid-twilight, is accompanied by **Saturn,** between 19° and 20° to Jupiter's lower right. The giant planets reach a maximum distance apart, 19¾° on July 11, when Jupiter's rate of retrograde (westward) motion against background stars begins to exceed Saturn's. The distance between the giants will then close until Oct. 24, when they'll be 15.4° apart. The general trend will be for them to move farther apart in coming years, as Jupiter moves farther ahead of Saturn. As seen from Earth, they'll appear in mutual opposition, 180° apart in celestial longitude, *five times* in 2029-31, and have their next conjunction, a single event in Virgo, on October 31, 2040.

Watch the **Moon,** just past Full, slip past Saturn and Jupiter on the mornings of July 24-26.

The other naked-eye morning planet is **Mercury,** visible very low in ENE for about the first three weeks of July. On July 1 it's 9° lower left of Aldebaran, eye of Taurus, the Bull. Mercury reaches greatest elongation, 21.5° west of Sun, on July 4. The innermost planet, brightened to zero magnitude, appears within 5° to the right of a 3-percent waning crescent Moon on the morning of July 8, and climbs highest above the morning mid-twilight horizon on July 9-11.

The brightest stars on July mornings are **Vega** sinking in WNW, and **Capella** ascending in NE.

Altair and Deneb complete the *Summer Triangle* with Vega. **Fomalhaut,** mouth of the Southern Fish, is in S to SSW, to lower left of Jupiter. **Aldebaran** is ascending in ENE to E, 31° lower right of Capella. After mid-month, **watch for the rising or Orion's two bright stars, Betelgeuse** about 10° north of east, **and Rigel** about 10° south of east. When the sky is dark enough, look for the three-star belt midway between them. Farther north, almost northeast, **watch for the rising of Castor and Pollux,** 4.5° apart, with Castor upper left of Pollux. The Twins aren't out of view for very long around the dates of their conjunctions with the Sun, because they're north of the Earth's orbit plane and above the horizon longer the Sun. Orion, south of the ecliptic, has been absent longer, ever since it departed from our early evening sky, in May.