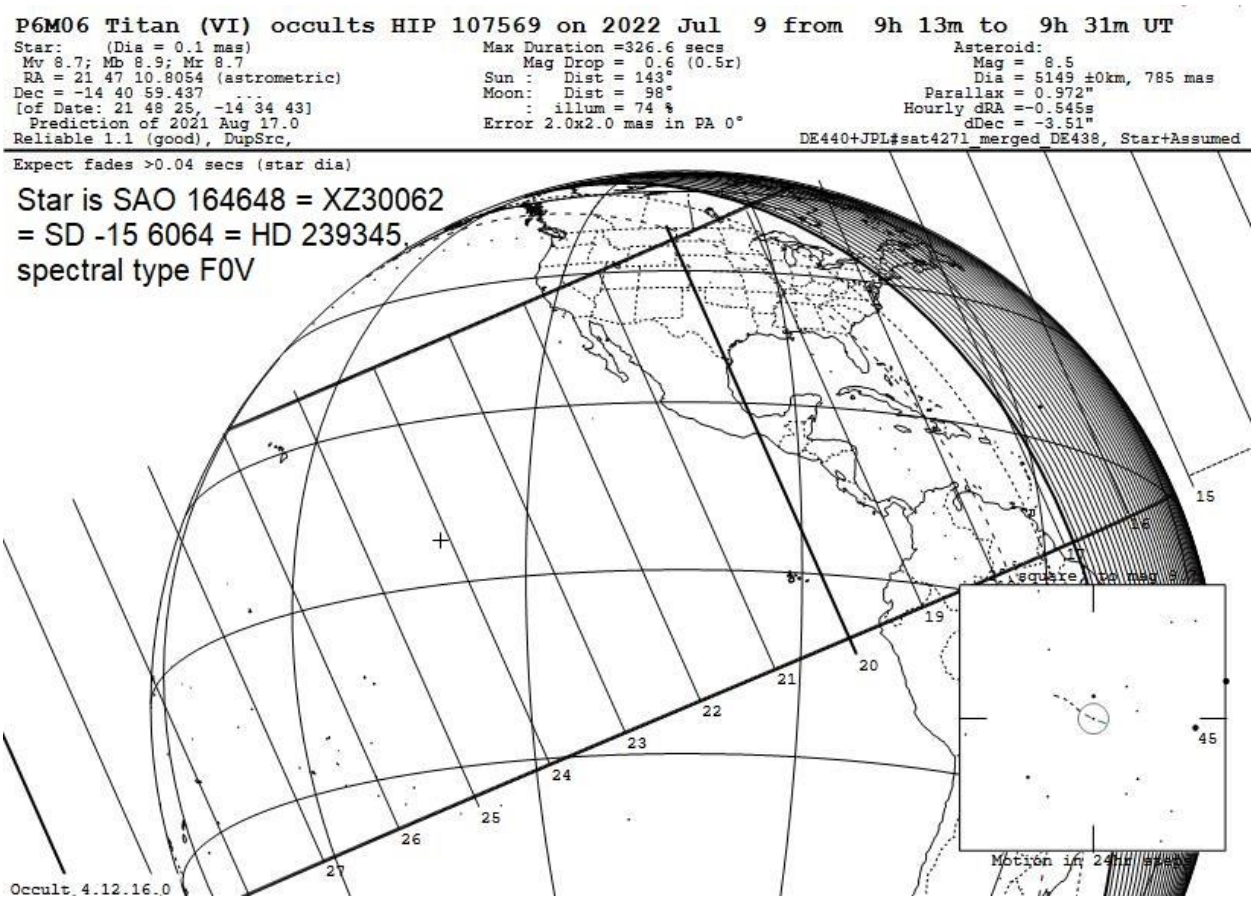
Occultation of SAO 164648 by Titan on 2022 July 9

Titan, the 8th-mag. largest moon of Saturn with a thick atmosphere, will occult a star of the same brightness on Saturday morning, July 9. The occultation will be visible from much of North America, south of the northern limit shown on the Occult map below; the southern limit crosses northwestern South America. Titan will be 3 arc-minutes east of Saturn when the occultation occurs. Local circumstance predictions (U.T. of central occultation, and altitudes of the star and Sun) and contact times for hundreds of cities in the region of visibility are available on the main page for the event at **https://occultations.org/publications/rasc/2022/20220709Titan.htm** . This document shows some maps and diagrams of the occultation, starting with the Occult overview map of the occultation below.



The star, HIP 107569, is also known as SAO 164648, SD -15° 6064 = PPM 239345 = HD 107123, spectral type F0V (an error in the 1st version had the wrong HD#, corrected here; thanks, Bob King, for noticing that). It is also 30062 in the zodiacal XZ catalog, a comprehensive ecliptic catalog first created at the US Naval Observatory in 1978 to support predictions and analysis of lunar occultations, and now maintained and updated (with the currently best available astrometric data) by the International Occultation Timing Association (IOTA). The next observable occultation after this of a similarly-bright star by Titan won't occur until 2048, and that will only be visible from Antarctica, so you are encouraged to make what observations you can of this rare event visible from much of North America.

The 1989 July 3 occultation of 5th-mag. 28 Sagittarii by Titan

The last really bright occultation of a star by Titan occurred 33 years ago, on 1989 July 3, when both Titan

and Saturn occulted 5th-mag. 28 Sagittarii. That Titan occultation was well-observed in Europe, and in fact was the most widely-observed occultation observed to date, by over 270 observers. However, most of the observations were visual and suffered from the problems with such methods for the gradual events that always occur during occultations by bodies with atmospheres; a few recorded the event with video or CCD systems. A good video, showing a strong central flash, was recorded by Hans Bode from Hannover, Germany; a link to that video, with some discussion of it, and implications for our event, is on the main Web page with the link given near the top of this document. An article documented the effort, published in Journal for Occultation Astronomy (JOA), Vol. 8, No. 2, pages 6-11 (2018); issues of JOA are freely available at **https://iota-es.de/joafree.html** . A short article about the 2022 occultation by Mike Kretlow will appear in a new issue of JOA that is nearing completion and expected to be issued before this event.

View of Saturn and Titan for our 2022 July 9 occultation

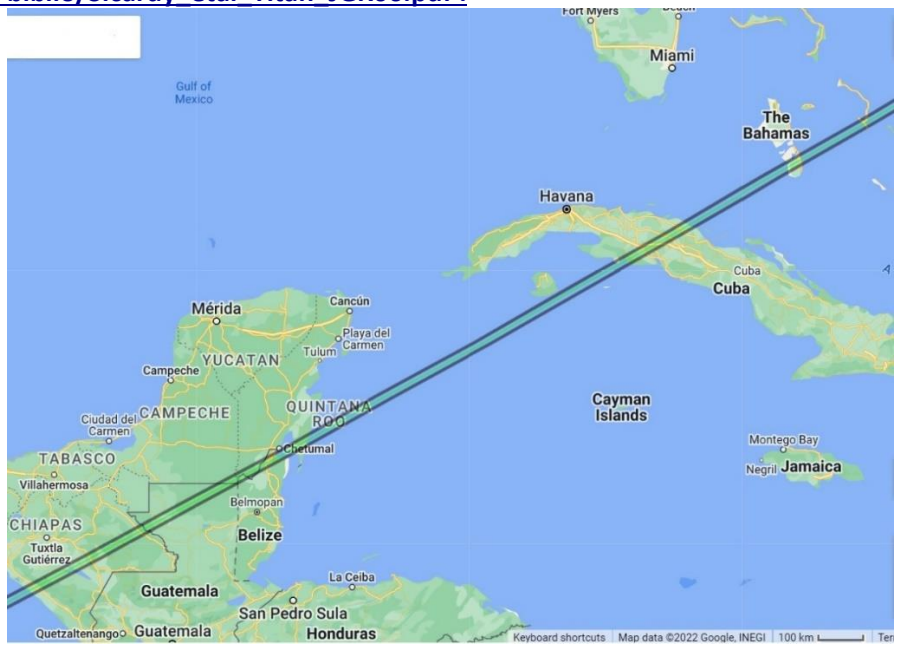
Titan and SAO 164648 should be easy to see, about 3' east of the much brighter ringed planet. Some diagrams, maps, and finder charts given in the pre-event version have been removed from this post-event version. Observers throughout the large part of the USA, Mexico, Latin America, and the Caribbean in the occultation zone are encouraged to try to record the occultation from their observatories, guided by the predictions for the city closed to them given in the prediction files on the main page. The occultation will last up to 5.5 minutes, shorter especially near the limits. With the events gradual, lasting at least 30s, you should start recording at least 2 min. before the predicted time of the D. When Titan gets close enough to the star that the two appear to merge, they will appear as a single object of magnitude 7.9. Then, for several seconds, the object will gradually diminish in brightness as the star sinks into Titan's atmosphere, eventually reaching the magnitude 8.5 of Titan as the star completely disappears. But there will also be sudden brightening "spikes" due to thermal inversion layers in Titan's stratosphere; you can see them in Hans Bode's video noted above. Recording with a larger telescope will help distinguish these spikes from Earth atmospheric scintillation. The merged objects will similarly brighten when the star reappears, with the changes amounting to only 0.6 magnitude, which will be difficult to notice by eye, but which can be recorded well with a sensitive video or CCD camera.

The Central Flash

Of special interest was the central flash that occurred close to the occultation's central line, when Titan's entire atmosphere will focus the star's light, causing it to brighten briefly, possibly even above its un-occulted level at central occultation. On June 1st, astronomers from the Southwest Research Institute (SwRI) deployed 10 stations across northern Australia in a successful effort to record the central flash during an occultation by Pluto; a good news account, with video of the event, is at **https://www.abc.net.au/news/2022-06-12/nasa-scientists-in-australian-outback-searching-for-pluto/101130096** . Pluto has wild seasons that causes its mainly nitrogen atmosphere to freeze out and reappear as the planet travels farther and closer to the Sun in its long orbit, so much interesting information can be obtained from its central flash observations. We also learned new information about Titan's atmosphere from the 28 Sagittarii central flash observations made in 1989. But since then, NASA's Cassini spacecraft studied Titan extensively during multiple Titan flybys while it was in orbit about Saturn for several years. When Cassini approached Saturn, it released ESA's Huygens probe into Titan's atmosphere, obtaining hundreds of images and measurements as it descended to the large moon's surface. We know much more about Titan now than in 1989, but Titan does have seasons as it orbits Saturn, causing changes in the atmosphere that are of interest. Such data could provide accurate astrometric information many years after the end of the Cassini mission, and before NASA's Dragonfly mission is due to arrive at Titan in 2033 with a drone to study the intriguing world. But Titan was so well

studied by Cassini and Huygens, that Dragonfly should have no trouble, with our current knowledge, to safely navigate to Titan's surface and perform its mission. Unfortunately, as far as we know, nobody travelled to the central line to observe the central flash. Some observers in the southernmost part of the USA had a slight brightening near the time of closest approach for their location. But interestingly, brightening spikes of the star were recorded during the gradual D and R phase, and even well north of the northern limit; in a few cases, the brightening was even greater than the unocculted brightness, and brighter than what was expected for the central flash. Bruno Sicardy notes that the **central flash zone is not so concentrated, due to the oblateness of Titan's atmosphere; strong central flash phenomena were expected to occur at least 100 km from the central line, 5 times as wide as the zone I had plotted.** This was found from analysis of previous Titan central flash observations, in 1989 [Ref. 1-4] and 2003 [Ref. 5]. Especially the first 2003 occultation is instructive since it was of an 8.6-mag. star, virtually the same brightness as the one to be occulted on July 9.

[1] Hubbard, Sicardy, Bode, et al., "The occultation of 28 Sgr by Titan", Astron. & Astrophys., Vol. 269, 541-563 (1993).
[2] Sicardy, Brahic, et al., "Probing Titan's atmosphere by stellar occultation", Nature, Vol. 343, 350-353 (1990).
[3] Sicardy, Ferri, et al., "The Structure of Titan's Stratosphere from the 28 Sgr Occultation", Icarus, Vol. 142, 357-390 (1999).
[4] Strobel and Sicardy, "Gravity Wave and Wind Shear Models", ESA Spec. Pub. 1177 (1997).
[5] Sicardy, Colas, et al., "The two Titan stellar occultations of 14 November 2003", J. Geophys. Res., Vol. 111, E11S91 (2006), doi:10.1029/2005JE002624, available at **https://lesia.obspm.fr/perso/bruno-sicardy/biblio/biblio/Sicardy_etal_Titan_JGR06.pdf .**



Map 1 – overview of the July 9th central flash zone, s.w. Mexico to the Bahamas. As noted above, it was expected to be at least 5 times the width that I plotted here.

20220709TitanNew.xml – This is the Occult input file for this event, available on the occultation's main page noted above.

David and Joan Dunham, dunham@starpower.net, 2022 June 28, updated July 1 and 17