See a Star "Go Out," A Startling Event — Howard L. Cohen

Don't miss an exceptional opportunity to see a naked-eye star wink out for several seconds as an asteroid passes in front of a star

Early Tuesday evening, April 17, 2007, at approximately 8:56 p.m. EDT, stargazers in Florida might see a naked-eye star do a disappearing act for several seconds. Furthermore, reliable observations of this event create an opportunity to contribute to astronomical research. The cause of this momentary disappearance is the passage of a main-belt asteroid between Earth and the distant star.

To witness this event observers must place themselves within a narrow path on the Earth's surface currently predicted to stretch through North Florida. Depending on your position within this narrow but long occultation path (roughly 47 miles or 76 km wide but stretching for thousands of miles), the occulting asteroid, 411 Xanthe, should cause the star 48 Iota-1 Cancri A (magnitude +4.0) to wink out for up to approximately 8.3 seconds. (See end of article for more on the nomenclature and properties of Iota Cancri and 411 Xanthe.)

Asteroid occultations occur when an asteroid, a small solar system body, moves in front of a star as seen from Earth momentarily hiding ("occulting") the star from view. These events occur infrequently for a given location on Earth but can give astronomers valuable information about the size and shape of the occulting asteroid. Moreover, sometimes occultations may reveal that the occulted star is also a *binary star*. Usually, the asteroid is too faint to see so the star simply "disappears" from view as the asteroid passes over the star, a truly startling phenomenon!

This April event is notable because the brightness of the occulted object, Iota Cancri, may allow observers to spot this star without a telescope from suburban areas free from glaring lights. (The naked-eye limit under *dark skies* is about magnitude +6 to +7.) *However, be sure to see "caveats" below.* In any case, binoculars or small telescopes should make the star visible. In addition, because Xanthe is too faint to see in most amateur telescopes, Iota Cancri will apparently drop 10.5 magnitudes to +14.7, the asteroid's magnitude, making the star invisible to the eye as it vanishes from view. Thus, Iota Cancri will seem to disappear from the sky!

Asteroids also usually occult faint stars since they are more numerous often making the event a challenging experience even with larger telescopes. So the occultation of Iota Cancri is an unusual and exciting opportunity to see a naked-eye star snap out of view only to reappear several seconds later. (For example, Xanthe also occults a star on January 30, 2007 for observers in western North America but the star's magnitude is only +11.1.)

Finally, this event occurs at a convenient hour, about 8:56 p.m. EDT, with the star high in the evening sky. Fortunately, too, no moonlight will interfere since the Moon's phase that evening is virtually new.

However, several caveats can thwart your attempt to view this occultation.

The occultation for North Florida occurs only one hour after sunset (about 7:57 p.m. EDT). Therefore, skies will not be completely dark. So, finding this star will be more difficult than usual. In fact, *nautical twilight* (about 8:51 p.m. EDT) ends shortly before this event occurs with the Sun about 13 degrees below the horizon at the time of the occultation. (*Astronomical twilight*, when the Sun contributes negligible amounts to sky illumination, is defined for the Sun 18 degrees below the horizon.)

Because of lingering sky brightness you will have precious few minutes to find, positively identify, and acquire the star in your instrument before the occultation begins.

Practice finding this star near the end of nautical twilight without moonlight. And you must do be able to do it quickly. (The Sun is 12 degrees below the horizon at the end of nautical twilight.) For convenience, **Table 1** gives Eastern Times for the end of nautical twilight in Gainesville, Florida for February through the April event date. (Notice that we now change to Daylight Time beginning the second Sunday in March.) Times should be similar for other locations in North Florida that do not differ substantially from Gainesville's longitude.

Table 1. 2007 Eastern Times of Nautical Twilight (Gainesville, Florida)

Day	February	March	April
1	7:01 p.m.	7:20 p.m.	8:40 p.m.
5	7:04 p.m.	7:23 p.m.	8:43 p.m.
10	7:07 p.m.	7:26 p.m.	8:46 p.m.
15	7:11 p.m.	8:29 p.m.	8:50 p.m.
20	7:14 p.m.	8:32 p.m.	8:53 p.m.
25	7:18 p.m.	8:35 p.m.	
30		8:39 p.m.	

Identifying the right star is vital. Obviously, observing the wrong star guarantees observers will see a "null event" Fortunately, Iota Cancri is an easy, colorful *visual double star* as seen through a small telescope! (See notes below about Iota Cancri.) This will help insure you have found the right star.

Iota Cancri is a classic example of a *wide double star*. Xanthe will occult its brightest appearing component (**A**), a fourth magnitude (+4.0), yellowish-white star. The second and fainter appearing component (**B**) is a +6.6 magnitude bluish-white star lying 30.7 arc seconds away. (This fainter star will *not* be occulted.) The combined light of both stars (mag. +3.9) makes this "combined star" the second brightest appearing star in Cancer. In small telescopes, the pair presents a glorious sight—a brighter pale yellow star attended by a fainter bluish star, reminiscent of colorful Alberio in Cygnus! (At the January star party some enjoyed a fine view of the Iota Cancri pair.) For more on this star see notes at the end of this article.

The disappearance of the brighter component of Iota Cancri leaving the fainter component still visible will make this occultation even more dramatic!

Cancer is not one of the more conspicuous constellations so use a good star chart to identify this star pattern and Iota Cancri. In fact, Beta Cancri is its brightest appearing star, shining only at magnitude +3.5, while Iota Cancri's combined light makes it second brightest at magnitude +3.9. Cancer lies between Gemini and Leo and contains the well-known and beautiful open star cluster, M44 (the "Beehive"), which lies 9.2 degrees almost due south of Iota Cancri. But, be careful, bright Saturn (near zero magnitude) now lies on the border of Cancer and Leo and will add a "spurious star" to Leo's pattern for the next few years. However, Saturn should also help you find Cancer in April. Use a finding chart like **Figure 1** to locate Cancer and Iota Cancri A.

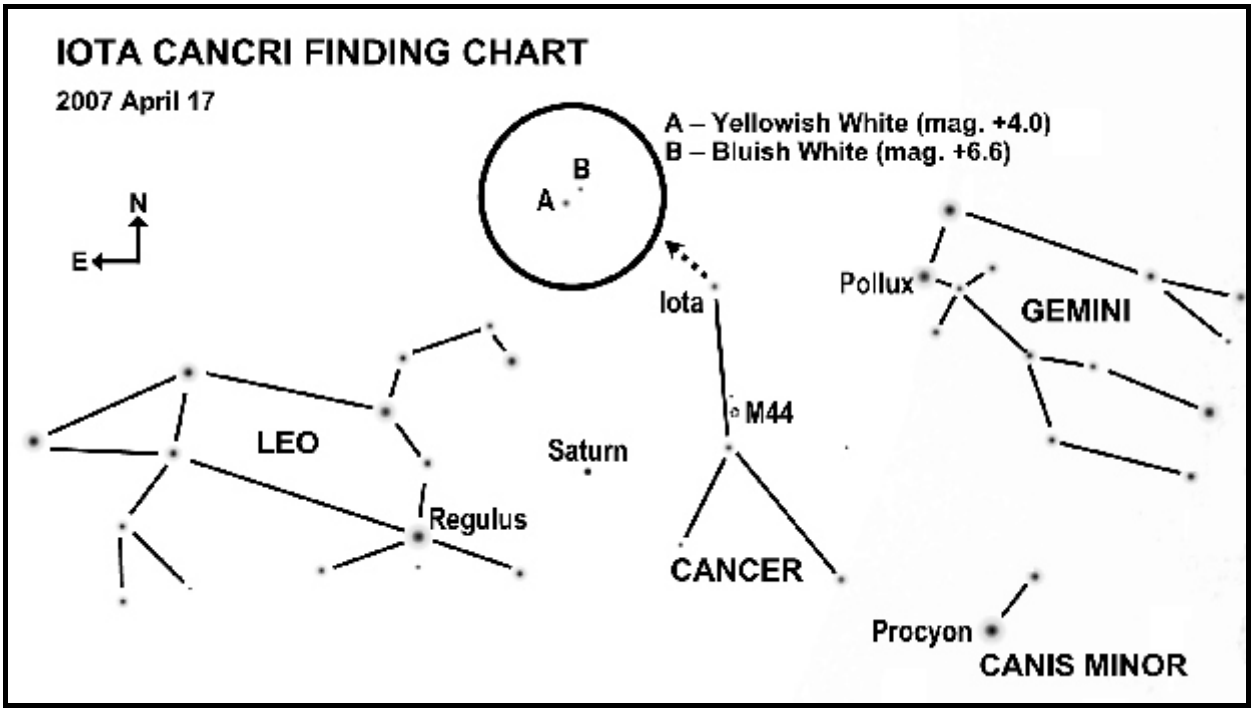

Figure 1. Finding chart showing location of Cancer and the positions of Iota Cancri A and B. Saturn now lies near the western edge of Leo and will continue to move slowly eastward through Leo over the next few years.

At the time of the occultation Iota Cancri will be almost overhead, only 5 degrees from the overhead point. Although astronomers like to observe celestial objects high in the sky to reduce problems with air clarity and turbulence, overhead objects can be challenging to see with binoculars or telescopes. Neck muscles may complain, the observer may be in an awkward position and some telescope mounts cannot point to objects near the *zenith* (the overhead point). Hence, you must determine if you and your instrument can conveniently observe stars near the zenith.

The width and location of the occultation path on the Earth's surface are narrow and uncertain. Consequently, unless you are within this path, you will not see the occultation. The occultation path is the asteroid's shadow on the Earth with the occulting star as the source of light. (The path width is essentially a projected "diameter" of the asteroid.) Uncertainties in the actual path result from uncertainties in the dimensions and shape of the asteroid, and uncertainties in the asteroid's orbit. Xanthe has an estimated diameter

of 47 km or 76 km but its precise size and shape are unknown, which is why asteroid occultations are important.

The current predicted path for this occultation (width 47 miles or 76 km) crosses North Florida moving approximately through Live Oak, Lake City, Starke and Palm Coast with the southern limit near Gainesville. Nevertheless, the path error could, for example, put the south edge of the path south of Bronson or north of Live Oak. See **Figure 2** for a map showing the current predicted path through North Florida. (The path could change due to future observations of the Xanthe's position.) The solid line is the center of the path and the long dashed line shows the northern and southern limits. An approximate 70 percent chance exists that the path limits should lie within the boundaries shown by the short dashed lines.

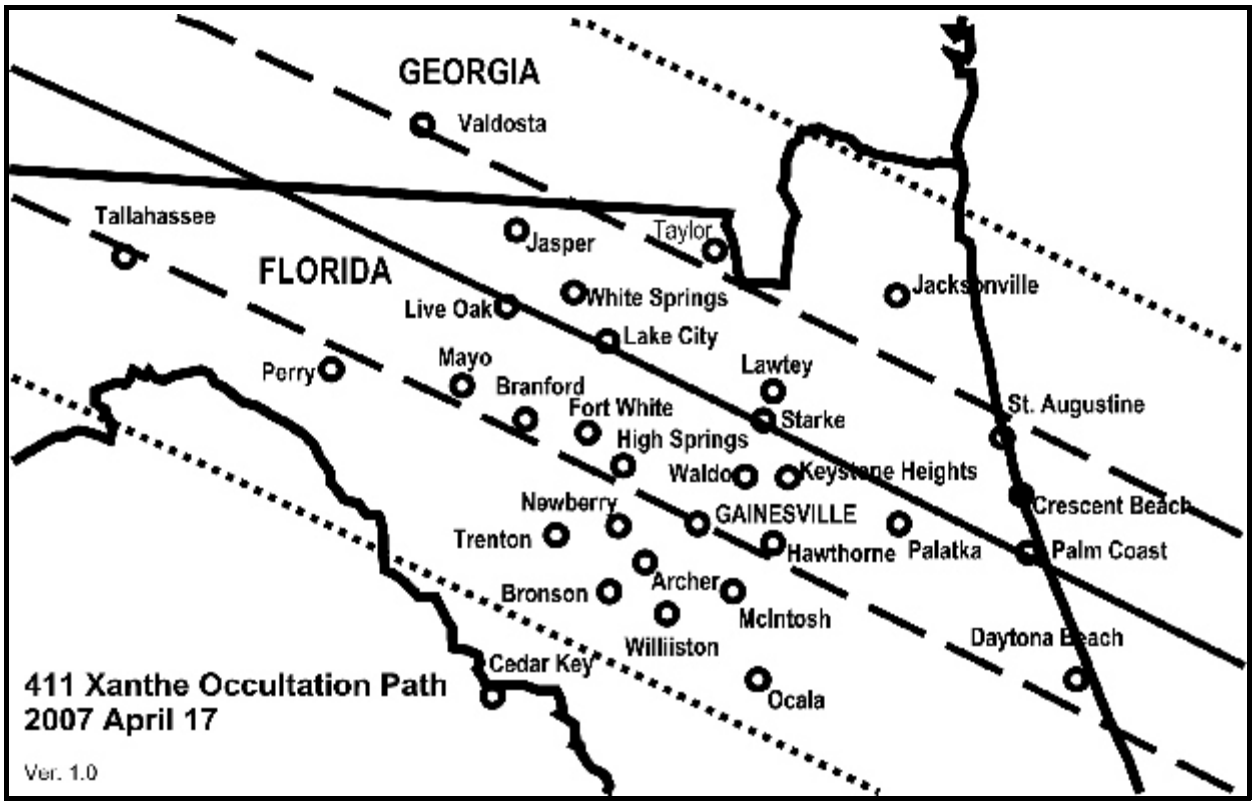

Figure 2. Occultation path through North Florida for the occultation of Iota Cancri A by asteroid 411 Xanthe on 2007 April17. The center line is the solid black line with long dashed lines showing the northern and southern limits. Short dashed lines indicate that an approximate 70% chance exists that the path limits should lie within these limits. Future observations of Xanthe could change the predicted limits.

The predicted time of the occultation can also be wrong by several minutes. Therefore, you must *continuously* observe Iota Cancri for at least three minutes before and after the predicted time or you may miss the occultation. Furthermore, the occultation will last only for a maximum of 8.3 seconds, much less if your location is near the edge of the path. In fact, the asteroid's shadow sweeps over the Earth's surface at approximately 9.2 km/sec (nearly 21,000 mi/h)! And, if you do not see the event, the actual occultation path may not have crossed your location. Yet, even observers who report no occultation

help astronomers constrain the size of the asteroid. Of course, this is why identifying the correct star is mandatory.

Often new observations of the asteroid's position just days before the event can lead to changes in the calculated path by hundreds of miles. Therefore, observers may need to relocate in the final days or hours before the event. However, recall that even observers who report no occultation provide valuable information because null events help set upper limits to the asteroid's dimensions (assuming you have identified the correct star).

Observers must know their precise geographical location. This is necessary if you want to make useful observations, even if a null observation results. GPS devices now make determining your location (latitude and longitude) simple and precise enough for asteroid occultations. Otherwise accurately noting your position from identifiable landmarks can pinpoint your location (within 200 ft.) if you use accurate and detailed topographic maps, or can later return to the observing site with a GPS unit.

Observers who fail to see an occultation (barring inclement weather) usually do so because of poor planning or lack of practice. Also, rehearse with your instrumental setup under the same conditions as the occultation. If you wait until a few days or weeks before the occultation, cloudy weather or moonlight can thwart your attempts to find Iota Cancri and use your equipment for this event. (Use fresh batteries and tapes.) Be sure to find an observing location that is safe, secure and free of distractions and glaring lights. If possible, visit your proposed observing location beforehand and do not use private property without first getting the owner's permission.

Finally, asteroid occultation observations can be done at different levels of sophistication including the use of visual, photographic, photometric or video methods. In addition, various means can be used to time the events from simply noting if the event occurred, timing the duration of the event or, better, timing the beginning and end of the event. (If possible time the event to at least an accuracy of 0.1 to 0.2 sec, probably the limit of careful visual timings.)

Everyone needs to decide for themselves how they want to observe or time this event, a decision dependent on your available equipment, experience and inclination. Serious occultation observers should consider attending future **ATM Meetings** (third Tuesdays of the month), especially the February 20, 2007 meeting, 7:00 p.m. ET. (Contact Chuck Broward, ATM coordinator, for meeting information and location at ATM@floridastars.org.)

At this meeting we will provide more information on how to observe this event, including pitfalls, resources and reporting results. We will also arrange to coordinate our observing efforts. Observers should be spread out over the width of the occultation path since each observer's location yields only one chord through the asteroid's silhouette and many chords are needed to assess the asteroid's size and shape.

Finally, subscribers to the AAC e-mail lists (AAC-L and especially ATM-OBSERVERS-L) should stay alert for future messages about this occultation.

Readers who want more information and details about occultations and how to observe and time them, should see the references listed at the end of this article.

NOMENCLATURE AND FURTHER NOTES ON THE STAR AND THE ASTEROID:

Iota Cancri:

Coincidentally, the occultation of the star **Iota** in Cancri is synonymous with the acronym for the **I**nternational **O**ccultation and **T**iming **A**ssociation, ***IOTA***! Technically Iota Cancri (ι Cancri) should be designated 48 Iota Cancri-1 (ι^1 Cancri, magnitude +3.9) because 57 Iota-2 Cancri (ι^2 Cancri, magnitude+5.4) is a dimmer looking star located 2.4 degrees to the northeast of Iota-1. *However, in this article we call Iota-1 just Iota.* In addition, the numerical designation for each star's name is the Flamsteed number whereas the Greek letter indicates the star's Bayer designation, which is used throughout this article. (Often either the Bayer or Flamsteed label is used by itself to name the star.) Finally, the designation "Iota A" refers to the "A" component since Iota Cancri is a double star (more fully described previously in this article). It is interesting and noteworthy that Bayer's method does not conform here to the more usual practice of labeling stars in a constellation by descending order of apparent brightness using the Greek letters alpha, beta, gamma, etc.

It is also interesting that W.T. Lynn published a short correspondence over a century ago (*The Observatory*, 1891, Vol. 14, pg. 201) that speculates past observations show Iota Cancri A was a variable star.

Distance measurements of Iota Cancri A and B suggest these two stars are separated in space by approximately 300 and 190 light years respectively. This would make the two stars unrelated—just a coincidental, line-of-sight double (also called an *optical double)*. However, their distances are uncertain. Motion studies show the two stars may be moving together in space not having changed relative positions in a century. This, and their close apparent separation of about one-half arc minute, strongly suggest the two stars may be gravitationally bound and make up a *binary star system*.

Iota Cancri A is probably an evolved *giant star* (technically classified G7.5 III) with a luminosity of about 200 Suns and with a surface temperature cooler than the Sun's by 800 K (1,400 F degrees). So, this produces its yellowish-white color. In contrast, Iota Cancri B is an ordinary *main sequence* star (technically A3 V) like the Sun but with a larger diameter, shining with a luminosity of about 16 Suns and *hotter* by 3,000 K (5,400 F degrees). This gives "B" its slightly bluish hue.

The Iota Cancri system is young compared with the Sun, perhaps only 200,000 to 300,000 million years old. (The Sun's age is estimated to be nearly five billion years.) However, the larger mass of "A" (approximately 3.5 times the Sun's mass) has apparently caused "A" to evolve faster changing this star from a very hot main sequence star into a cool giant with an inert helium core. Meanwhile component "B" (with a mass of approximately two solar masses) is evolving more slowing than "A" and may still have about a billion years left to fuse all its core hydrogen into helium.

411 Xanthe:

The designation for asteroid *411 Xanthe* (pronounced Zan-thee, a Greek name meaning yellow or fair hair) includes both a permanent sequential number (which does not necessarily indicate order of discovery) plus a name accepted by the International Astronomical Union, usually proposed by the discoverer. Sometimes either the number or name is used by itself to designate the asteroid.

Xanthe was discovered on January 7, 1896 by Auguste Charlois, a French astronomer who discovered 99 asteroids! Xanthe travels in a slightly noncircular orbit (eccentricity 0.12 or about seven times larger than the Earth's orbital eccentricity). The asteroids mean distance from the Sun is 2.9 times the "Earth-Sun mean distance" (called an astronomical unit or AU, about 93 million miles or 150 million km). The asteroid's orbit is also tilted 15 degrees to the plane of Earth's orbit. Xanthe orbits the Sun every 5.0 years with its distance from the Sun ranging from 2.6 to 3.3 AU. This keeps Xanthe within the solar system's main asteroid belt between Mars and Jupiter. Infrared observations suggest a diameter of 76 km (47 mi), a rotation period of 7.5 hours, and a low reflectivity (under ten per cent?) like some areas of the Moon.

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