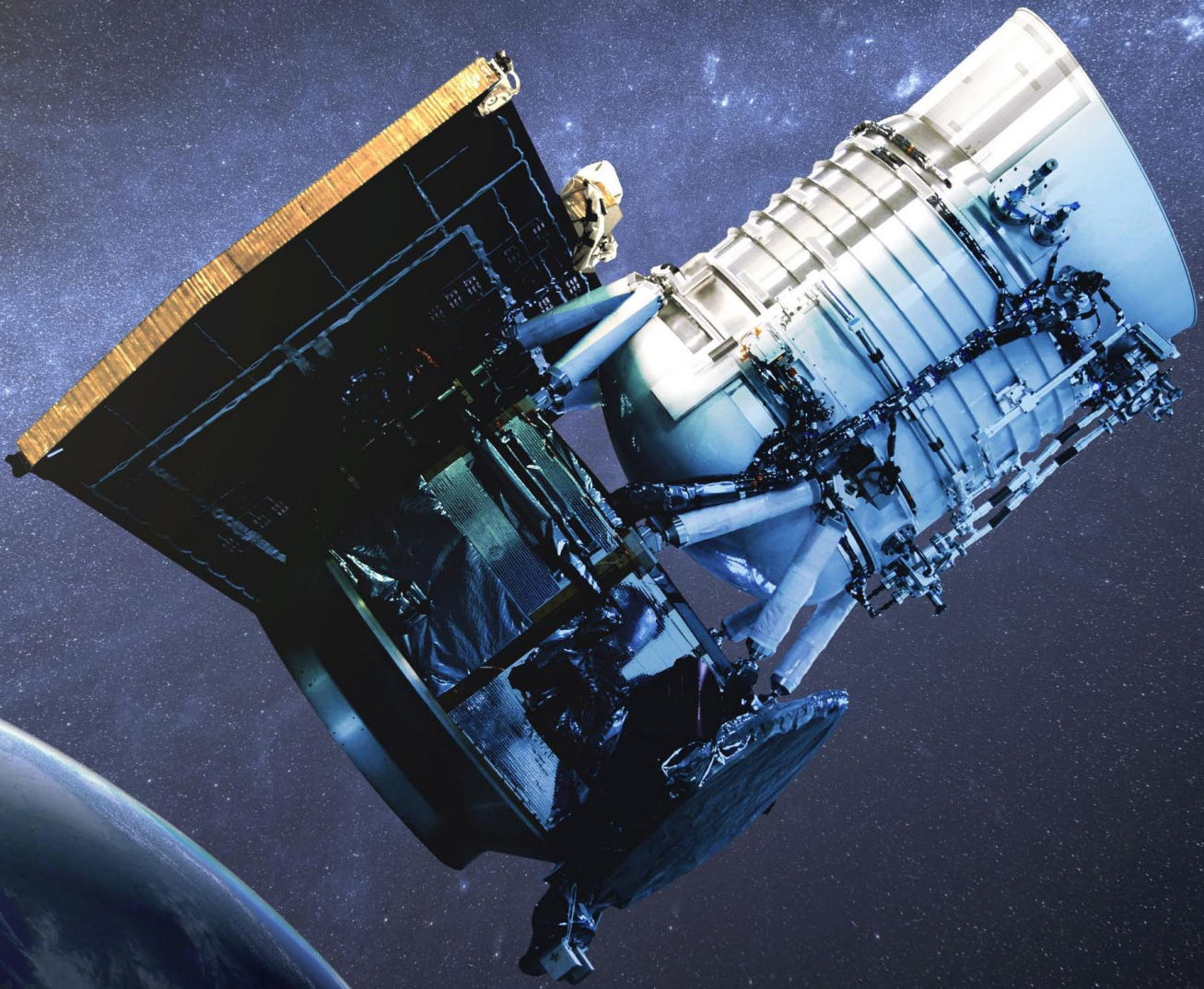


ICE & STONE 2020

WEEK 14: MARCH 29-APRIL 4, 2020

Presented by The Earthrise Institute



#14

Authored by Alan Hale

THIS WEEK IN HISTORY



MARCH 29, 1807: The German astronomer Heinrich Olbers discovers the asteroid now known as (4) Vesta, the brightest and second-largest asteroid in the main asteroid belt. Vesta was orbited by the [Dawn](#) spacecraft between July 2011 and September 2012. It and the other first-known main-belt asteroids are discussed in the Week 1 “[Special Topics](#)” presentation.



MARCH 30, 240 B.C.: Astronomers in China make the first sighting of what is now known as Comet 1P/Halley. This comet’s history is discussed in a previous “[Special Topics](#)” presentation.



MARCH 30, 2021: The [James Webb Space Telescope](#) is scheduled for launch from Kourou, French Guiana. Webb, which will be placed near the Earth-Sun L2 Lagrangian point 1.5 million km directly anti-sunward of Earth, is touted as being the successor to the [Hubble Space Telescope](#), although its detector sensitivity is primarily in the infrared.

MARCH 31, 2005: Michael Brown and his team discover the large Kuiper Belt object now known as the “dwarf planet” (136472) Makemake. The “dwarf planets” and other Kuiper Belt objects are discussed in a future “[Special Topics](#)” presentation.

COVER IMAGES CREDITS:

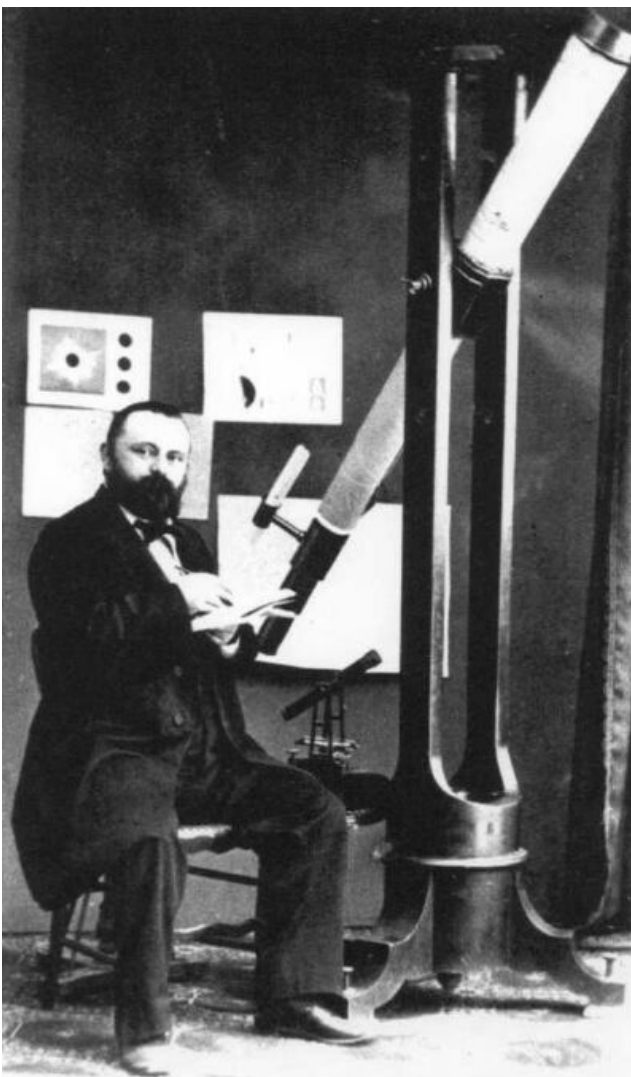
Front cover: This artist’s concept shows the Wide-field Infrared Survey Explorer, or WISE spacecraft, in its orbit around Earth. From 2010 to 2011, the WISE mission scanned the sky twice in infrared light not just for asteroids and comets but also stars, galaxies and other objects. In 2013, engineers brought the spacecraft out of hibernation to hunt for more asteroids and comets in a project called NEOWISE. Courtesy NASA/JPL-Caltech.

Back cover: This graphic shows the orbits of all the known Potentially Hazardous Asteroids (PHAs), numbering over 1,400 as of early 2013. These are the asteroids considered hazardous because they are fairly large (at least 460 feet or 140 meters in size), and because they follow orbits that pass close to the Earth’s orbit (within 4.7 million miles or 7.5 million kilometers). But being classified as a PHA does not mean that an asteroid will impact the Earth: None of these PHAs is a worrisome threat over the next hundred years. By continuing to observe and track these asteroids, their orbits can be refined and more precise predictions made of their future close approaches and impact probabilities. Courtesy NASA/JPL-Caltech.



APRIL 1, 1997: Comet Hale-Bopp C/1995 O1 passes through perihelion at a heliocentric distance of 0.914 AU. At this writing this is the northern hemisphere's most recent "Great Comet" and, for obvious reasons, had a major impact on my life. It is a future "Comet of the Week."

APRIL 1, 2019: American scientist Robert DePalma publishes a paper describing a site in North Dakota that contains numerous fossils, possibly indicating a rapid mass death following a tsunami-like upsurge of water from the Cretaceous-Tertiary (K-T) impact event. The conclusions are controversial and are not universally accepted at this time, but do provide areas of future research. The K-T event is the subject of a future "Special Topics" presentation.



Astronomer Ernst Wilhelm Leberecht Tempel at his observatory in Marseille.

APRIL 3, 1867: The German astronomer Wilhelm Tempel, observing from Marseilles, France, discovers the comet now known as 9P/Tempel 1. After being observed at the next two returns, the comet was lost for almost a hundred years before being recovered in the mid-20th Century. It was the destination of the [Deep Impact](#) mission in 2005 and was also visited by the [Stardust](#) spacecraft in 2011, becoming the only comet that has been visited by spacecraft on two different returns. It is a future "Comet of the Week."

APRIL 3, 2020: The main-belt asteroid (3) Juno will be at opposition. It is traveling through the constellation Virgo and is about magnitude 9.5.

***THERE ARE NO CALENDAR ENTRIES FOR APRIL 2 AND 4.**

COMET OF THE WEEK: BENNETT 1969I

Perihelion: 1970 March 20.04, $q = 0.538$ AU



Comet Bennett over the Swiss Alps on the morning of March 26, 1970, from Gronergrat, Switzerland. This photograph was taken by, and is provided courtesy of Claude Nicollier, who would later become an astronaut for ESA and who flew on four Space Shuttle missions.

One of the underlying foundations of "Ice and Stone 2020" is the fact that it marks the anniversary of my observations of my very first comet, Comet Tago-Sato-Kosaka 1969g – also, incidentally, the first comet ever observed from space. (I discuss this comet, including my observations of it, in a previous "[Comet of the Week](#)" presentation.) Less than two months later another, and significantly brighter, comet came along, and it was probably that object more than anything else that inspired my lifetime of comet observing. The fortuitous occurrence of two bright comets coming in quick succession right after I first began serious observations of the night sky led that budding young astronomer to believe that bright comets are a fairly common phenomenon – something that I have long since learned is not true. By the time I learned that, however, I was "hooked" . . .

This second comet was discovered on December 28, 1969, by a South African amateur astronomer, John

Bennett. At that time it was about 9th magnitude and located in southern circumpolar skies and, traveling in an orbit almost exactly perpendicular to Earth's, traveled northward and brightened over the subsequent weeks. By about the beginning of February 1970 it had reached naked-eye brightness, and it was close to 4th magnitude near the end of that month. By mid-March it had brightened further to about 1st magnitude and was exhibiting a bright dust tail close to 10 degrees long. Shortly after perihelion passage the comet became visible from the northern hemisphere, and it was as bright as magnitude 0, with the bright dust tail being in excess of 10 degrees in length, when I saw it for the first time on the morning of March 24.

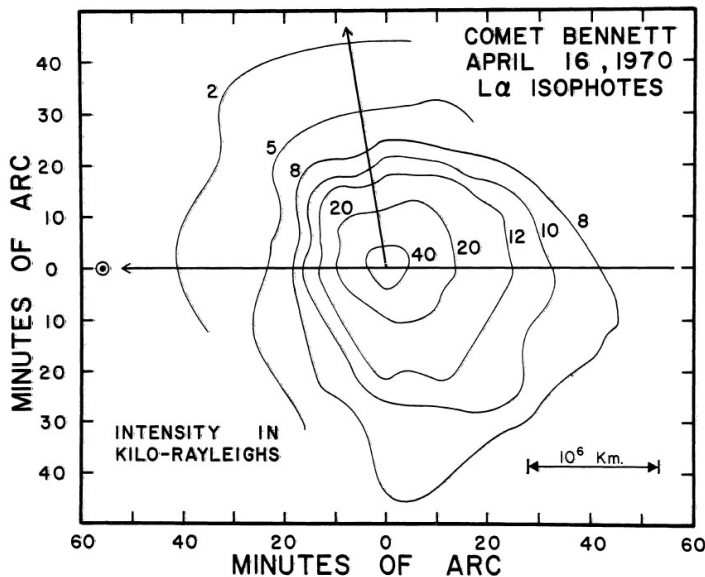
Continuing its northward trek, Comet Bennett remained a bright and conspicuous object throughout most of April, fading only slowly, and with the dust tail remaining bright and prominent,

with some reported measurements being close to 20 degrees. It also exhibited a fainter ion tail close to 10 degrees long, and meanwhile telescopic observations revealed an active inner coma with various jets and “hoods” or “envelopes” – indicative of rotation.



My first attempt at photographing a comet – at age 12, with a handheld Brownie camera: Comet Bennett on the morning of March 25, 1970.

The comet finally dropped below naked-eye visibility around the middle of May, by which time it was in northern circumpolar skies. It passed seven degrees from the North Celestial Pole in late September and remained visually detectable until November, with the final photographs being taken in February 1971.



Isophotes of the Lyman-alpha cloud around Comet Bennett taken by the OAO-2 spacecraft on April 16, 1970. The direction to the sun is indicated on the left. From a 1972 paper authored by Arthur Code, Theodore Houck and Charles Lillie; provided courtesy Blair Savage.

Scientific studies of Comet Bennett include infrared observations obtained by University of Minnesota astronomer Raymond Maas (who tragically died of a heart attack less than 24 hours after obtaining these

observations) which show silicate grains essentially identical to those in the atmospheres of red giant stars – an important link in the study of how planetary systems form. The comet was observed in the ultraviolet with the Orbiting Astronomical Observatory 2 (OAO-2) satellite and also with the Orbiting Geophysical Observatory 5 (OGO-5) satellite, and these showed the presence of a large cloud of hydrogen surrounding the coma, ten times the size of the sun in the case of the OGO-5 observations. OAO-2 had detected a similar, albeit smaller, cloud around Comet Tago-Sato-Kosaka, and we now know that these “Lyman-alpha” clouds accompany almost all comets that visit the inner solar system.

I have learned informally that Comet Bennett was the first comet to be observed by astronauts in space, as the crew of the ill-fated Apollo 13 mission viewed it while en route to the moon. I have also heard that were plans for the astronauts to photograph the comet as well, but these were apparently pre-empted following the explosion of the Service Module on April 13.



Photograph of Comet Bennett in the morning sky of April 5, 1970, suggestive of its naked-eye appearance. Courtesy Herman Heyn.

The orbit of Comet Bennett is a distinct ellipse, with calculations indicating an orbital period of 1600 to 1700 years. Its high intrinsic brightness suggests that it should have been observable on its previous return, and in 1979 the Japanese astronomer Ichiro Hasegawa suggested it might be identical to a comet that was observed from China and Europe during August and September in A.D. 363 and which according to the Roman historian Ammianus Marcellinus was believed to presage the death of the Roman emperor Jovian the following year. Unfortunately, that comet was not well enough observed for a valid orbit to be computed, so we may have to wait until Comet Bennett returns again – sometime around the 37th Century – before we can clear this matter up one way or the other.

SPECIAL TOPIC: ANCIENT IDEAS ABOUT COMETS



A 19th Century French cartoon depicting the destruction of Earth by a cometary impact. In reality, while the impact of a large comet might significantly affect the Earth's biosphere, the planet itself would remain relatively unscathed.

To our ancestors of several centuries to a few millennia ago, the nighttime sky was, to some extent anyway, a generally predictable place. The stars remained "fixed" relative to each other in the patterns that we call constellations, each culture "seeing" whatever constellations that they considered relevant. While these shifted east-to-west over the course of a night, and then over the course of a year, they always returned with predictable regularity. Meanwhile, a handful of bright "wandering stars" traveled against the pattern of the constellations, but the sky-watchers who studied these regularly found that their motions were predictable, and that they kept to a certain band of constellations that we refer to as the zodiac. These "wandering stars" are, of course, the objects we now call "planets," and while the ancient peoples may not have understood the mechanism that produced the "wandering," they at least found that "wandering" to be regular and predictable.

The comets, however, were a different story. These appeared at irregular intervals, without warning, and in all parts of the sky. They traveled against the background stars in paths often quite dissimilar to

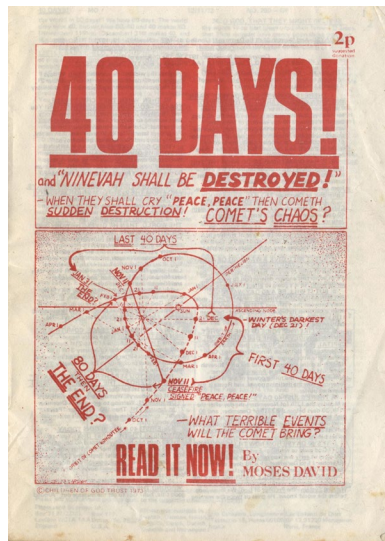
those of the planets, changed their appearances over the course of days or weeks – with no two comets appearing exactly alike – and would disappear as suddenly as they had appeared. Some comets, with tails stretching a considerable distance across the nighttime sky, could be truly imposing objects.

Given all this, and given the reasonable consensus that the goings-on in the nighttime sky were directly related to the goings-on here on Earth, it is easy to understand how ancient peoples came to view comets as some sort of divine or supernatural phenomenon, perhaps as some kind of messenger from whatever gods or other deities in which the particular culture involved happened to believe. Furthermore, since events like wars, natural disasters, epidemics, and so on, were always taking place, and since accordingly it would not be unusual for one or more such events to be happening around the time of a comet's appearance, it would not be too large of a step in logic to associate the comet with those particular events. Thus, in many ancient societies comets came to be thought of as portents of disaster and/or as omens of some kind of divine displeasure.

The specific role that a comet might play in a culture's view of the sky would depend upon the overall culture itself. The most meticulous observers of the sky one to three millennia ago were the astronomers in China and elsewhere in the Orient, who recorded the passages of numerous comets. These were generally of two types: "bushy stars" were comets that didn't exhibit much of a tail, just a large coma; and "broom stars," which were comets that exhibited long tails. According to some old Chinese texts, "broom stars," in particular, would "govern the sweeping away of old things and the assimilation of the new."

The ancient societies in Europe, beginning with the Greeks and then the Roman Empire, and then its successor societies, provide probably the best-known of the medieval views of comets. A brilliant comet appeared in 44 B.C. shortly after the assassination of Julius Caesar, and was widely believed to be his soul ascending to the heavens. (This particular comet is a future "Comet of the Week.") The appearance of [Comet 1P/Halley](#) in A.D. 66 was believed afterwards as foretelling the destruction of Jerusalem four years later, and as discussed in this week's "Comet of the Week" presentation, a comet that appeared in A.D. 363 (and that may have been the previous return of Comet Bennett 1969i) was believed by some to have foretold the death of the Roman emperor Jovian the following year.

For the next millennium, as Christianity held sway throughout most of Europe, comets were almost always viewed with fear as being instruments of divine retribution against various shortcomings of



Front and back pages of "The Christmas Monster" pamphlet distributed by a religious cult, the "Children of God," during the appearance of Comet Kohoutek 1973f.



Devil, the Turk, and the Comet" does seem to be what we would now call an "urban legend," however, although it's nevertheless believable considering the tenor of the times.

An interesting example, and at the same time an interesting variation, is presented by the return of Comet Halley in 1066, during which it passed close to Earth and became quite brilliant in the nighttime sky.



A section of the Bayeux Tapestry, which commemorates the Battle of Hastings. It shows Comet 1P/Halley during its 1066 return, with King Harold II of England and his aides gazing fearfully at it. The Latin inscription reads "They marvel at the star."

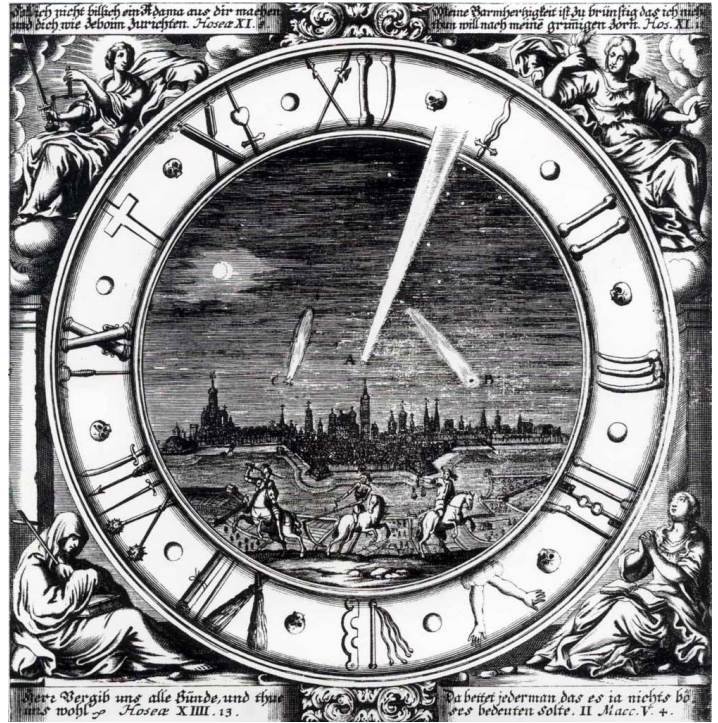
humanity, and thus causing various pestilences. Pictorial representations of comets in literature of the time often embellished comets as being shaped as, or at least accompanied by, swords or other weapons of war, as well as skulls, blood, and so on. The oft-told story that the return of Comet Halley in 1456 triggered a Papal Bull requiring the people to pray for salvation from "the

King Harold II of England viewed it as an omen of ill fortune, whereas across the English Channel, William of Normandy viewed it as a portent of good luck. As I discuss in Comet Halley's "[Special Topics](#)" presentation, these two views both turned out to be self-fulfilling prophecies, as demonstrated at the Battle of Hastings.

Considering the overall divine/supernatural mystique that surrounded the human view of comets, there really was not much in the way of scientific studies of them. The general prevailing scientific view, such as it was, was put forth by the Greek philosopher Aristotle in the 4th Century B.C., and held that comets were "exhalations" of gases from the ground into the upper atmosphere. In this way of thinking, then, comets are not celestial objects like stars or planets, but instead are phenomena of our own air. If this were true, comets could only be visible from certain locations on Earth at any given



Medieval representations of comets as portents of doom. Left: A representation of the destruction wrought by a 4th Century comet. Note that the tail is directed towards the horizon, which is the opposite of the orientation comets' tails usually exhibit. From the *Theatrum Cometicum* from Stanislaus Lubienietki. Right: German representation of the comets of 1680, 1682 (Halley), and 1683, with three of the four "Horsemen of the Apocalypse" in the foreground, together with war instruments, religious figures and appropriate Old Testament verses.



time, but since communications between widely separated locations were all but non-existent at that time there was nothing in the way of any evidence to the contrary.

This Aristotelian view of comets held sway well into the 2nd Millennium. What could probably be considered the first scientific observation of a comet was made by the German philosopher Petrus Apianus (Peter Apian), who in studying Comet Halley in 1531 noted that the comet's tail was always directed away from the sun. (There is evidence, meanwhile, that ancient Chinese astronomers were at least somewhat aware of this fact.) Then, in 1577 the Danish astronomer Tycho Brahe carried out detailed observations of the brilliant comet that appeared that year, and was able to determine that it showed no discernible parallax when viewed from widely separated locations on Earth's surface – thus showing that the comet was at least four times farther away from Earth than is the moon. This in turn showed conclusively that comets are true celestial objects and not phenomena of Earth's atmosphere. (This particular comet, meanwhile, is a future "Comet of the Week.")

Beginning with Edmond Halley's demonstration in the early 18th Century that at least one comet returned on a regular basis and thus was a member of the solar system just like the planets, the scientific study of comets has proceeded apace, as is discussed throughout the various presentations in "Ice and Stone 2020." While there is still plenty left to learn about these objects, they are now well within the realm of physical objects that can be examined scientifically; meanwhile, while the sight of a bright comet in the nighttime (or even daytime) sky can be breathtakingly

beautiful and might well elicit feelings of a spiritual nature, they have been forever removed from the realm of the divine and supernatural.

There does remain one way in which comets can be rightfully feared: they can impact Earth, with significant and perhaps devastating effects on the biosphere, and this indeed has happened from time to time throughout Earth's natural history. The odds that such an event might happen within our lifetimes, or even within the next several centuries, are very remote, although they are not zero. The comprehensive sky survey programs that have become operational over the past couple of decades – and that will be discussed in a future "Special Topics" presentation – should go a long way towards identifying any potentially threatening objects long before they might threaten Earth, although the long-period comets will remain an ever-present, even if very remote, threat.

Given all that we know about comets nowadays, it is unfortunate that non-scientific ideas – based somewhat on the ancients' ideas, but intermixed with more modern "mythologies" – remain among some segments of the general public. By the time Comet Halley returned in 1910 spectroscopic studies of comets had revealed that the cyano radical CN was a constituent of comets' comae; on a popular level this was mistakenly believed to be the poisonous gas cyanogen, and since orbital calculations suggested that Earth might be passing through the comet's tail, this generated some public panic. I have read contemporary reports of a wealthy rancher in Albuquerque, New Mexico who committed suicide on the day of the comet's closest approach because



Top of the home page from the [web site](#) of the Heaven's Gate religious cult, that committed a mass suicide near San Diego, California in March 1997 during the appearance of Comet Hale-Bopp.

he did not wish to see the end of the world, and meanwhile several unscrupulous entrepreneurs made fortunes selling "comet pills" allegedly designed to ward off the effects of the "deadly gas."

Even more recent comets have produced fear and hysteria. Comet Kohoutek 1973f – a future "Comet of the Week" – engendered quite a bit of "end times" forecasts around the time of its appearance, even though the comet itself failed to live up to the original forecasts of its performance. I had to deal with this myself when Comet Hale-Bopp appeared, as various forms of "end times" paranoia kept rearing its head. Some of this was based on an alleged "companion" alien spacecraft supposedly accompanying the comet; there were some claims that this was "four times larger than Earth," notwithstanding the fact that such an object would have been easily visible to the unaided eye, and even a casual glance at the comet would reveal that no such object was present. The hysteria reached its crescendo when several members of a religious cult near San Diego, California, committed mass suicide in an effort to join their "companions" aboard this "spacecraft."

Even today, the hysteria persists. Orbital calculations suggested that Comet Elenin C/2010 X1 might become a naked-eye object after its perihelion passage in September 2011, and various "end times" scenarios very quickly traveled around the Internet and in popular media. Some writers even claimed that the comet's discoverer, Leonid Elenin, wasn't a

real person: supposedly, the "ELE" in his name stood for "Extinction Level Event," a term that is not used scientifically but rather was coined in the 1998 movie [Deep Impact](#), and "NIN" stood for "Nibiru Is Near," Nibiru being a supposed planet – for which there is

no scientific evidence whatsoever – that would be arriving soon and wreaking havoc. All of this was notwithstanding the facts that "Leonid" and "Elenin" are both relatively common Russian names, and that the comet's discoverer is an accomplished amateur astronomer with four other comet discoveries to his credit. As things happened, Comet Elenin disintegrated before it reached perihelion, and even had it survived, its closest approach to Earth would only have been 0.23 AU, which is perhaps close enough to be interesting but hardly unusual or cause for concern.



A label for the "Comet Pills" sold during the 1910 return of Comet Halley.

It would seem likely that we will see something similar when the next potentially bright comet begins to make its appearance. Indeed, if the inbound [Comet ATLAS C/2019 Y4](#) does end up becoming a bright object – which current observations suggest is at least possible – there might well be claims that it is somehow "associated" with, say, the

current [coronavirus](#) pandemic (the full extent of which is unknown at this writing). I urge all "Ice and Stone 2020" participants to ignore all this, and instead study the comet, take photographs of it, make scientific observations of it, or write stories and/or songs about it or engage in whatever other activities might be appropriate. Above all else, appreciate the beauty of the comet for its own sake. This should be the legacy of a bright comet.

www.halebopp.org

www.iceandstone.space

