

Mars Opposition in 2020: *Stellarium* Modeling

by HR Suiter

Once again, 2 years and about 2 months have passed by and Mars is scheduled to make a close approach in what is technically known as an opposition. Even though Mars is the planet that comes closest to Earth, it yields surprisingly poor views much of the time. But every other year (plus a couple of months) it figuratively brushes past the Earth's nose like a buzzing gnat. Then briefly, for a couple of months on either side, it looks halfway decent in a small telescope. Advanced observers on mountaintops with large telescopes can push this a bit further, but for us commoners, a couple months out of 25 or 26 is all we get.

Let's use the power of *Stellarium* to model Mars' behavior the next several months. I will describe what I do so you can follow me with your own copy of *Stellarium*.¹

The first thing to do is to choose the pole-oriented tilt denoted by the German-equatorial mounting in the horizontal menu bar. This levels the sky equator.



Figure 1. Horizontal bar, showing "Equ. Telescope" icon



Figure 2. To do advanced calculations, choose the astrolabe icon in the vertical menu

Next, choose the advanced calculations icon in the left vertical menu bar. This brings up a set of calculations windows.

Choose the "Graphs" tab. What you see, after all the dialogue entries are filled in properly, appears in Figure 3. The arrows are meant to indicate which curve applies to which axis. The left vertical axis corresponding to distance is Astronomical Units (1 AU = distance from Earth to Sun). It is the red curve and seems to bottom out sometime

after the 5th of October at a little over 0.3. The yellow curve applies to the axis at

¹ *Stellarium* is a free, open-source planetarium simulator for Linux, Windows, and Mac. It is available at stellarium.org.

the right, and is the angular size of Mars as viewed from the Earth. Here it seems to go through a maximum of about 22 arcsecs, again somewhere after Oct 5. Note that if we use as a criterion Mars being less than 1/2 of its size, then it extends between about 5 July to about 20 Dec. Let's do the plot against the stars from July 1 to Jan 31, just to make sure we have the retrograde loop enclosed. (Retrograde is reverse motion against the stars.)



Figure 3. The distance of Mars and its angular size during 2020.

Next, set the date somewhere in the vicinity of October 5, and the time at 23:59 (be sure to stop the real-time advance of time by hitting the media control at lower right of the main window). Then, find Mars using the "search" icon in the vertical menu (the hourglass).

Here is the top part of the menu you need to fill out. If it is not already at the "Ephemeris" tab, move it there. "Ephemeris" is just a fancy Latinized Greek word meaning *daily*. It plots trajectories, although not necessarily every day.

We fill in the rest of the window as follows: 1) Celestial body: Mars, naturally. 2) From: beginning date, July 1, 2020. 3) To: end date. Jan 31, 2021. 4) Frequency



Figure 4. The "Ephemeris" tab.

of calculation. Here we choose 10 days. Five days seemed too busy and fifteen days seemed too seldom. A lot will depend on what you are calculating. Uranus wouldn't have to be calculated more often than once a month. In the following I want to calculate Mars every day to find the conditions around opposition, but I wouldn't want such a huge span.

"Show markers" is the only other choice that results in a good display for this calculation. "Use horizontal coordinates" results in another calculation. It is useful for results where the position of the horizon is important. The date and magnitude labels are interesting, to be sure, but for the present calculation they create a much-too-busy display and cover up the markers. Be sure to "Cleanup ephemerides" when you change anything.

Figure 5 is the window after the calculation is made. Note the distances in the "Dist AU" column. It seems to be a minimum before 10/8, yet the definition of opposition is maximum elongation from the Sun, which reaches a maximum between 10/8 and 10/18. What gives? I can do a finer-scale calculation right around opposition to find out if this is indeed the case. There is no need to repeat this yourself, however.

Three yellow circles are denoted in Fig 6: one for the minimum distance, one for maximum brightness, and another for the maximum elongation from the Sun. The maximum brightness is a crude estimate. It depends on atmospheric conditions

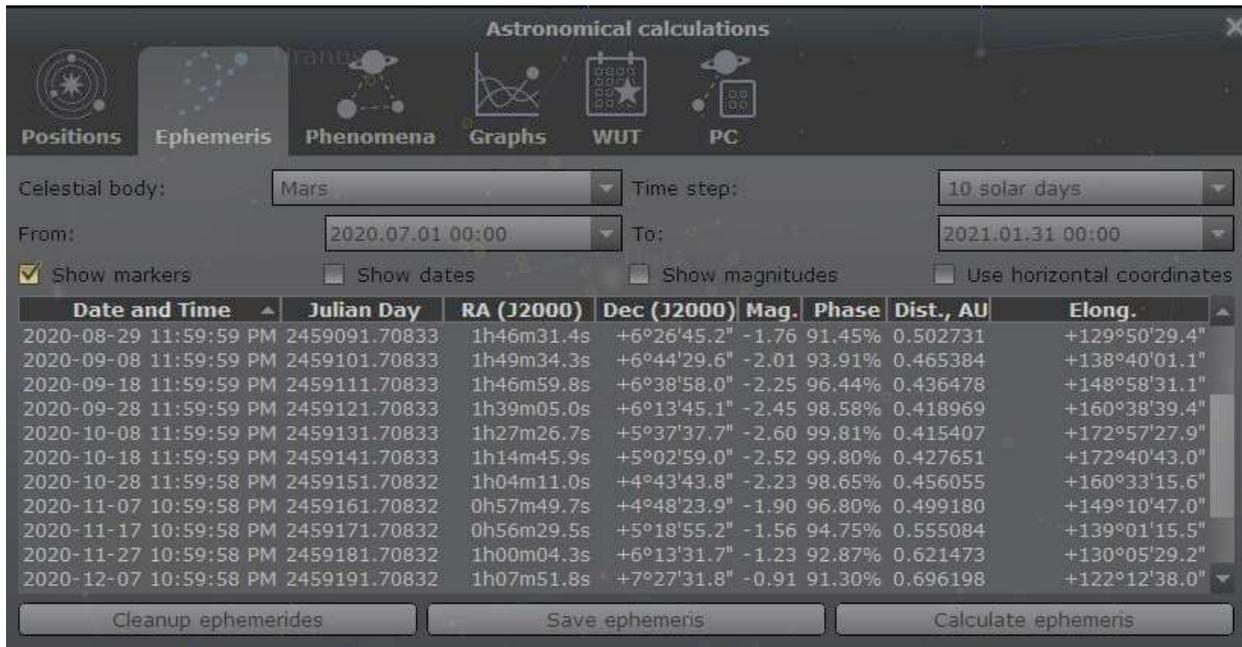


Figure 5. Mars ephemeris calculated in coarse increments

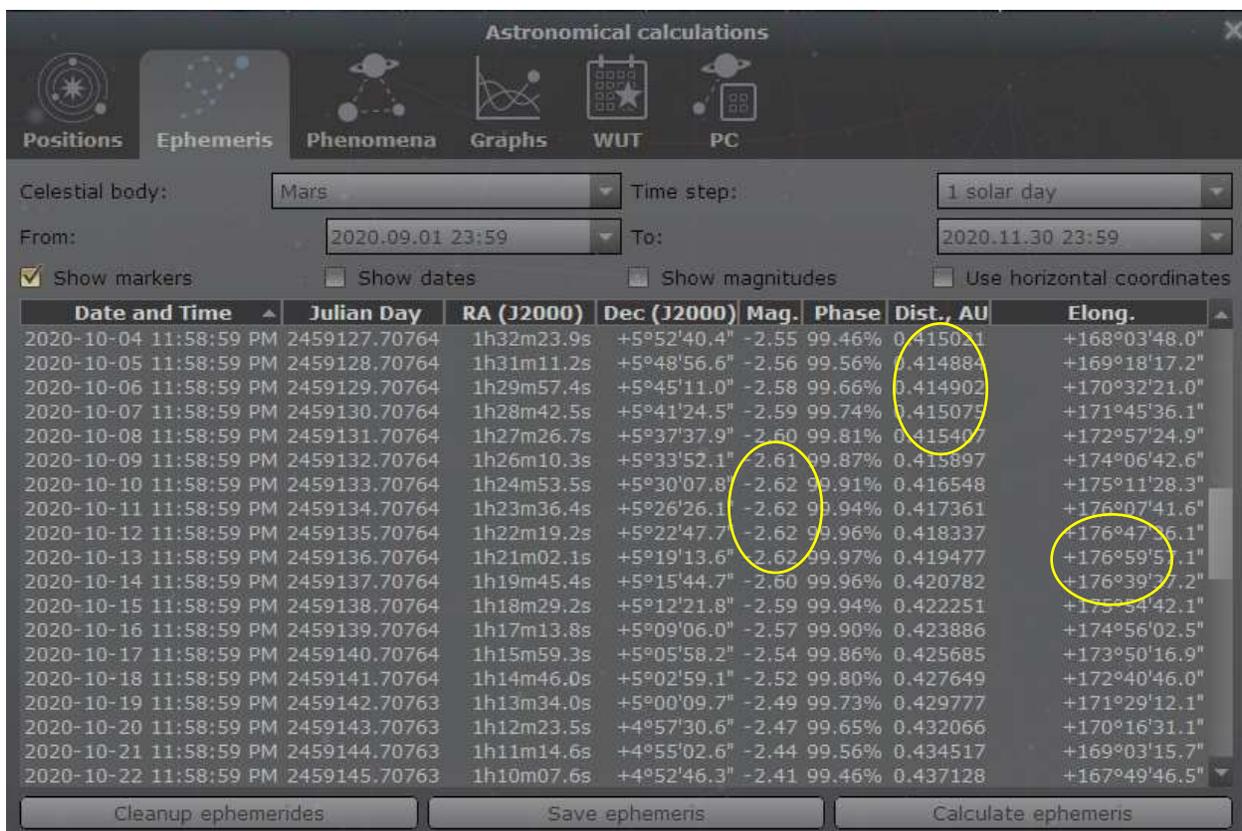


Figure 6. Mars ephemeris calculated in fine increments of 24 hours.

on Mars' surface and the reflectance near the edge. The purely geometric terms of minimum distance (about 0.415 AU during 10/5 or 10/6) and direct opposition (about 177 deg during 10/13) seem to disagree, until we recall that Mars has an orbit of greater ellipticity than the Earth's. It could well be closest at a point slightly different than the 10/13 point of formal opposition.

Finally, let's look at the results of this 10-day-jump ephemeris calculation plotted against the sky.

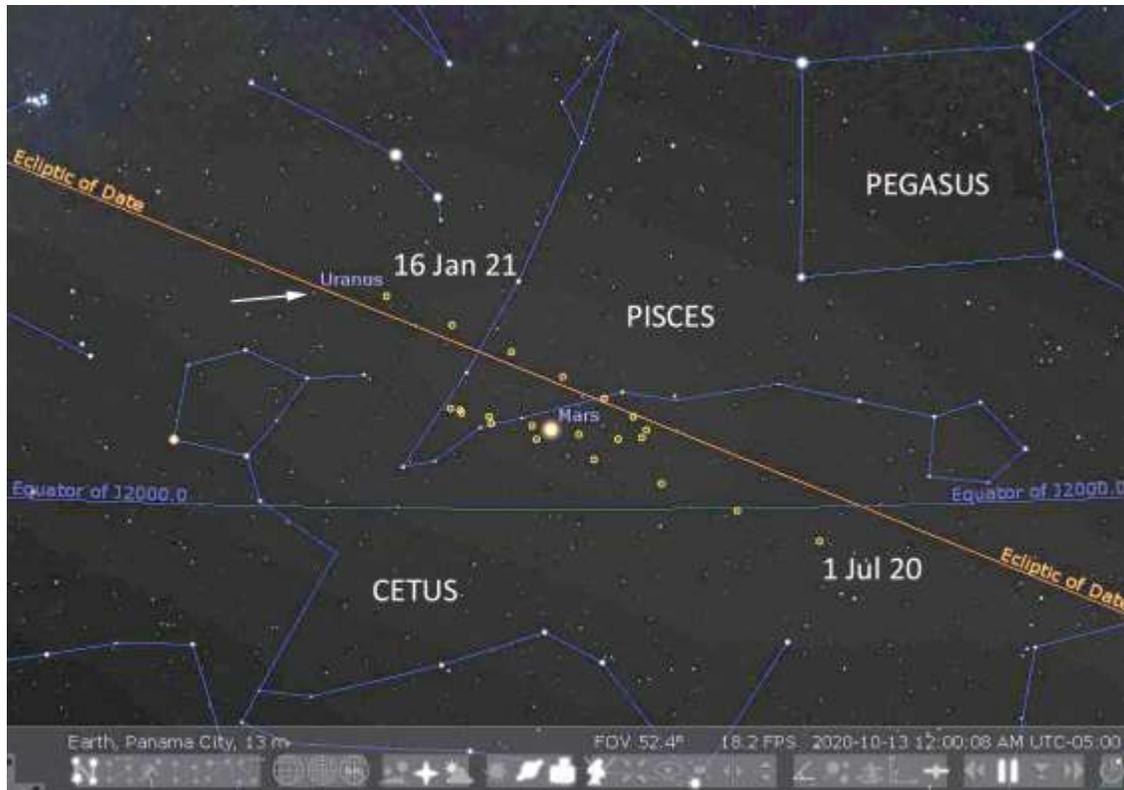


Figure 7. Position of Mars plotted at 10 day intervals.

We see the effect of turning on the button "Show markers" in the ephemeris window. Mars executes a pretty loop against the stars. Its position is plotted for October 13, together with some annotation. This is very much a Pisces venue for this opposition. Uranus, is much farther away, and is shown as a dot on Oct 13.

Finally, we ask when it is most convenient to observe. On Oct 13, it is lying on the horizon at sunset, and so is sufficiently elevated to actually see after 9 PM (alt =34 deg). But wait a couple weeks and it is sufficiently elevated to be over 41 degrees just after 7 PM. It is still a respectable 20 arcsec in size. The latter part of the month is when to see it, as well as view Saturn and Jupiter.

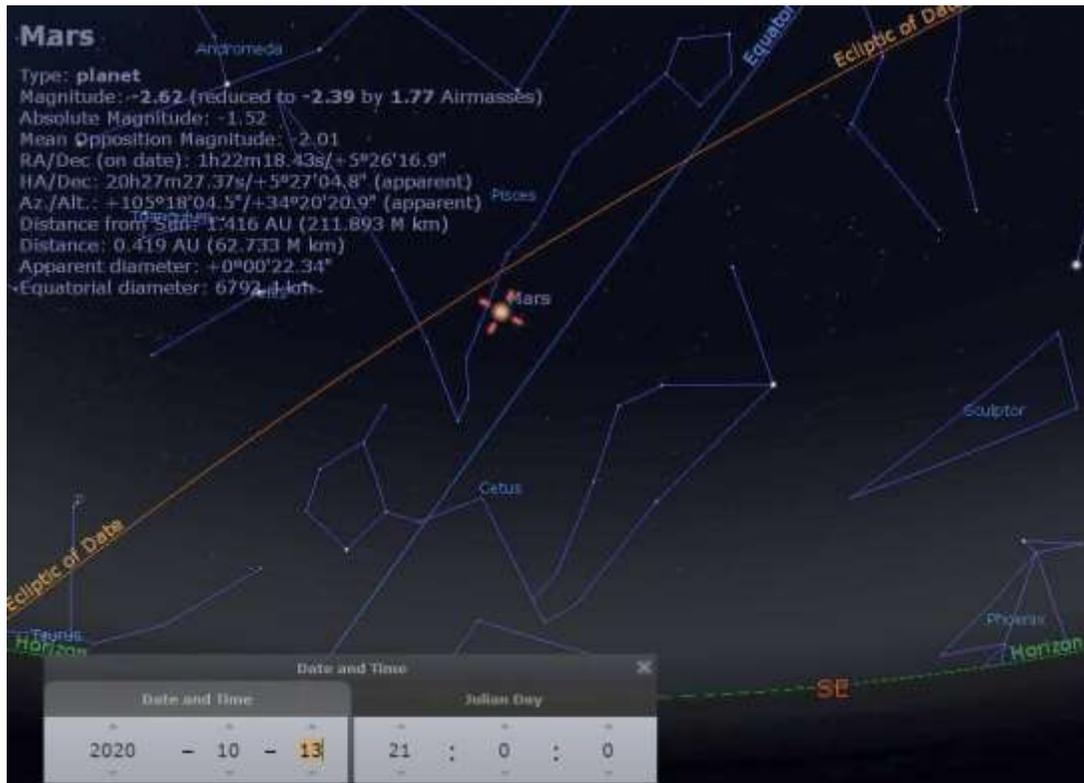


Figure 8. Mars climbing the sky during late October.