

# ICE & STONE 2020

WEEK 11: MARCH 8-14, 2020

*Presented by The Earthrise Institute*

#11

*Authored by Alan Hale*

# THIS WEEK IN HISTORY



**MARCH 8, 1772:** A French amateur astronomer, Jacques Montaigne, discovers a comet that is followed for one month and that reaches 7th magnitude. Over the next 5½ decades the comet is discovered on two subsequent returns, the latter of these being in 1826 by an Austrian army officer, Wilhelm von Biela, for whom it was eventually named. Comet 3D/Biela, which was “Comet of the Week” three weeks ago, split into two components two decades later and subsequently disintegrated, producing strong displays of the Andromedid meteor shower during the next few “returns.”

**MARCH 8, 1986:** The Japanese [Suisei](#) spacecraft makes a distant flyby of Comet 1P/Halley at a distance of 151,000 km. The history of Comet Halley is the subject of this week’s “Special Topics” presentation, and the 1986 return in particular is this week’s “Comet of the Week.”

**MARCH 8, 2003:** A team of astronomers led by Olivier Hainaut obtains the final images of Comet 1P/Halley on its 1986 return with the [European Southern Observatory’s](#) Very Large Telescope. The comet’s heliocentric distance at the time was 28.1 AU.



**MARCH 9, 1986:** The Soviet Union’s [Vega 2](#) spacecraft passes 8000 km from Comet 1P/Halley. Vega 2 obtained several images of Halley’s nucleus and aided in navigating the European Space Agency’s [Giotto](#) spacecraft to its close Halley flyby five days later.

**MARCH 9, 1997:** The [path](#) of a total solar eclipse crosses northern Mongolia and eastern Siberia. Ground-based observers in Siberia successfully detected Comet Hale-Bopp during totality.



**MARCH 10, 1977:** Uranus occults the 9th-magnitude star HD 128598 in Libra. Prior to being covered by the planet itself, the star disappeared and reappeared several times, and did so again as the planet was receding, leading to the discovery of at least nine thin rings orbiting the planet. This was one of the first clear examples of physical information about an object being discovered when it occults a background star, which led the way to detailed observations of occultations by asteroids. This subject is covered in more detail in a future “Special Topics” presentation.

*Front cover: Three impact craters of different sizes, arranged in the shape of a snowman, make up one of the most striking features on Vesta, as seen in this view from NASA’s Dawn mission. Courtesy NASA/JPL-Caltech/UCLA/MPS/DLR/IDA*  
*Back cover: This enhanced-color view from NASA’s Dawn mission shows an unusual ‘pitted terrain’ on the floors of the crater named Cornelia on the giant asteroid Vesta. Courtesy NASA/JPL-Caltech/UCLA/MPS/DLR/IDA/JHUAPL*



**MARCH 11, 1986:** The Japanese [Sakigake](#) mission makes a distant flyby of Comet 1P/Halley at a distance of 7 million km.

**MARCH 11, 1998:** The IAU's Central Bureau for Astronomical Telegrams issues IAU Circular [6837](#), concerning the near-Earth asteroid 1997 XF11 – now designated (35396) – that had been discovered three months earlier and that calculations indicated would be passing extremely close to Earth – 0.00031 AU, or slightly over 6 Earth radii above the surface – in October 2028. Although pre-discovery images from 1990 that were identified the following day moved the 2028 “miss distance” out to 0.006 AU, and even closer future approaches have since been identified, the entire incident demonstrated that very close Earth approaches were taking place, and helped lay the foundation upon which calculations of these events are now performed. This process is discussed in a future “Special Topics” presentation.



**MARCH 12, 1932:** Eugene Delporte at the Uccle Observatory in Belgium discovers the near-Earth asteroid now known as (1221) Amor. Although it wasn't the first representative of the group to be discovered, near-Earth asteroids with perihelion distances between 1.0 and 1.3 AU are now called “Amor-type” asteroids. The various groups of near-Earth asteroids are discussed in a previous “[Special Topics](#)” presentation.



**MARCH 13, 1759:** Comet 1P/Halley passes through perihelion at a heliocentric distance of 0.584 AU. The comet's recovery on this return fulfilled the prediction made in 1705 by Edmond Halley and firmly established that comets are members of the solar system in orbit around the sun. The story of Comet Halley is the subject of this week's “[Special Topics](#)” presentation.

**MARCH 13, 1930:** The Lowell Observatory in Arizona formally announces the discovery of Pluto by astronomer Clyde Tombaugh three weeks earlier. The story of Pluto is the subject of a future “[Special Topics](#)” presentation.

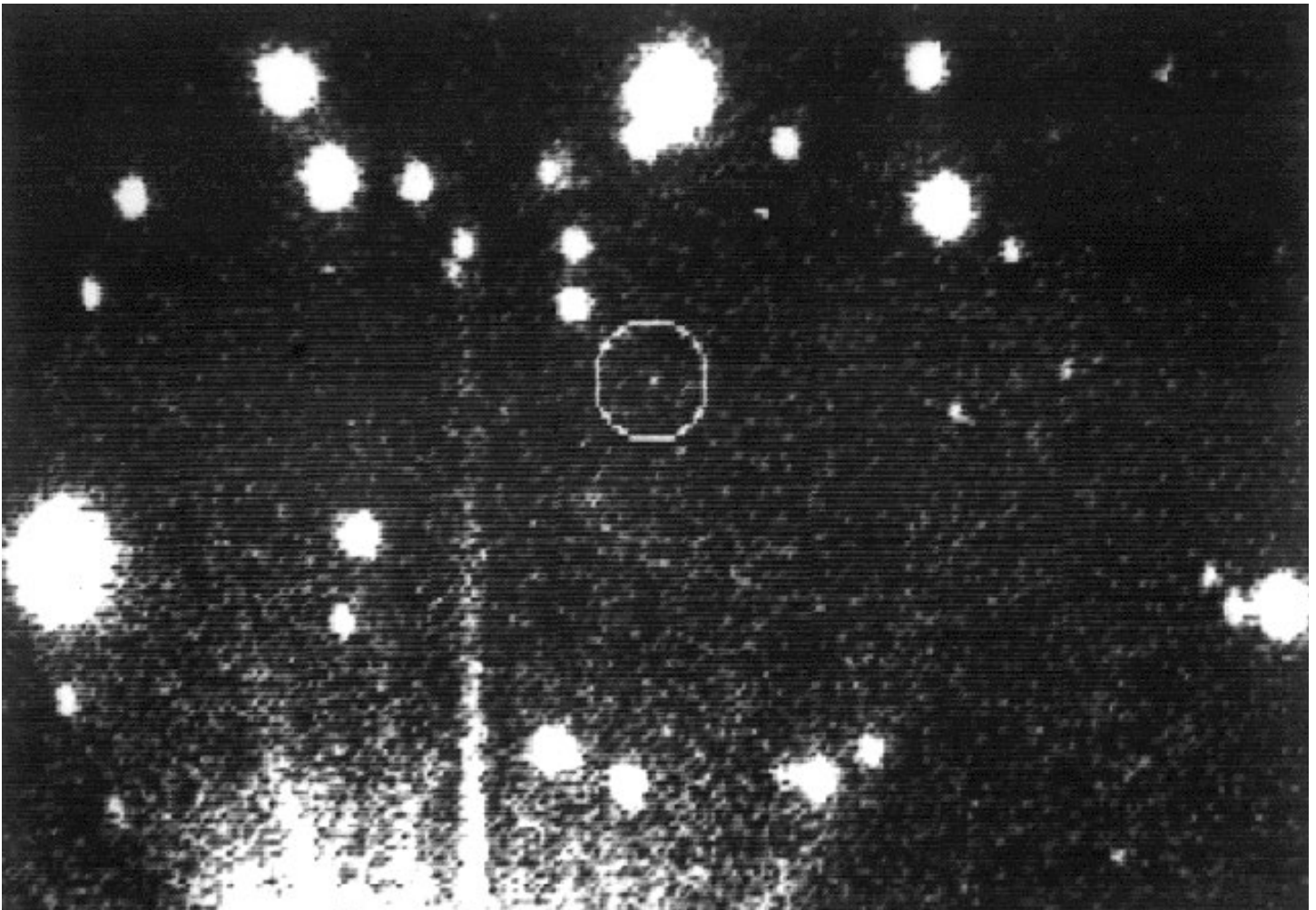


**MARCH 14, 1986:** The European Space Agency's [Giotto](#) spacecraft passes just 600 km from the nucleus of Comet 1P/Halley, providing the first very clear views of a comet's nucleus. In addition to the discussions of Comet Halley in this week's “[Special Topics](#)” and “Comet of the Week” presentations, the role of the Giotto encounter in confirming Fred Whipple's “icy conglomerate” model of a cometary nucleus was discussed in last week's “[Special Topics](#)” presentation.

**MARCH 14, 2020:** The main-belt asteroid (1428) Mombasa will [occlude](#) the 7th-magnitude star HD 89239 in Leo. The [predicted path](#) of the occultation crosses the east-central U.S., west-central Canada, north-central Alaska, and far northeastern Siberia.

# COMET OF THE WEEK: 1P/HALLEY 1982I

Perihelion: 1986 February 9.46,  $q = 0.587$  AU



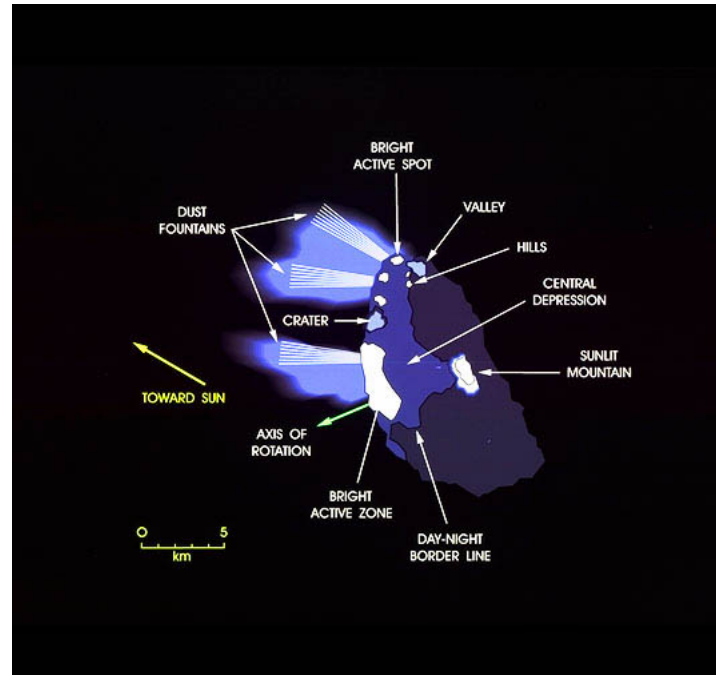
*The Halley recovery image, taken October 16, 1982, with the 5.1-meter Hale reflector at Palomar Observatory in California. Courtesy David Jewitt and G. Edward Danielson.*

Those of us space-minded people who came of age during the middle decades of the 20th Century learned of Comet Halley and its impending return in 1986, and many of us undoubtedly heard stories of its appearance during its excellent return in 1910; my paternal grandmother, an 11-year-old farm girl in Virginia at the time, saw it then. Calculations soon began to reveal, unfortunately, that the viewing geometry in 1986 would be substantially less favorable than it was in 1910, although conversely it would remain viewable for an unusually long period of time.

Astronomers began making recovery attempts as early as 1977, although these were obviously unsuccessful. The comet was finally recovered on October 16, 1982, by a CalTech graduate student, David Jewitt – who has since gone on to become one of the world's top comet astronomers – and G. Edward Danielson, a staff

astronomer at [Palomar Observatory](#) in California, using a CCD attached to the Hale 5.1-meter telescope at Palomar. The comet, then slightly over 11 AU from the sun, appeared as a stellar object of 24th magnitude. This, incidentally, was the first time a comet had ever been recovered via CCD imaging, something which is quite routine nowadays.

By late 1984 Halley was beginning to exhibit a small coma, and the first gaseous emissions were detected in early 1985. Meanwhile, in late January 1985 amateur astronomer Steve O'Meara, then with [Sky & Telescope](#), successfully obtained the first visual observations of Halley, with a 61-cm telescope at Mauna Kea Observatory in Hawaii; the comet appeared as a stellar object of magnitude  $19 \frac{1}{2}$ . These remain the faintest visual observations ever made of a comet.



The nucleus of Comet Halley (left) as imaged by the European Space Agency's *Giotto* spacecraft on March 14, 1986. Several areas of jetting activity are obvious. Image courtesy ESA. Right: Principal features identified on the images of Comet Halley returned by ESA's *Giotto* probe on the same date. Courtesy ESA.

After being in conjunction with the sun in mid-1985 Halley emerged into the morning sky around August at around 14th magnitude. It brightened rapidly, and became visible to the unaided eye as a 6th-magnitude object around the time of opposition in mid-November. By early January 1986 it had brightened to 5th magnitude and was exhibiting a tail a few degrees long, and by the time it disappeared into evening twilight near the end of that month it had reached 4th magnitude.

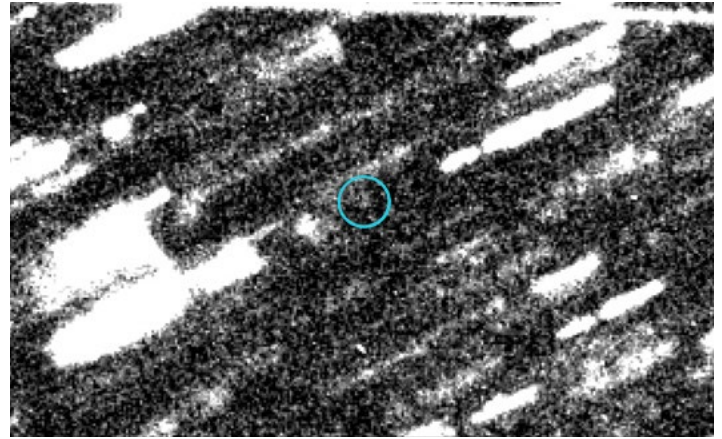
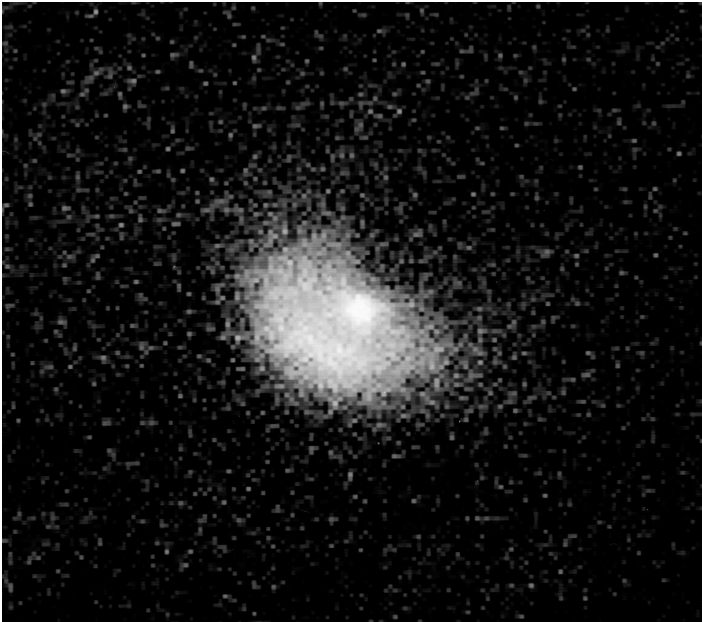
The comet was near conjunction with the sun around the time of perihelion passage in early February, and was near 3rd magnitude when it emerged into the morning sky late that month. Throughout March it remained close to 3rd magnitude, with a bright dust tail that gradually lengthened, to about 8 to 10 degrees by the latter part of that month. Around the time of opposition and closest approach to Earth (0.42 AU) in early April Halley was briefly as bright as 2nd magnitude, however it was moderately deep in southern skies at the time and, moreover, the tail – projected against rich Milky Way star fields – was directed more-or-less away from Earth. As the comet moved over into the evening sky the apparent tail length grew rapidly, to 25 degrees or longer by late April, however the comet itself had faded to 5th magnitude by then and the good views were restricted to dark rural sites. It dropped below naked-eye visibility by around mid-May and the brightness had decreased to about 9th magnitude by the time the comet disappeared into evening twilight shortly after mid-year.

With the dramatic improvements in astronomical

instrumentation that had been made over the previous few decades, and recognizing the scientific importance of the impending return of Comet Halley, in the early 1980s the world's astronomers organized themselves into the International Halley Watch, which was headed by Ray Newburn at the Jet Propulsion Laboratory in California. The astronomers involved with the IHW – which included amateur astronomers from around the world – studied just about every physical aspect of Halley during its return, from studies of its nucleus and near-nucleus environment, all the way out to its outer coma and tail. The results of the various IHW investigations were presented at various conferences, and it's a fair statement that our knowledge of comets was completely revolutionized by the studies of this object.



Photograph I took of Halley on the morning of March 7, 1986 – my 28th birthday – from the Angeles Crest Highway near the turnoff towards Mt. Wilson Observatory.



Two outbound images of Halley. Left: February 12, 1991, from the European Southern Observatory, following the comet's dramatic outburst in late 1990. Above: the final image of Halley, taken between March 6 and 8, 2003, with the European Southern Observatory's Very Large Telescope. Both images courtesy [European Southern Observatory](#).

Certainly the most dramatic component of the scientific study of Halley was the series of spacecraft visits launched by several nations. The Japanese probes [Sakigake](#) and [Suisei](#) made somewhat distant flybys – with Suisei performing important ultraviolet studies of the comet's environment – and the Soviet Union's [Vega 1](#) and [2](#) probes passed within a few thousand km of Halley's nucleus in early March and returned the first-ever direct images of a comet's nucleus. (Incidentally, there were no American missions to Halley, although the 20-year-old sun-orbiting [Pioneer 7](#) spacecraft made a distant flyby of it in late March and performed measurements of the interactions between the comet's ion tail and the solar wind.)

The highlight, of course, was the European Space Agency's [Giotto](#) mission which, utilizing navigational data supplied by the Vega missions – a welcome example of international collaboration in the midst of the Cold War – passed just 600 km from Halley's nucleus on March 14. The images from Giotto revealed the nucleus as being a dark, oblong, peanut-shaped object some 15 km by 9 km in size, with several active jets, and these images, along with those obtained by the two Vega spacecraft, fully confirmed Fred Whipple's "icy conglomerate" model of a cometary nucleus (as discussed in last week's "[Special Topics](#)" presentation). Giotto and some of the other missions also detected a strong presence of formaldehyde and other organic compounds – some in the form of polymers – and also small particles that have been dubbed "CHON" (for carbon, hydrogen, oxygen, and nitrogen), the relative compositions of which are consistent with the composition of interstellar dust clouds.

Meanwhile, following conjunction with the sun Halley emerged back into the morning sky in late 1986, initially around 12th magnitude but fading; in late April 1987

it underwent a distinct outburst to about magnitude 12 ½, during which I obtained my final observation. The last visual observation was made in February 1988 by David Levy with the 1.5-meter reflector on Mount Catalina in Arizona; the comet, slightly over 8 AU from the sun at the time, had faded to 17th magnitude.

By 1990 Halley had faded to 24th magnitude and appeared entirely stellar, however in February 1991 astronomers found that it had apparently undergone a dramatic outburst (at a heliocentric distance of 14 AU) a couple of months earlier, and was close to 19th magnitude and exhibiting a distinct coma 40 arcseconds in diameter (corresponding to a physical diameter of at least 300,000 km). The physical cause of such a large outburst at this large a heliocentric distance remains a mystery. In any event, the comet faded back to "normal" thereafter, and the final observations were obtained in images taken in early March 2003 by Olivier Hainaut and his team with the [European Southern Observatory's](#) Very Large Telescope in Chile; the comet's heliocentric distance at the time was 28.1 AU and it appeared as a stellar object of magnitude 28.

At this writing Halley is just a few years away from aphelion, which takes place in December 2023 at a heliocentric distance of 35.1 AU. I am not aware of any observation attempts since 2003, although it should only be about a magnitude fainter at aphelion than it was then, and with the continuing improvements in instrumentation technology it would not surprise me if observation attempts then are successful. Regardless, Halley will then be starting its journey back into the inner solar system, and some of the present readers should hopefully see it when it once again shines in our nighttime skies in 2061. And, if I should happen to make it to the age of 103, perhaps I might even see it again as well.



*Halley from northern Mexico on the morning of March 13, 1986.  
Photograph copyright [Dennis Mammama](#).*

# SPECIAL TOPIC: COMET 1P/HALLEY



*Comet Halley in 1682 over Augsburg, Bavaria.*

To our ancestors of just a few centuries ago, comets were, at best, mysterious objects, very possibly of divine or supernatural origin. When one considers that bright comets could appear anywhere in the nighttime sky, seemingly out of nowhere, and after being visible for a few days or weeks would then disappear, it is little wonder why they thought so. Only gradually did human understanding of comets grow to the point where we know that they are regular members of our solar system – albeit still very interesting and worthy of study for a variety of reasons.

What could be considered the watershed moment in our understanding of comets is due to a British astronomer, Edmond Halley, who was born in Haggerston in 1656. Halley had a productive and colorful career, including two decades as Britain's "Astronomer Royal." He made many contributions to astronomy and other sciences, perhaps one of the most important of these being the "proper motion" of stars and thus the fact that stars, including our sun, travel through space. He was a contemporary and friend of the eminent British physicist Isaac Newton, and funded the publishing of the latter's treatise *Philosophiae Naturalis Principia Mathematica* (Latin

for *Mathematical Principles of Natural Philosophy*) – usually called the *Principia* – in 1687, wherein he described his laws of motion and gravitation.

In the early 18th Century Halley decided to apply Newton's technique to calculating the orbits of 24 historical comets. Upon doing so he noticed that three of them, which had appeared in 1531, in 1607, and in 1682 (which he himself had observed as a young man), had orbits strikingly similar to each other, and moreover appeared at approximate intervals of 76 years. Halley then reasoned that these might not be three separate comets, but instead were returns of the same comet with that orbital period. He published his results in early 1705, and made the bold prediction that that same comet would return again in 1758.

Halley passed away in 1742 at the age of 85 and thus did not live to see whether or not his prediction would turn out to be correct. As 1758 approached several astronomers of that era, including the French astronomer Charles Messier who would become a champion discoverer of comets in subsequent decades, began making attempts for it, but these



## OBSERVED PERIHELION PASSAGES OF COMET 1P/HALLEY, PLUS THE NEXT TWO RETURNS

PERIHELION	q (AU)	PERIHELION	q (AU)
240 B.C. May 25.12	0.585	989 September 5.69	0.582
164 B.C. November 12.57	0.584	1066 March 20.93	0.574
87 B.C. August 6.42	0.586	1145 April 18.56	0.575
12 B.C. October 10.85	0.587	1222 September 28.82	0.574
66 January 25.96	0.585	1301 October 25.58	0.573
141 March 22.43	0.583	1378 November 10.69	0.576
218 May 17.72	0.581	1456 June 9.63	0.580
295 April 20.40	0.576	1531 August 26.24	0.581
374 February 16.34	0.577	1607 October 27.54	0.584
451 June 28.25	0.574	1682 September 15.28	0.583
530 September 27.13	0.576	1759 March 13.06	0.584
607 March 15.48	0.581	1835 November 16.44	0.587
684 October 2.77	0.580	1910 April 20.18	0.587
760 May 20.67	0.582	1986 February 9.46	0.587
837 February 28.27	0.582	2061 July 28.72	0.593
912 July 18.67	0.580	2134 March 27.90	0.593

were initially unsuccessful. Finally, on December 25, 1758, a German amateur astronomer, Johann Palitzsch, discovered a comet in the constellation Cetus which a month later was recognized as being the long-awaited comet predicted by Halley. The actual perihelion date was March 13, 1759, and it became a conspicuous naked-eye object; meanwhile, in honor of his prediction and his recognition that comets are regular members of the solar system, the comet has been referred to as "Halley's Comet" ever since.

Once its periodic nature had been established, it has been possible to identify previous returns of Comet Halley, and indeed every return back to that of 240 B.C. has now been positively identified in the records of the respective

times. It has almost always been a conspicuous naked-eye object, and has come quite close to Earth on occasion, the closest approach being to 0.033 AU in A.D. 837; according to Chinese records the

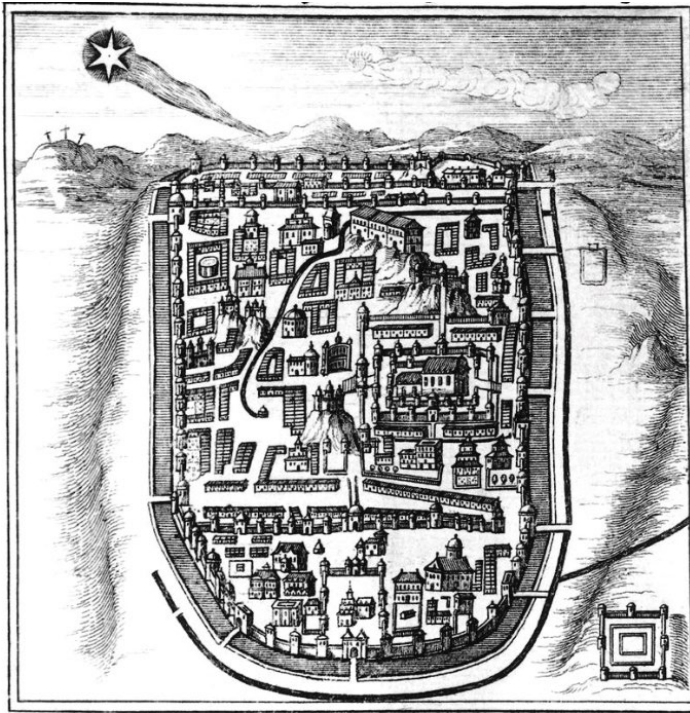
tail around that time was approximately 90 degrees long. Other close approaches include ones of 0.088 AU in A.D. 374, of 0.090 AU in A.D. 607, and of 0.104 AU in 1066.

The comet has managed to insert itself into our history from time to time. Its return in A.D. 66 was later believed by the Jewish historian Josephus to foretell the destruction of Jerusalem by Roman forces four years later. Its return in 1301 is alleged to have inspired the Italian painter Giotto

di Bondone to make a comet represent the Star of Bethlehem in his fresco painting "Adoration of the Magi" in the Scrovegni Chapel in Padua. (The comet,



*Comet Halley over London in 1759, as painted by British artist Samuel Scott. Westminster Abbey is on the far left.*



Representation of Comet Halley over Jerusalem in A.D. 66, later believed by the Jewish historian Josephus to foretell the city's forthcoming destruction. Engraving from "Theatrum Cometicum" by Polish scientist Stanislaw Lubieniecki in 1668.

in fact, had returned in 12 B.C.) The European Space Agency's [Giotto](#) mission to the comet in 1986 was named in his honor.

The return in 1066 not only involved a close approach to Earth, the comet was also apparently unusually bright. It is depicted in the Bayeux Tapestry, which shows King Harold II of England and his aides looking at it fearfully, as they took it as an omen of ill fortune. Across the English Channel, William the Conqueror took it as a good omen and launched his invasion of England; the comet turned out to be a self-fulfilling prophecy in both cases, with William defeating Harold's forces at the Battle of Hastings. The comet's return that year is also apparently depicted in Native American petroglyphs at [Chaco Canyon](#) in New Mexico.

The return of 1531, in addition to being the first of the ones that Halley used in his calculations, is scientifically important for another reason. The German philosopher Petrus Apianus (Peter Apian), then a professor at the University of Ingolstadt in Bavaria, called attention to the fact that the comet's tail always pointed away from the sun. It would be centuries before the explanation of this phenomenon was worked out – the solar wind in the case of ion tails, and solar radiation pressure in the case of the more visually prominent dust tails.

Since its return in 1759, Comet Halley has returned three more times. In 1835 it was recovered on August 6 by

Father Etienne Domouchel and Francesco de Vico in Rome, en route to its perihelion passage in mid-November. It became as bright as 1st magnitude and exhibited a tail up to 20 degrees long, and was extensively studied by the astronomers of the era, including John Herschel – son of Uranus discoverer William Herschel – from the Cape of Good Hope in South Africa, and Friedrich Bessel in Germany. Bessel, in particular, made detailed studies of the "jets" in the inner coma, and surmised – correctly, as it turned out – that these acted as what are today known as rocket engines and, via Isaac Newton's Third Law of Motion, caused the accelerations that had been observed in other comets, notably 2P/Encke. These motions, now called "non-gravitational forces," are discussed as part of last week's "[Special Topics](#)" presentation.

Comet Halley's 1910 return, with perihelion passage taking place on April 20, was eagerly awaited by the astronomers of the time, in part because the viewing geometry would be excellent, but also because astro-photography and other relatively modern observing techniques had been developed. It was recovered on September 11, 1909, by Max Wolf at Heidelberg Observatory in Germany, being about 16th magnitude at the time. It brightened steadily after that, and was close to 8th magnitude when it disappeared into evening twilight in early March 1910.

Following conjunction with the sun, the comet emerged into the morning sky in early April, already a conspicuous naked-eye object of 2nd magnitude



The fresco "Adoration of the Magi" by Italian painter Giotto di Bondone in the Scrovegni Chapel in Padua, completed in 1305. Giotto was supposedly inspired by the appearance of Comet Halley in 1301 to include it as the Star of Bethlehem.



Representations of Comet Halley during its return in 1066. Left: From the Bayeux Tapestry, commemorating the Battle of Hastings. The Latin inscription reads "They marvel at the star." Right: Petroglyphs at Chaco Canyon in New Mexico. The bright star and crescent moon likely depict the appearance of the supernova of 1054 (which produced the Crab Nebula) and the series of concentric circles with streamers to their right is likely a depiction of the comet. Photograph courtesy Michael Lloyd of Wild Light Imaging Studio.

with a short dust tail. It continued brightening as it approached Earth – minimum distance being 0.151 AU on May 20 – and by the middle of May had become as bright as magnitude 0 with a tail in excess of 30 degrees. Shortly before its closest approach it passed directly between Earth and the sun, but while several attempts were made to observe it in transit across the solar disk, these were all unsuccessful, indicating that any solid component must be very small – which we now know to be true. Meanwhile, on the morning of May 19 the comet's tail swept from well in front of Earth to well behind it, with measurements indicating a length of between 120 and 140 degrees – the longest cometary tail that has ever been observed.

Following its passage by Earth the comet reappeared in the evening sky, still a very conspicuous object of 1st magnitude with a 45-degree-long tail. It slowly faded thereafter, finally dropping below naked-eye visibility by mid-July. The final visual sighting was made by Edward Barnard, using the 102-cm refractor at Yerkes Observatory in Wisconsin, in late May 1911,

and the final photographs were taken a month later by Heber Curtis at Lick Observatory in California.

Numerous scientific investigations were obviously carried out during the comet's 1910 return. Among the more important of these involved the Eta Aquarid

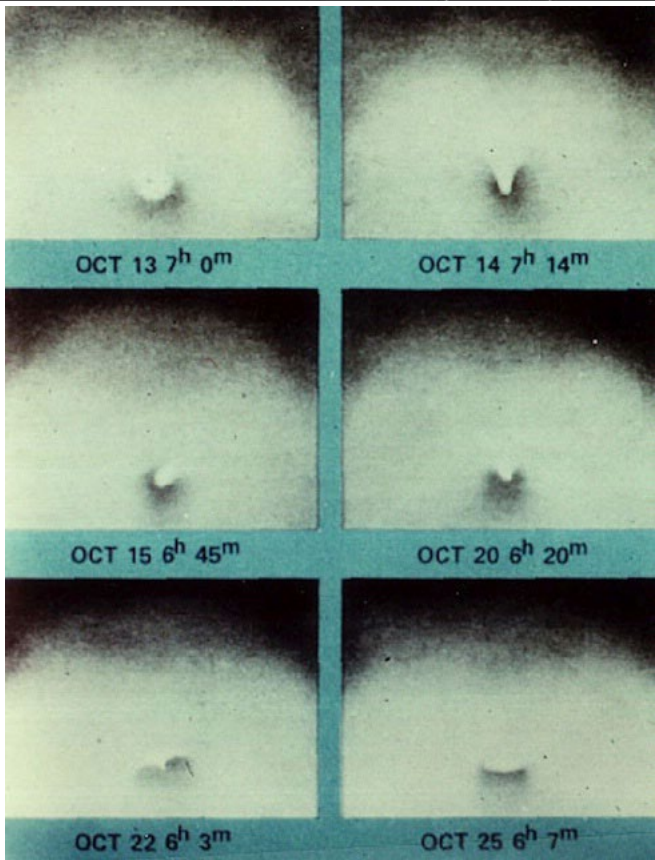
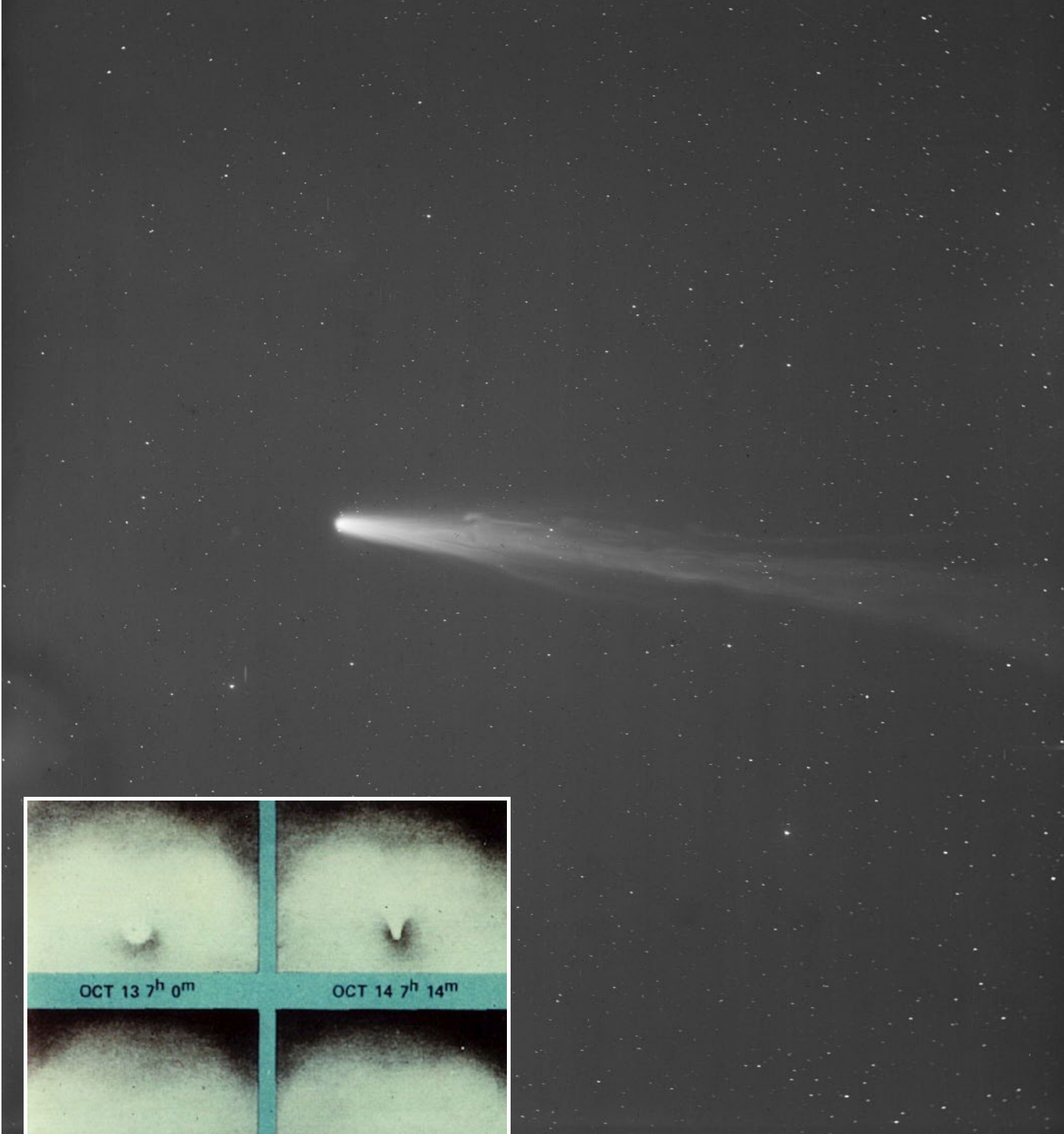
meteor shower, which peaks in early May and is best visible from the southern hemisphere, and the Orionid meteor shower which peaks during the third week of October. Both showers – which have peak rates of 20 to 40 meteors per hour – had been believed to be associated with Comet Halley, but the studies carried out during the 1910 return verified this relationship for both showers.



Representation of Comet Halley traveling through Leo during its return in 1531, as rendered by German philosopher Petrus Apianus (Peter Apian) at Ingolstadt, Bavaria. The sketches show the comet's tail pointing away from the sun.

As dramatic as the comet's 1910 return was, there was also a downside. The cyano radical CN, often confused with the poisonous gas cyanogen, had previously been

detected in comets spectroscopically, and since it seemed rather possible that Earth might be passing through the comet's tail when the two bodies passed by each other in May, this led to widespread



Sketches of the inner coma of Comet Halley in 1835 made by Friedrich Bessel, showing jetting activity.

Comet Halley (above) on April 21, 1910, from Harvard's station in Arequipa, Peru. Photograph courtesy Harvard College Observatory.

panic amongst the general public, as well as some unscrupulous entrepreneurs who made fortunes selling "comet pills" and "comet masks," supposedly to ward off the effects of the comet's "deadly gas." Aside from the fact that CN is not the same thing as cyanogen, the gas in a comet's tail is so rarefied that it would make a good vacuum by human standards, and any effects on Earth's atmosphere and its inhabitants would have been nonexistent. For what it's worth, modern calculations suggest that the comet's tail missed Earth by about 400,000 km.



Comet Halley and the passage of time. Unidentified source.

A somewhat more lighthearted anecdote involves the American writer Samuel Clemens, better known under his pen name Mark Twain. He had been born in 1835, just two weeks after Comet Halley's perihelion passage, and in his 1909 autobiography, in referring to himself and the comet, pointed out: "The Almighty has said, no doubt: 'Now here are these two unaccountable freaks; they came in together, they must go out together.'" Twain passed away of a heart attack one day after the comet's perihelion passage in 1910.

Comet Halley most recently returned in 1986, and that return is discussed in detail as this week's "Comet of the Week." As is pointed out there, the 1986 return had significantly less favorable viewing geometry than did the return of 1910, and much of the general public – who also had to contend with significantly increased light pollution – was disappointed. It still found its way into popular culture, one of my favorite examples being the Mary Chapin Carpenter song "[Halley Came to Jackson](#)," which describes the true story of Pulitzer Prize-winning author Eudora Welty who was shown the comet as a baby in 1910 and who saw it again in 1986.

The comet will be at aphelion (heliocentric distance 35.1 AU) in late 2023, and thereafter starts the journey back to the inner solar system. Perihelion next occurs on July 28, 2061, and although the viewing geometry

will be much different than it was in 1986, it will still not be especially favorable. At perihelion it will be near inferior conjunction some 21 degrees due north of the sun and, although perhaps as bright as magnitude 0, it will probably be difficult to observe. Prior to perihelion it will be observable in the morning sky, and after perihelion it will be fairly conveniently placed in the evening sky, possibly still as bright as magnitude 0 or 1, and perhaps with a rather long apparent tail. The elongation from the sun does not get especially high and the show will be fairly brief, however.

The return after that, with perihelion passage on March 27, 2134, is much better. Six weeks after perihelion, on May 6, the comet will pass only 0.096 AU from Earth – the closest it has come to our planet since the 9th Century – at which time it may be as bright as magnitude -2. Unfortunately for observers in the northern hemisphere, it will be at the high southerly declination of -81 degrees at that time, and even more unfortunately for all concerned, the moon will be full. Perhaps prospective comet-watchers of that era will be able to travel to other vantage points, i.e., beyond the moon, for the show.

As for me . . . clearly there is no way I will live long enough for the 2134 return, but if I'm still alive I would be 103 when Comet Halley returns in 2061. All I can say is, we'll see.

[www.earthriseinstitute.org/is20home.html](http://www.earthriseinstitute.org/is20home.html)

[www.iceandstone.space](http://www.iceandstone.space)

