THE NEW YORK TIMES, SATURDAY, SEPTEMBER 21, 1985

Again Seeing Halley's Comet: A Twice-Told Tail

By John del Valle

WESTLAKE VILLAGE, Calif. — As far as most people are concerned, Halley's is *the* comet, a once-in-a-lifetime celestial spectacular that recurs on average every 76 years or so with slight irregularity. Most other comets are less accommodating — they either come every few years, or at intervals of thousands of years, or when you least expect them.

Halley's came around last in early 1910, and is due back in November, tarrying in the vicinity through late April 1986 to beguile an almost wholly new audience here on Earth.

In 1910, the Scientific American commented: "After this date, it will disappear . . . not to emerge again till 1985, when most of those who read this . . . will have ceased to care about comets."

Well, here is one who saw it then. And who now, in 1985, still cares.

The truth is, I am not yet over its 1910 visit. Although I was only 6 at the time, I vividly recall my parents getting me up and dressed a little after midnight, to go and look at the comet that was due to be at its best at 3:15 A.M. My parents, my 13-year-old big sister and I trudged up a small hill in Oakland, Calif., where we then lived. We brought along my mother's mother-of-pearl opera glasses as the nearest thing we had to binoculars.

The comet showed right on schedule. I think the date was May 21, but I might be off by a few days. The comet appeared as a thing of grandeur, a great sweep of light curving across the black of the sky. With a gleaming head at one end, it was like a bright star with a flowing tail. (The word "comet" comes from the Greek "kometes," meaning "long-haired.") The comet resembled nothing I have ever seen, before or since. Much better than any July 4 pyrotechnics, or anything the National Aeronautics and Space Administration has since wrought in outer space, although NASA has really done quite well. The comet was sky-filling, awesome and unforgettable.

Later that day, I got to tell my fellow first-graders at Franklin School, and our teacher, Mrs. Morris. Few of the other pupils appeared to have seen it. I guess they didn't all have parents enterprising enough to get them up in the middle of the night. And there were no TV reruns in those days. No TV, for that matter. The children listened in awe to my breathless account, and Mrs. Morris had me draw some pictures on the blackboard. My artistry wasn't much, but that chalk talk was all it took for me to become a momentary celebrity.

Now, with any luck, I shall soon get to see the comet again, and that's better even than Edmund Halley managed. He was the eminent English astronomer-mathematician for whom the comet was named — although he didn't discover it — because he was the first to compute its orbit. He first saw it Nov. 22, 1682. He died in 1742 — 16 years before it returned.

And Mark Twain, whose life span coincided just about exactly with two successive appearances of the comet — he was born the year it arrived, 1835, and died, as he predicted with some prescience, the day after it returned, in 1910. "I came in with Halley's Comet . . . and I expect to go out with it," he said. Which is what happened.

Halley's Comet is a visitor that has been observed and noted, and both feared and revered, at every appearance but one for the more than 2,000 years that records of this sort have been kept, most dependably by the Chinese. Their records missed only the visitation of 164 B.C., according to their meticulous notations. But, then, no one's perfect.

The comet's orbiting schedule should continue long into the future, unless the comet collides with a planet or is absorbed by the sun. It does cross various planetary orbits, including Earth's, each time it comes and goes, so there is potential for collision.

But not to worry — the comet's capacity for doing damage is regarded as slight. In a sense, a comet is largely "fluff."

Halley's is a luminous body, huge in spread but light in mass and weight. It moves in a tremendously elongated elliptical orbit under the sun's gravitational influence. From close around the sun, it swings past the solar system's outermost planets to a point in deep space and then back again, on a schedule that varies from 75 to 79 years. This variation is attributed to the perturbations that Jupiter, in particular, and other planets in general exert on such stellar transients.

The comet shines from reflected sunlight, and perhaps by radiation from the gas, dust or ionized molecules of which its flamboyant tail is thought to be composed. This luminous tail always streams out in a direction away from the sun, as a sort of solar wind sock. So when a comet is receding, it travels tail-first in a most ungainly manner.

The comet's head, or nucleus, is tiny and bright. It is enclosed in a much larger spherical gas cloud.

When Halley's came around in May 1910, many people were frightened. This was especially so in Chicago, some of whose inhabitants became paranoid on the subject. It was held that the comet's tail was composed of deadly cyanogen gas, and that when Earth passed through the tail some days hence, the gas would kill people by the millions. And maybe bring about the end of the world. Some people took "comet pills" of questionable efficacy. Others prayed. Nothing happened.

There have been fears like this down through the centuries. The repeated appearances of Halley's Comet, and of other comets, have been associated in people's minds with wars, earthquakes, plagues, deaths of monarchs and other events, mostly calamitous. In 184 B.C., Hannibal, the Carthaginian general who was bent on conquering Rome, saw a comet (probably not Halley's) and consulted a soothsayer, who told him he would die. He took poison, and did.

This time around, several sky probes by the Japanese, the Russians and Western Europeans will be dispatched aloft for a close inspection of the comet by arrays of scientific instruments and television cameras. Except for sending a small instrument package on a Soviet vehicle, the United States will not, for budgetary reasons, be included in this effort.

In November, at the age of 81, I'll be watching with the same pair of mother-of-pearl opera glasses as before and a reflex camera loaded with fast film. Barring a heavy overcast or unsuspected perturbations from Jupiter, I expect to get some good pictures. Blackboard drawings are for kids.

The *next* coming of Halley's Comet is scheduled for 2061. But I'll pass on that one. □

John del Valle, a former newspaper reporter and public-relations writer, is now a magazine writer.

In Brooklyn and Queens, High Fashion

By ANNE-MARIE SCHIRO

High-fashion boutiques abound in Manhattan and in the city's prosperous outer suburbs. But two of New York's best high-fashion boutiques are in Brooklyn and Queens: Jimmy's, at 1226 Kings Highway in Flatbush, and Hirshleifer's, at 116-15 Queens Boulevard in Forest Hills.

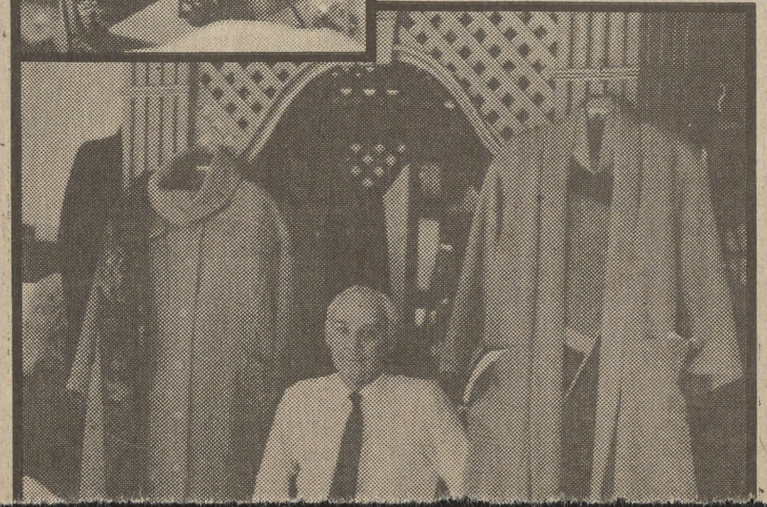
Neither of these is a discount store and neither is a flash in the pan. Both have been in existence for many years and attract customers from near and far with clothes by such designers as Valentino, Basile, Ferré, Montana, Ungaro, Lagerfeld, Alaïa, Blass, Beene and Galanos.

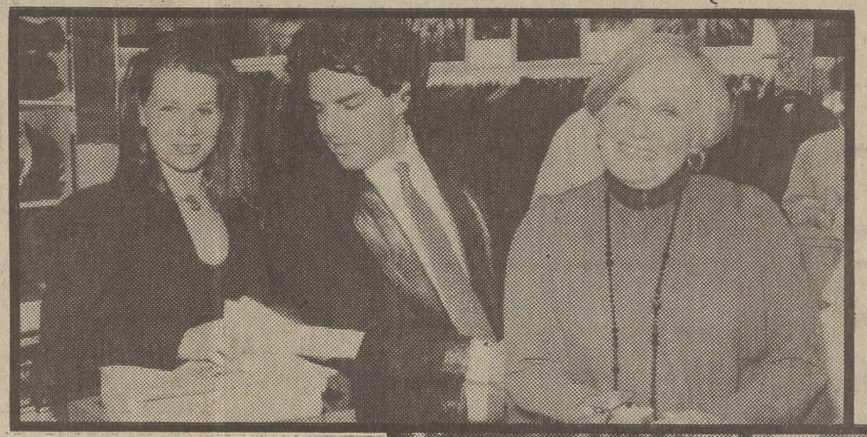
These customers are not working women. They are the wives of successful men, they have plenty of time and money to shop and they expect to be treated royally. The stores oblige them by offering a high degree of personal service, including valet parking, shopping by appointment and free alterations.

"We're in an area where people have to come to us," Paul Hirshleifer says. "They come from Westchester, New Jersey and Manhattan. When they come here, they come to shop, not to browse. They may come in for a few black cocktail dresses, but while they're here they'll look at anything else that catches their eyes."

Gloria Jacobs, whose husband founded Jimmy's, tells a similar story. "Our customers don't work, they work out," she said. "They need outfits to go to lunch, to go to the theater, to go shopping. The nucleus of our business is the Brooklyn lady and the Brooklyn lady who moved away, to Long Island, New Jersey, Pennsylvania. Our customers write to us from St. Louis, from Florida. Once we sell a customer, we don't lose her."

Paul Hirshleifer, below, in his Forest Hills store. His mother, Rose, left.





Gloria Jacobs of Jimmy's, left, with daughter and son-in-law, Elizabeth and Dominick Lepore. Jimmy Jacobs with a customer, below.

The New York Times / Bill Cunningham

"A woman last week bought five leather Montana jackets," she said. "Her husband is coming in tonight."

He'll find Montana's leather jackets for men, if that's what he wants. Jimmy's started out 35 years ago as a men's and boys' store, then added women's fashion when Mrs. Jacobs got involved in the 1960's and the couple went on buying trips to Italy and France. Now the men's wear runs to the likes of Missoni, Castelbajac, Versace, Ferré and Byblos.

Chances are that Jimmy Jacobs himself will help to fit a man's trousers while Mrs. Jacobs takes his wife to the store's comfortable second floor to show her the newest delivery of clothes, shoes and bags.

A Family Operation

And chances are that the grown children of those customers will have made appointments to shop with the Jacobses' daughter and son-in-law, Elizabeth and Dominick Lepore. It's a real family operation, where everyone shares in the buying and selling, unpacking of cartons and educating sales help to coordinate the clothes.

"I'm a purist and a c[illegible] door or across the street," Mr. Jacobs [illegible] European designers were added [illegible]

This Journey Comes Once In 76.3 Years

Where to see Halley's comet in 1986

By ROBERT MERKIN

Travelers dream of spectacular destinations throughout the world, but the next major trek for as many as 10,000 North American adventurers may be to gaze at something entirely beyond this world — the return of Halley's comet next April.

The best seats on the planet will be in the Southern Hemisphere. But no one will be forced to travel below the Equator for a good show, according to the astronomer Stephen J. Edberg, coordinator for amateur observations at the Jet Propulsion Laboratory in Pasadena, Calif., and unofficial high lama for every amateur Halley hunter on the continent.

"For those willing to make some effort," he says, "there'll be a very satisfactory view in the Northern Hemisphere." The effort will require an exodus from urban areas to the nearest desert or clear rural or wilderness skies, but once there, Halley's comet, nucleus and tail, should be visible to the naked eye and clear and detailed through ordinary binoculars.

But stay-at-home or globetrotter, you might as well kiss the comet goodbye if you don't catch it in 1986; it returns to this neighborhood roughly once each 76.3 years. If a 10-year-old child is old enough to understand what he or she is viewing and remember it, that child will be 86 years old when the next opportunity knocks, around 2062. (It could be worse. The Great Comet of 1864 won't be back for about 3 million years.)

The British Astronomer Royal, Edmund Halley, calculated his comet's average period, or circuit time around the sun, during its 1682 visit, but this period can be as short as 74 or as long as 79 years. One reason astronomers are so keen about next year's visit is to glean information to verify their best theories about these fluctuations or to suggest better ones. The best theory to date suggests that the comet ejects gases on a schedule determined by its day-night rotation and exposure to the sun, and this outgassing changes its course and speed through space.

However, as soon as California's Mount Palomar telescope confirmed, in October 1982, that Halley's comet was back in the neighborhood, knowledgeable comet watchers were able to calculate its closest approach to earth and make their reservations accordingly. The full moon interferes with good viewing, so its dark phases will leave a best-observation window from April 4 or 5 through April 20. (The comet will be visible to a greater or lesser extent from January through April. March and April will be the best months. February will be the poorest because the comet will be too close to the sun.)

Past performance and guesswork about the weather determine the best observation sites. For purely scientific considerations, Mr. Edberg of the Jet Propulsion Laboratory favors the desert of northern Chile, followed by the desert of central Australia and the Kalahari Desert of South Africa. He explains that several other factors — local politics, personal finances, language and other things to do and see in the vicinity after you've seen the comet — will naturally lead many Halley hunters to Australia. But he's been frustrated in his search for relevant weather information about Australia. "Almost all weather observations," he says, "are made during the day, so that doesn't do us any good. As Halley's will be an early morning [pre-dawn] object, we have to make do with early morning [post-sunrise] observations from most places."

The Chilean desert, however, has several world-class optical observatories, which have kept long records of precisely the right kind of weather observations, and the viewing news from Chile is certifiably superb, says Mr. Edberg. Telescopic observers dig for gems called "photometric nights" — nights free from even invisible clouds, which can degrade a telescope's image of the skies. "Chile has many photometric nights in March and April," he reports, and the southern Peruvian desert offers much the same prospects.

To amateur astronomers or the curious, however, there'll probably be little or no noticeable difference between observing Halley's comet from any of the appropriate deserts. "Madagascar's weather prospects are fairly good and it should be a location of convenience for many Europeans," Mr. Edberg explains, "and New Zealand will also be a fine and popular spot."

Charles Morris, an oceanographic meteorologist at the Jet Propulsion Laboratory, has had a date with Halley's since he began hunting comets in grade school, and he is now organizing what may be the most thorough, flexible and goof-proof of Halley's tours. Mr. Morris will lead an expedition to Australia while a fellow comet hunter (and professional fireman), John Bortle, will lead another to South Africa. Mr. Morris and Mr. Bortle are among the world's leading comet observers. Mr. Morris, who was the co-recoverer (first to spot the return) of comet Faye, expresses doubts about the value of some of the other scheduled tours he has heard about. He says some are going to the wrong places or during the full moon. (Some tours and cruises that will or intend to be in the right places at the right times are listed in the accompanying box.)

Do-it-yourself navigators, Mr. Morris says, should head for the Southern Hemisphere belt between 20 and 40 degrees of latitude, where the comet is guaranteed to be nearly overhead in the night sky, and then consider political stability, weather and local attractions beyond the comet. His own tour, CHASE (Comet Halley American Southern-Hemisphere Expedition), 1986 expects to capitalize on such factors with locales in Alice Springs and Ayers Rock in the central Australian desert. The South African contingent will converge on the Sabi Sabi game preserve.

The CHASE tours in Australia and South Africa will be broken down to groups of no more than 45 people, each with its own professional astronomer-guide and transportation. The Australian expedition has also added Daniel Green, of the Harvard-Smithsonian Center for Astrophysics, to its roster. According to the organizers, the tours are designed to accommodate any level of comet lust, from obsessive to merely curious, and no one will be forced to worship the comet any longer than desired. Mr. Morris says he is emphatically against expensive telescope purchases — the average lay person will get maximum pleasure from good binoculars, and may regret the expense, trouble and worry involved with sophisticated portable telescopes. "The comet will be visible all night and there'll be plenty of high-quality telescopes available," he says. (The groups will include dedicated watchers with first-class equipment.)

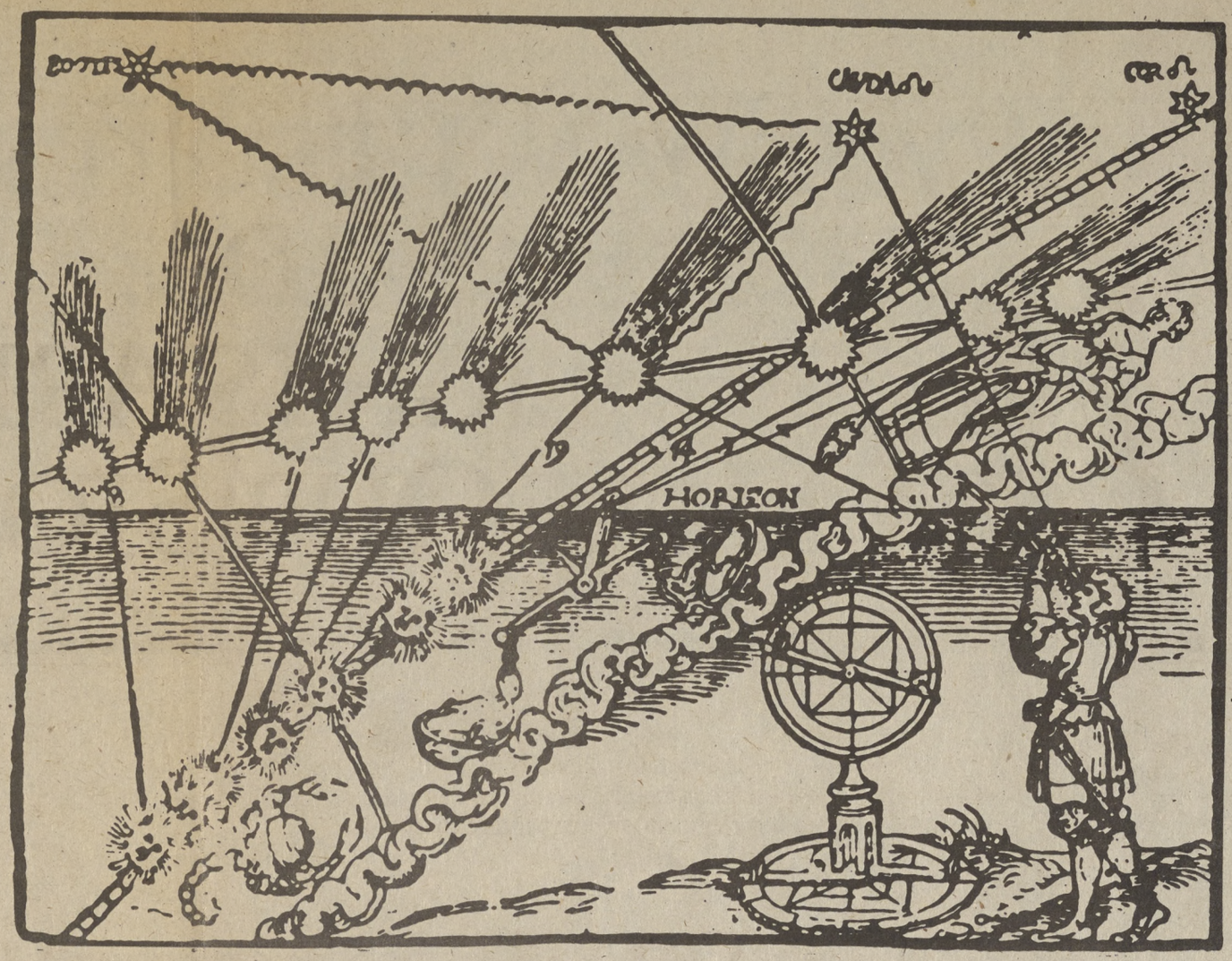
"Take along a pair of binoculars," Mr. Edberg says. "The field of vision of a Questar or Celestron (the best known brands of high-quality portable telescopes) is one degree [of the night sky]. Halley's comet is an object 20 to 30 degrees long. It will overfill these telescopes' field of vision." That's good, he adds, for a finely detailed closeup of the relatively small nucleus or head of the comet and its surrounding fuzzy, hairlike halo called the coma, but if you've traveled halfway around the globe to see a whole comet with tail, such high-quality telescopes can actually be a detriment or disappointment — like viewing a super closeup of the Mona Lisa's left nostril.

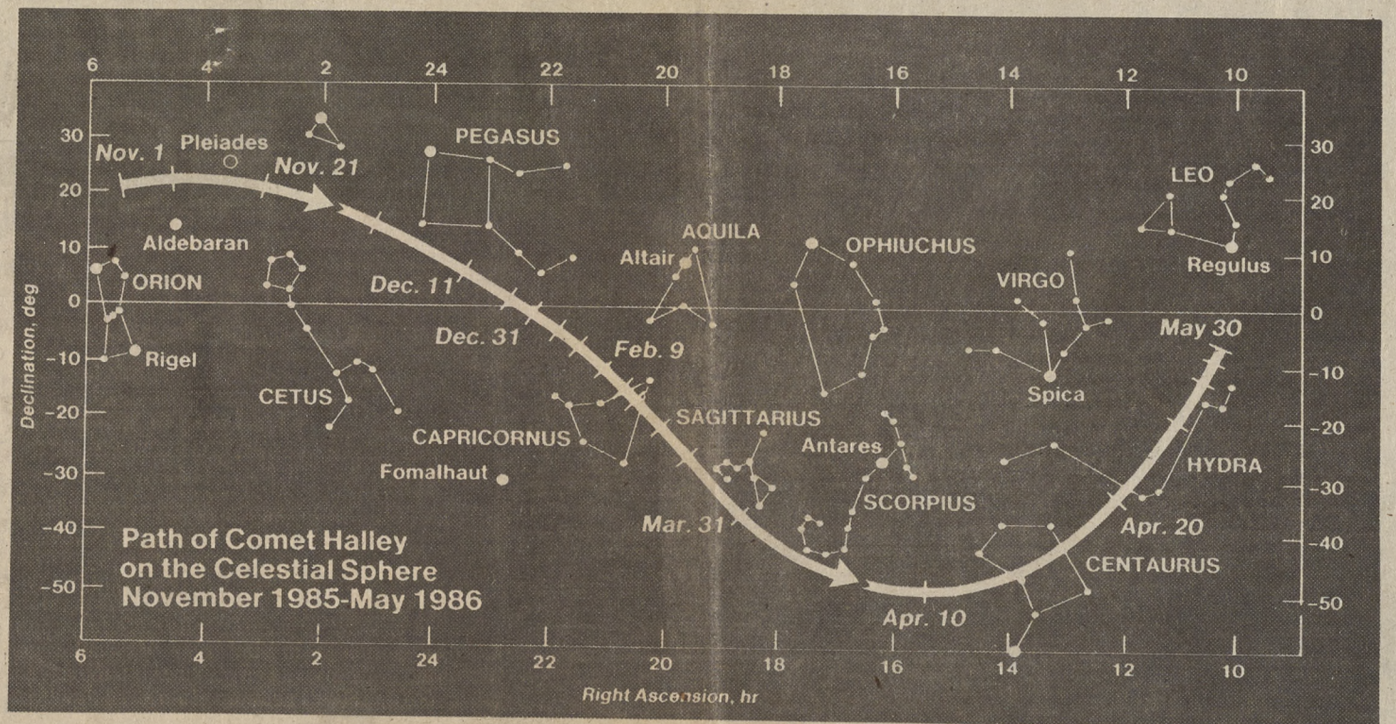
Meanwhile, the only mildly sentient "earthers" with tickets straight to the comet itself are robots, and foreign robots at that. The United States has chosen not to send a space probe of any kind on a Halley's comet mission, although several American multipurpose satellites will be doing their best to sniff the comet from a distance, and the Soviet probes are carrying some American experimental packages.

According to Dr. William M. Irvine, a radio astronomer at the University of Massachusetts at Amherst, the Soviet Union will send two probes to Halley's with local pauses first near Venus. These probes are acronymously named Vega, for Venus and Halley, whose name Russians spell with a G. One of these Vegas will be the first to approach Halley's nucleus, and the Soviets have agreed to share information about its precise location in

Continued on Page 34

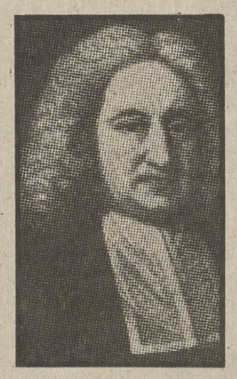
ROBERT MERKIN is a novelist whose next book, "Zombie Jamboree," is to be published by William Morrow. He lives in Northampton, Mass.





From "The Comet Halley Handbook" by Donald K. Yeomans, published by NASA

The figures on the borders of the sky map, used to plot location, are analogous to latitude and longitude.



Woodcut of observations of the comet in 1531. Edmund Halley calculated correctly when it would return.

Halley's Comet

Continued From Page 19

space with the Japanese and the joint European space agency, both of whom are sending later probes to Halley's. The Soviet Union launched its two probes last December. The Japanese sent one up in January and will launch another in August. The Europeans have scheduled their probes for July.

The Europeans are also aiming for the nucleus and have named their probe Giotto, for the Italian painter. One of the Japanese probes, Planet A, will pass through the tail about 62,500 miles from the comet's nucleus. The Soviet and European probes hope to pass as near to the nucleus as 620 miles — close enough to cause concern that some instrumentation may not survive.

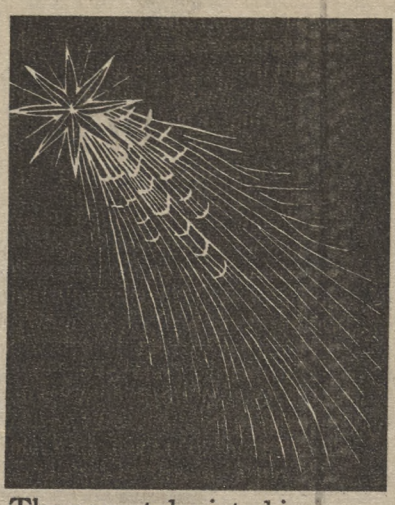
At every wondrous sight, there's always a clown nearby who says, "Yeah, but you should have seen it a few years ago. It was really great then." Halley's comet is no different. Each of the comet's visits offers a different view to the earth, because each time it dives for the sun — which is when we see it — the earth may be either quite close to the comet's path or far away, depending on the season.

You should have seen it in A.D. 837 when it was a mere 3 million miles from earth. (The closest that Venus, our nearest planetary neighbor, approaches is 25 million miles.) The Chinese were the first to record the comet's appearance in A.D. 66.

The last time Halley's cruised by was in 1910. Dr. Irvine says that this time around won't be one of Halley's better performances, with a nearest earth approach of 37 million miles. While this is bad news for ground-based professional optical and radio observations, it won't affect the space probes or amateurs. The Northern Hemisphere's professionals, with their huge, stationary installations, will have to look over the shoulders of their Southern Hemisphere counterparts, who will have by far the finest photographic opportunities, but even stay-at-homes won't be disappointed: their once-in-a-lifetime encounter will be merely spectacular.

Before Dr. Halley, comets appeared without warning or prediction, and the most common explanation was that they were omens of nasty historic events on the horizon. In the 16th century the Danish astronomer Tycho Brahe carefully observed comets and proved that, whatever they were, they weren't atmospheric phenomena but objects in space well beyond the earth, in a class with the planets and stars. His protégé, Johannes Kepler, used Brahe's reams of detailed observations to discover the fundamental laws of planetary motion, but failed to pin the same rules on the erratic comets.

Halley's analyses and inspiration led him to accuse the comet of 1682 of being the same frightening object that had appeared in 1606 and 1530, when earlier astronomer-astrologers had thoughtfully charted its sky path. He then predicted that it would return in roughly 76 years. He was right (and



The comet depicted in a 1493 Nuremberg woodcut.

dead for 16 years) when it showed up on schedule in 1758. His confirmed prediction tore the veil of ominous superstition and mystery from comets forever; it ranked with Newton's feats as a stunning symbol of the power of Enlightenment science.

In our own century, astrophysicists like Britain's Fred L. Whipple have narrowed our notions of the physical makeup of comets. Unlike the planets, comets seem to be largely balls of frozen gases, chiefly methane, carbon dioxide and water vapor. They have a spherical nucleus or head and a long and far less dense tail. The "snowball" nucleus of Halley's comet has a diameter of about 620 miles.

The tails of some comets may be as long as 28 million miles and become visible as they pass within the orbit of Mars. The sun projects a radiation flux powerful enough to push against matter in far-off space, and the density of the comet's gaseous tail is so low that the solar radiation always points the tail away from the sun, so that, on the outbound voyage, the comet appears to be flying backward.

So why even think about flying 5,000 or 10,000 miles to see the comet? Everyone knows what a comet looks like (at least from cartoons of a knock on the head), and that a handful of times each decade a comet appears that's large enough to be seen in some detail with the naked eye. One appealing aspect of comets in general and Halley's in particular is that amateurs aren't unwanted nuisances in the total scientific picture. There are so many comets of all sizes, brightnesses and periods that a full scientific grasp of them depends heavily on the high-quality observations and tracking that amateurs love to make at their own expense. Amateurs and their small rigs rather than giant government or university telescopes are often the discoverers and recoverers of new or returning comets, and lay watchers regularly write the definitive papers on the latest developments in the comet population.

After Halley's vanishes into the void again, the robots may get the glory and the professors the prime-time interviews, but the observations and photographs of the southbound swarm of amateurs will contribute enormously to the new intimate knowledge about the most famous comet of all. ■

Tour guide for comet watchers

CHASE Tours

The travel agent booking the CHASE 1986 tours is Lynn R. Luehrs, of Astronomy Tours International, 19143 Victory Boulevard, Suite 13, Reseda, Calif. 91335 (818-505-0448). The 14-day Australian tour will include about 40 to 60 hours of comet viewing. The price, including round-trip air fare from the West Coast to Sydney, accommodations and some meals is $3,250. There'll be side trips to the major observatories in Australia, including NASA's ground tracking station at Woollahra. The South African package costs $3,600 from the East Coast or $3,750 from the West Coast.

Other Trips

Among travel companies offering Halley's comet tour packages are the World of Oz, 3 East 54th Street, New York, N.Y. 10022 (212-751-3250) and Discovery Tours, the tour organization of the American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024 (212-873-1440). Sun Line Cruises, 1 Rockefeller Plaza, Suite 315, New York, N.Y. 10020 (212-397-6400 or 800-445-6400) and Royal Viking Line, 1 Embarcadero Center, San Francisco, Calif. 94111 (415-398-8000 or 800-422-8000) have scheduled comet cruises.

World of Oz has trips to South Africa, Australia and New Zealand, Chile, and Rio de Janeiro and South Africa. Prices, including round-trip air fare from New York and hotel accommodations, range from $1,650 for a nine-day trip to Chile to $3,900 for Rio and South Africa, an 18-day package. Discovery Tours offers several land and sea programs at times when the comet will be visible. The director of the museum, Dr. Thomas D. Nicholson, will be aboard the Illiria on museum-sponsored cruises when it sails from Singapore to Athens (April 4-May 7) and from New Guinea to Fiji (Feb. 16-March 6),

The Sun Line has announced that astronomers and other scientists will be on board as lecturers for eight sailings of the Stella Solaris and Stella Oceanis next January, March and April. March, the line says, "is the optimum time for viewing Halley's comet in the southern latitudes," and among its cruises is one of 19 days leaving Fort Lauderdale, Fla., for Brazil on March 1. The fares, depending on cabin, range from $3,450 to $6,600 a person.

Royal Viking will have Dr. Carl E. Sagan, the astronomer, among its experts aboard two of its series of comet cruises. Dr. Sagan will sail with the Royal Viking Sea when she leaves San Francisco for a round-trip Panama-Pacific cruise next Dec. 19. Fares, which include round-trip air fare from many United States cities, run from $3,864 to $15,351 a person. Dr. Sagan will also be among the lecturers on the Royal Viking Star, leaving Auckland, New Zealand, on March 26 for a 14-day trip ending in Sydney, Australia. Fares: $2,828 to $10,220 a person. The line is also scheduling seven other comet cruises in the South Pacific from United States and Australian ports.

Equipment

Those who haul telescopes to distant deserts are warned by one globetrotting astronomer that equipment survivability through good packing and cushioning is one's own responsibility, not the telescope manufacturer's. If you can eventually prove a shattered telescope was the airline's fault, you may get a new one someday, but you'll still miss that intimate closeup of you-know-what.

Photographers needn't invest in expensive equipment, says Charles Morris of the Jet Propulsion Laboratory. "Dust off your ordinary 35-millimeter camera with a standard 50-millimeter or 24-millimeter lens and get a sturdy tripod and a time-release cable. With today's high-speed black and white or, preferably, color film, you don't need a motorized tracking device for excellent star-trail photos." A star-trail photograph emphasizes, rather than eliminates, the comet's apparent trail (not its actual tail) caused by the earth's rotation during the 15-second average time exposure. Mr. Morris plans to concentrate on this kind of photo. R. M.

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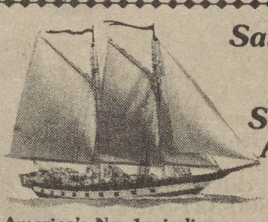

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LAURENCE L. SHIELDS
Princeton University

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terpiece, *Principia*, which Halley himself financed. Then, in 1686, Halley was appointed clerk to the Royal Society, a post he held until Newton had him appointed deputy comptroller of the mint at Chester in 1696. Two years later he made extensive voyages in the South Atlantic Ocean for surveying purposes and to measure compass variations from true north. In 1703 he became Savilian professor of geometry at Oxford, holding this chair for the rest of his life.

Comet Studies and Later Work. Halley's important study of cometary orbits, *Synopsis astronomiae cometicae*, appeared in 1705. In it he analyzed available observations of comets in accordance with Newtonian mechanics. In particular he forecast that a comet he observed in 1682—now known as Halley's comet—would return in 1758. The fulfillment of this prediction, after Halley's death, convinced the last skeptics of the power of Newtonian mechanics.

Among Halley's contributions to mathematics in these years were his editions of the works of classical authors, notably his translation (1710) of the *Conics* of Apollonius. His numerous astronomical papers include the first announcement (1718) that some stars show individual motions, contrary to the belief held since ancient times that the stars are fixed in their relative positions. He also made contributions in geodetic surveying, barometry, and other fields.

Halley succeeded John Flamsteed as astronomer royal in 1720. His main interest was in continuing his earlier studies of lunar motion, hoping to win the prize offered by the government for a method of determining longitude at sea. His withholding of the lunar and planetary tables he had printed in 1719 reputedly led to a quarrel with Newton in 1727, in the last months of Newton's life. (The tables eventually appeared in 1749.) Halley continued active astronomical work at the threshold of extreme old age. He died at Greenwich on Jan. 14, 1742.

M. A. HOSKIN
Cambridge University

HALLEY'S COMET, hal'ēz, the first comet to be recognized as reappearing periodically. In an early application of Newtonian mechanics, the English astronomer Edmond Halley computed the orbits of some 24 comets observed between 1337 and 1698. In a work published in 1705 he suggested that objects seen in 1531 and 1607, and one that he had seen himself in 1682, were reappearances of the same comet, with a period of about 75 years. He predicted its return in 1758.

The comet was observed again in December of 1758 on its approach to perihelion in March 1759. Now known as Halley's comet, it has been seen during intervals of weeks or months at passages near the sun in 1835, 1910, and 1986. Future returns are expected in 2061 and 2134.

The motion of Halley's comet has been traced computationally back to 1404 B.C., but the earliest appearance for which reliable observations have been found occurred in 240 B.C. Particularly close approaches to the earth took place in 374 A.D. and 837 A.D., and is expected to take place in 2134. A relatively close approach to the earth occurred in May 1910, but distances from the earth during the return of 1985–1986 remained substantially larger than usual. At the time of perihelion passage on Feb. 9, 1986, the comet was almost directly in line with, but on the far side of, the sun.

Halley's comet is the only periodic comet that regularly and predictably becomes bright enough to be visible without optical aid. Viewing circumstances generally are most favorable from locations in the earth's Southern Hemisphere a few weeks following perihelion. At favorable returns the brightness of Halley's comet can match that of the brightest stars, while the length of the tail can exceed 100 degrees.

The orbit of Halley's comet is an elongated ellipse that extends from within the orbit of Venus to beyond that of Neptune. The revolution period ranges from 76 to 79 years, depending on disturbances of the comet's motion caused by the planets. Half the time of each revolution is spent in the small orbital arc beyond Neptune. The plane in which the orbit lies is inclined by some 18 degrees to that of the earth's orbit around the sun, but the direction of revolution of the comet is opposite to that of the planets. Thus spacecraft exploration of the comet at its return in 1986 was made difficult by very high relative velocities of comet and spacecraft at the time of encounters.

Debris scattered along the orbit of Halley's comet causes showers of meteors twice each year as the earth approaches close enough to the comet's orbit that particles penetrate the earth's atmosphere. The Eta Aquarids are seen in early May and the Orionids in October.

ELIZABETH ROEMER
University of Arizona

Further Reading: Chapman, R., and Brandt, J., *The Comet Book* (Jones & Bartlett 1984); Flaste, R., and others, *The New York Times Guide to the Return of Halley's Comet* Times Bks. 1985); Grewing, M., and others, *Exploration of Halley's Comet* (Springer-Verlag 1988).

HALLGRÍMSSON, häd'əl-grēms-son, **Jónas** (1807–1845), Icelandic lyric poet. He was born at Hraun farm in Öxnadalur Valley in northern Iceland on Nov. 16, 1807. After attending the University of Copenhagen, he returned to Iceland on a geological mission for the Danish government but thereafter devoted himself to traveling and writing.

In 1835, with Konrád Gíslason and Tómas Sæmundsson, he began to publish the periodical *Fjolnir*, in which most of his own works appeared. As a lyric poet he was especially successful in introducing European ideas and meters, at the same time revitalizing the classical language and meters of Iceland. His work inspired later generations of poets to preserve and enlarge Icelandic literature. Hallgrímsson died in Copenhagen on May 26, 1845.

HALLMARK, a symbol stamped on silver, gold, or pewterware to show conformity to the legal standard. Hallmarks are also used for bullion control and the collection of revenue. The standards for silver in England are sterling (92.5% fine) and Britannia (95.84% fine).

Early Byzantine silver was stamped for bullion control, but hallmarking really started in France with townmarks (Montpellier, 1220); London followed in 1300. Maker's marks were made compulsory in the 14th century, and date

Hallmarks (*l. to r.*): maker, standard, assay office, date.

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SHOWERS	DATES	SEEM TO COME FROM	AVERAGE NUMBER PER HOUR
Eta Aquarids	May 4–6	Aquarius	20
Orionids	October 21	Orion	20

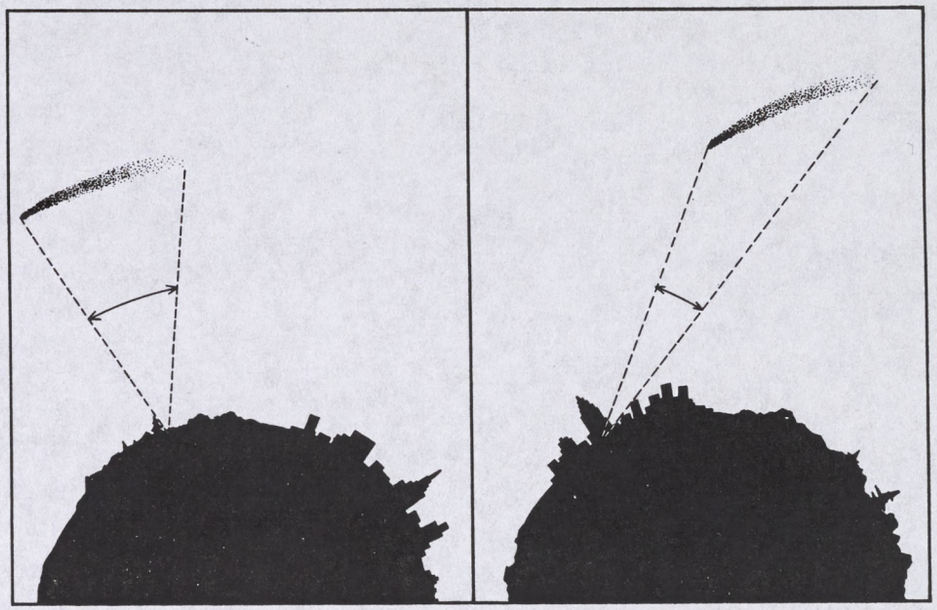
Every time a comet passes close to the Sun, it loses millions of tons of dust and gases. Very likely the comets with the longest tails lose the most material.

Eventually a comet may be reduced to nothing but solid material—all dust and gases have been pulled out of it. The chunk may remain in orbit around the Sun, or it may be captured by a planet. It may be pulled out of the solar system by a distant star. Or it may become a solid object flying through space between the orbits of Mars and Jupiter. That's the region occupied by the asteroids—solid masses ranging from pebbles to huge objects several hundred kilometers across. Very likely remains of comets are scattered here and there throughout the asteroid belt.

COMET TAILS

The tail of a comet is the part that is most apparent because it is so large. In 1986, Halley's tail may stretch for millions of kilometers and may appear to cover 30 or 40 degrees. That would be impressive, since it would mean it would extend seven or eight times the distance between the pointer stars of the Big Dipper.

Before the comet's appearance no one can be certain that the tail will be this large. It may be shorter and wider, or it may be ragged and uneven. There may even be two tails; one rather straight and the other curved. If we compare reports of ancient sightings with those of 1910 and



The length of Halley's tail depends upon the viewing angle. The tails here are equal in length. The one at right appears shorter because of its angle to the viewer.

1835, it seems that the tail has been growing smaller with each sighting. That would be as expected, for, as already mentioned, each time a comet passes close to the Sun, it loses millions of tons of its dust and gases.

DUST TAILS Comets do not produce their own light; they are illuminated by the Sun as they travel near it. There are slight differences between direct sunlight and the sunlight reflected from the tail of a comet. When these differences are studied, scientists can determine what the tail is made of and how the light is produced.

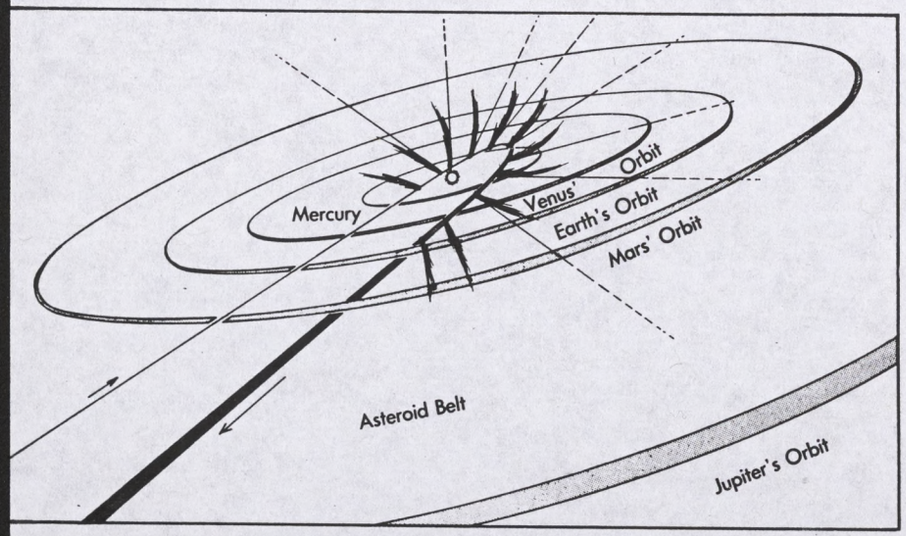
Sunlight, like all light, exerts pressure. The amount is small, but in space it is enough to push free atoms and electrons. It may even be enough to push comet debris beyond the planets and out of the solar system.

As the Sun shines on particles given off by a comet's nucleus, it pushes them away, causing them to stream into space and form the tail. As they are pushed along, the particles are also lighted by the Sun. They reflect that light to us, making it possible for us to see the comet.

Whether a comet is moving toward the Sun or away from it, the pressure of sunlight is enough to thrust the small particles away from the nucleus and coma. Therefore, the tail is always pointed away from the Sun. The tail trails the comet head during the approach to the Sun, and it goes before the head as the comet moves away from the Sun. It can be compared to someone holding a flashlight so the beam is in front.

As the comet speeds around the Sun, its tail becomes curved; it does not point straight away from the Sun. The action is similar to that of a garden hose: If you swing the

When Halley is close to the Sun, a dust tail will be thrown out by the nucleus. It will curve away from the nucleus, much as water curves away from a garden hose when swung from side to side. Should Halley develop a plasma tail, it would tend to be located along the straight lines radiating from the Sun, which represent the course of the solar wind.

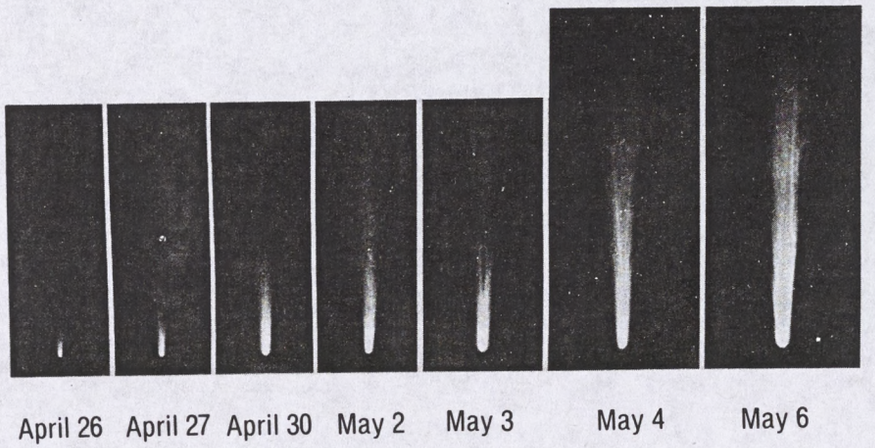


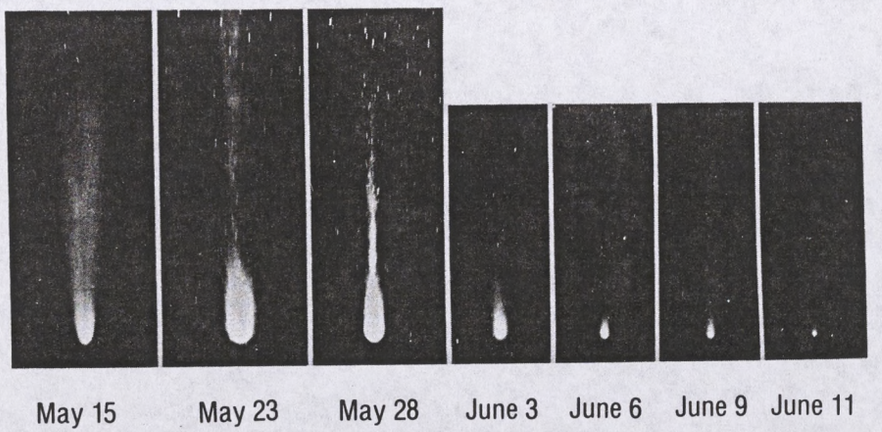
hose from right to left, the stream of water curves away. So it is with the particles thrown out by the comet.

During the visit of Halley in 1910, observers saw a section of the tail break away. The main part of the tail was made of comet dust; the part that broke away was made of plasma.

This series of photos shows changes in Halley's tail. On May 23, 1910, a section broke away, but by May 28, a new one had developed.

Mount Wilson and Las Campanas Observatories, Carnegie Institution of Washington





PLASMA TAILS Every day the Sun throws a million tons of plasma—atoms that are electrically charged—into space. (Ordinarily an atom is electrically neutral. However, if it loses an electron, it carries a positive charge; if it gains an electron, it is negatively charged. In either case, the atom becomes an ion.)

Together, these ions, along with the nuclei of atoms, make up what is called the solar wind. This wind streams away from the Sun in all directions at a speed of 400 kilometers an hour. When it meets a comet, the wind reacts with the atoms in the comet's gases, changing many into ions, which become part of the plasma. Then the wind blows this plasma away from the comet head, making a tail—a plasma tail. The particles in it stream away faster and straighter than the particles in the comet's dust tail. Usually the plasma tail is also slimmer than the dust tail.

We see a dust tail because of reflected sunlight. The plasma tail is visible because of light produced by fluorescence. When you turn on a fluorescent lamp, ultraviolet radiation (which is invisible) is produced inside the tube. This radiation falls on a phosphor, a chemical that glows when it receives ultraviolet radiation. Different kinds of phosphors produce different colors, and so there are white, bluish white, and pink ultraviolet lamps. In a similar fashion, energy from the Sun is absorbed by the ions in the plasma tail. They act as a phosphor, so after a short interval the ions give off the energy in the form of visible light. Scientists know that the light in the plasma tail is given off by a variety of ions, including those of sodium, carbon, hydrogen, and oxygen.

Even though there are millions of tons of matter in a comet's dust tail, and millions of tons of ions in the plasma tail, the material is so spread out that you can see stars through the tails. There might be one speck in a volume the size of a room.

As mentioned earlier, once the particles form a tail, they are lost. During a single visit to the Sun, a comet may lose several hundred million tons of dust and vapor. During its history, Halley has probably lost a cubic kilometer of ice. No one can say how much it will lose in 1986. Providing all is not lost, however, we can be quite certain that the material left in Halley will remain intact, becoming once more a dark, cold cosmic snowball on a long journey out to the boundaries of the solar system.

these ellipses could be very flat or very nearly perfect circles, depending on many conditions, such as speed of motion and nearness of masses with strong gravitation.

After long discussions with Newton, and after studying information available about the appearances of other comets, Halley suspected that comets did not arise spontaneously, nor did they appear and disappear in a random fashion, nor travel in straight lines. In fact, he said, comets (or at least some of them) moved in great curves and so reappeared over and over again. He believed that a comet that had appeared in 1531 and again in 1607 was the same one he saw in 1682. After turning this idea over in his mind for 23 years and discussing it with Newton, Halley wrote in 1705, "... whence I would venture confidently to predict its return (the comet of 1682) in the year 1758." This was no easy matter. In the first place, the 1682 comet had been seen during only a small part of its orbit. And in order for it to return in 1758, its orbit had to be a flat ellipse that extended far out into space, much farther than the edge of the solar system as it was then believed to be (this was before the discovery of the outer planets, Uranus, Neptune, and Pluto).

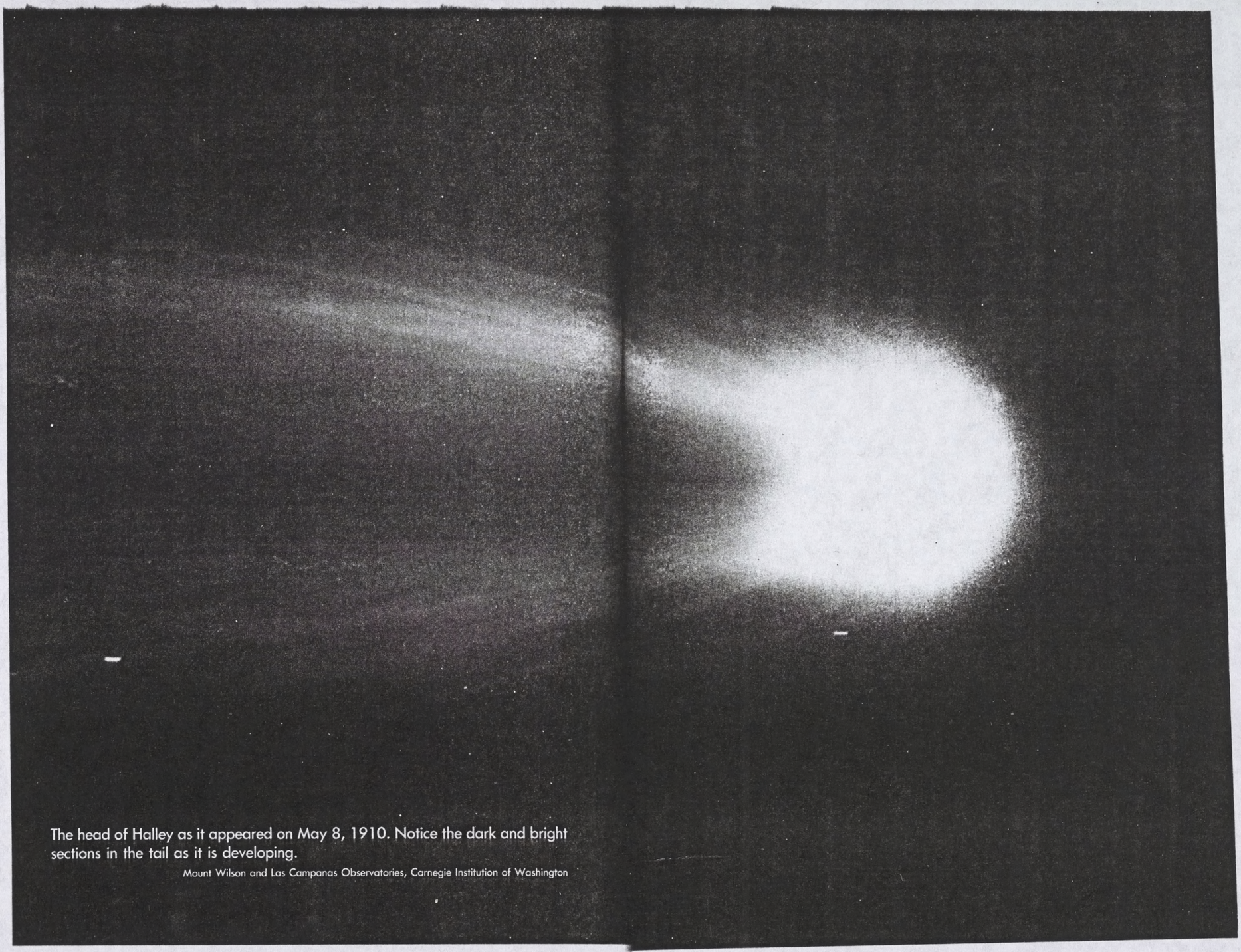
To make the prediction, Halley had to work out how much the pull of Saturn and Jupiter would affect the orbit of the comet. This was a complex matter, for the positions of the planets were always changing, sometimes speeding up the comet and at other times slowing it down. And the comet itself was sometimes close to the planets and at other times more distant. Nevertheless, Halley calculated that the comet of 1758 would be delayed by 618 days, the time required for it to complete an orbit would be a year and eight months longer than in its previous journey. Halley said the comet would reach perihelion, its closest

approach to the Sun, in the middle of April 1759, give or take one month.

This was a sensational announcement because it was contradicting the general belief that comets came and went in a haphazard fashion; they arose spontaneously, and just as rapidly disappeared. Half a century after this prediction, astronomers and the public who had heard about Halley watched the skies with great care to catch the first glimpse of the "comet of 1682." They were not disappointed, for the comet passed through perihelion on March 12, 1759, one month before Halley had said it would. Unfortunately, Halley had died in 1742 and so was not able to see the return he had predicted. However, ever since that day, the comet of 1682 has been called Halley's comet, in honor of the man who first proved that comets were parts of our solar system and moved in elliptical orbits around the Sun, much as the planets do.

For perhaps three thousand years or more, Halley has been returning to our region of space every 76 years on the average. As we know, the most recent return of Halley was in 1910, when it passed through perihelion on April 20. The first photographs of it were made on September 11, 1909. From March 9, 1910, to the middle of April, it was invisible, since it was in the glare of the Sun. When it reappeared, the comet grew brighter, reaching second magnitude, which is about as bright as Polaris (the North Star) on May 10. One tail, which was visible in the hours after midnight, reached a length of 100 degrees. (There are 180 degrees from horizon to horizon.)

On May 18 the nucleus of the comet passed in front of the Sun. On May 19–21, the tail was visible before dawn, and at that time it grew to cover 140 degrees. It was then that Earth passed through the tail.



The head of Halley as it appeared on May 8, 1910. Notice the dark and bright sections in the tail as it is developing.

Mount Wilson and Las Campanas Observatories, Carnegie Institution of Washington