No. 1 - Winter 1984-85

The Return of Halley's Comet

On February 9, 1986, the most famous comet of all time will make the closest approach to the Sun in its current 76-year trip around our star. For a few months, before and after that date, the comet will be visible from our vantage point on the Earth — but, alas, not as well as it was in 1910. We begin the inaugural issue of *The Universe in the Classroom* with an in-depth look at Comet Halley (pronounced to rhyme with "Sally'') and its upcoming "not-so-close encounter'' with the Earth.

What exactly are comets?

Comets are literally cosmic icebergs — chunks of ice with dust and rocky particles embedded in them. This "dirty ice'' includes not just frozen water, but many other frozen substances as well. A typical comet iceberg is only a few kilometers wide, very small compared to most of the objects astronomers study.

According to our modern theories, comets are frozen debris, left over from the formation of the solar system. We believe there is a vast "cloud'' of icy pieces in the outer regions of the solar system, far beyond the orbit of Pluto. While most of these will never leave their distant orbits, a few are disturbed in their motion and come into the inner solar system, revealing themselves to us.

These comets then move around the solar system in huge elongated orbits, which means they spend most of their time far away from the Sun. Out there a comet remains frozen and is invisible to even our best telescopes. But as a comet's path brings it closer and closer to the Sun, the heat begins to evaporate the ices and release some of the dust particles trapped within them.

The freed gas and dust particles form a cloud or "halo'' around the iceberg which astronomers call a coma. A comet's coma can get as large as 100,000 km across as the comet nears the Sun, and the glowing gases of the coma produce the "fuzzy patch'' appearance we associate with comets.

Not all the material liberated from the comet iceberg remains in the coma. A flow of high speed particles from the Sun (which astronomers call the "solar wind'') pushes on the gas particles in the coma and sweeps them into a long "tail'' pointing away from the Sun. In addition, the dust particles in the outer coma are pushed into a gently curving dust tail by the pressure of the Sun's radiation.

Comet tails can stretch out for more than 10 million kilometers. Yet they contain so few particles in total that the material in a com- et tail could easily fit into an average suitcase and leave enough room for a change of clothes.

Why does Comet Halley come back regularly?

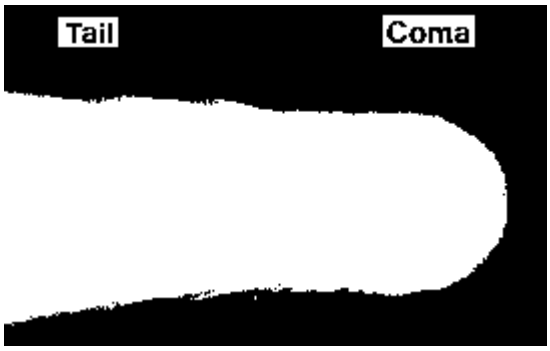
The comets we see follow a variety of paths across the expanse of our solar system. Some make a single pass into the region of the Sun and then retum to the deep freeze of the outer solar system, never to be seen again. Others may have long elliptical paths that will bring them back to us, but only after many thousands or millions of years have passed.

Some comets, on the other hand, have had their orbits altered by the gravitational pull of the giant outer planets — Jupiter, Saturn, Uranus, and Neptune. These "short-period comets'' — of which about 100 are known — mostly stay within the region of the planets and can thus grace our skies much more regularly.

Comet Halley is a fine example of a short-period comet, taking about 76 years to make one orbit around the Sun. At its closest point (perihelion), the comet is only 88 million kilometers from the Sun (about 60% of the Earth's distance from our star.) At its most distant point (aphelion), Halley is 5.2 billion kilometers from the Sun and thus beyond the orbit of Neptune.

Why is the comet named *Halley?*

The British astronomer Edmond Halley (1656-1742) was using Isaac Newton's ideas of gravitation to analyze the motion of bodies in the solar system. He noticed that the records for the bright comets of 1531, 1607, and 1682 showed that all three comets had very similar orbits. He drew the bold conclusion that all three were really the same comet, trapped by the gravitational pull of the outer planets, and predicted that the comet would retum in 1758-59. The comet was found again on Christmas night 1758 and was then named in the late astronomer's honor.



The coma and tail of a comet, indicated on a photograph of Halley's Comet taken on May 8, 1910. (Mt. Wilson Observatory photograph.)

Is Comet Halley on target for its rendezvous with the inner solar system?

On October 16, 1982, a team of astronomers led by David Jewett and G. Edward Danielson recovered Comet Halley using the 200-inch telescope on Palomar Mountain in Southern California. Since the comet at that time was about fifty million times fainter than the faintest objects our eyes can see, they had to use not only the largest American telescope but also special electronic equipment which had been developed for the upcoming Space Telescope.

When they found the comet, it was about 1.6 billion kilometers from the Sun, still beyond the orbit of Saturn. This recovery beats the previous record for finding Comet Halley by over two years! The comet was almost exactly where astronomers predicted it would be and right on time for its closest pass to the Sun on February 9, 1985.

How well will we be able to see Comet Halley this time around?

Unfortunately, this will be one of the less favorable appearances of the comet and significantly less impressive than the one in 1910. How dramatic a comet appears to us on Earth depends on several factors: how bright it really is, how close it is to the Earth when it crosses our orbit, on which side of the Sun it makes its closest approach to our star, and how high above the horizon it is when we see it. The news on many of these fronts is not very promising.

On its way in toward the Sun, Comet Halley will pass closest to the Earth on November 27, 1985, at a distance of 93 million kilometers. On its outward journey, the comet will come within 48 million kilometers of us on April 11,1986. In 1910, however, the closest approach was within 24 million kilometers and we passed through one part of the comet's tail. Therefore, the comet will look a lot fainter this time around and some astronomers predict that in the bright skies of most cities it may well be invisible to the naked eye.

To make things a bit more complicated, the comet's orbit is tilted when compared to the orbits of the planets. This means that the comet will be better seen in the Northern Hemisphere as it approaches the Sun and in the Southern Hemisphere as it is leaving. Since it will be closer to the Earth in the spring of 1986, Southern Hemisphere observers get a better show this time around. But the best views of the comet should come from spacecraft and orbiting observatories (see below).

The best way for the average person to observe the comet will be to use a good pair of binoculars in a location that is away from city lights and has a good view of the horizon (since the comet will be low in the sky). 7x50 or 7x35 binoculars should provide the best views.

Here in the United States, when will be the best times to see the comet?

For much of January 1986, the comet should be faintly visible low in the western sky for a short while after sunset. Then it will disappear behind the Sun and re-emerge from the Sun's glow in the morning sky after the first week of March. Since the comet will be favoring the Southern Hemisphere at this time, the farther south you are, the better your view will be.

During the second week in April the comet will be very low in the predawn sky and impossible for many of us in the U.S. to see. It will become visible later in April in the evening sky and will be getting fainter and fainter as the month goes on.

We will have much more detailed observing guides and suggestions in this newsletter as the comet comes closer.

Other than providing a show in the sky, why are comets of interest to us?

Astronomers believe that comets formed at the same time as our solar system, almost 5 billion years ago. Here on Earth (and on many of the other planets), geological processes, volcanoes, and weather long ago erased all traces of this remote epoch that gave us birth.

Comets, on the other hand, spend most of their time in the "deep-freeze'' of the outer solar system. The material in the comet "iceberg'' is thus well preserved and could tell us a great deal about what things were like in that ancient time.

Astronomers can also use comets as probes of the present conditions in the solar system. By watching a comet's coma and tail develop and change, we can learn about the flow of particles and energy from the Sun, the details of the magnetic fields and particles between the planets, and the detailed characteristics of the comets themselves.

How will astronomers be studying Comet Halley?

To coordinate observations of the comet around the world, astronomers have formed The International Halley Watch, consisting of professional and amateur astronomers in many countries. All observations will be sent to IHW to establish a single archive that will be the richest record of a cometary encounter ever assembled.

Not only will Halley be observed with all sorts of telescopes on Earth, the advent of the space age makes it possible for the first time to send space probes to make close-up measurements of the comet's properties. A small armada of spacecraft will monitor Halley, including five that will fly by the comet in March of 1986. Japan and the Soviet Union are each sending two probes to Halley, while the European Space Agency (the European equivalent of NASA) is sending one. The U.S. decided not to send a fly-by craft to Halley, but we are redirecting an older probe to fly by another comet (Giacobini-Zinner) in September 1985. In addition we will be making observations of Comet Halley with a special package of instruments called Astro 1, to be carried aloft by the Space Shuttle in early March of 1986.

Is there any danger from Comet Halley?

Before we understood the nature and orbits of comets, people worried about the effects a comet might have on us. Today we know enough about these objects to provide a reassuring "environmental impact statement.'' Unless a comet physically collides with the Earth (which Halley will be far from doing), these small chunks of dirty ice pose no danger to us. Their effects are on the mind, stimulating our curiosity and kindling our imaginations.

Resource Corner

As the comet approaches, an enormous amount of resource material will be available for teachers. We will review the best of these in future issues. In the meantime, here is a selection of good resources that are already available.

Books:

Chapman, R. and Brandt, J.: *The Comet Book: A Guide for the Return of Halleys Comet* (1984, Jones and Bartlett) — Excellent book for teachers, featuring comet science, comet lore, and good suggestions for observing the comet.

Branley, F.: *Comets* (1984, T.Y. Crowell) — good picture book for students in grades K-3.

Krupp, E.: *The Comet and You* (1985. Macmillan) — an illustrated book for students grades K-4; ready in February 1985.

Schatz, D.: *The Comet Cometh: An Activity Book for the Return of Comet Halley* — (a teacher's guide to be published in 1985).

Articles for Teachers (or High-School Students):

Bortle, J.: "Brighter Prospects for Halleys Comet'' in *Sky and Telescope* Jan. 1984, p. 9.

Glenn, W.: "Halley's Comet Makes a Comeback'' in *The Science Teacher* Jan. 1984, p. 38.

Neugebauer, M.: "The Comet Fleet'' in *Mercury*, May/June 1984, p. 66.

Slides:

Comets and Comet Halley — A set of 31 slides and detailed captions by Dr. John C. Brandt of NASA; produced by the Astronomical Society of the Pacific.

Computer Software:

Halley's Comet (Starsoft, P.O. Box 2524, San Anselmo, CA 95472; for IBM computers)

Halley's Comet on Your Home Computer (S & T Software. 13361 Frati Lane, Sebastopol. CA 95472; for Apple computers)

(Both of these provide information and plot the position of the comet).

Note: An illustrated catalog of useful educational materials in astronomy is available from the Astronomical Society of the Pacific (390 Ashton Ave., San Francisco, CA 94112) and includes a number of the above resources.

Activity Corner: "Invent an Alien''

by Dennis Schatz, Pacific Science Center

This activity is ideal to enhance a unit concerning the solar system for grades 4-8. It helps students learn about the planets and moons, uses their language and art skills, encourages use of library resources, and promotes creative thinking.

Objective:

To construct a model of an Alien Being that could exist on another planet or satellite in our solar system.

Materials:

Any common items found around the house.
Paper and pencil

The purpose of the activity is to encourage students to learn about the planets through an enjoyable project that encourages their creativity. The scientific accuracy of their Alien Beings may not be as important as the learning and reasoning processes they go through as they construct their alien.

Place the name of each planet or satellite the class will be studying (except the Earth) on separate slips of paper. Make enough slips so there is one for each student in the class. Place the slips of paper in a hat or box and have each student pick a world. The students should not reveal to other members of the class which world they have.

Tell the students that their goal is to construct the model of an Alien Being that could live on the world they picked. These should be three-dimensional models made from any material they can find around the house. Give the students a week to ten days to complete the task. Ask them also to write half-page to one page descriptions of their Alien Beings, stating why they have the characteristics the students have selected. The day you assign the project is an appropriate time to discuss what some of the requirements are for a "Being'' to exist on a given world. These should include:

1. a means to get food
2. possibly a way to move around the planet
3. a way to breathe
4. other means to sense the environment, equivalent to our five senses
5. other suggestions they may have, such as the effects of a gravitational pull that is much larger or smaller than we experience

You may find this is a good discussion to have again after they have researched the nature of their worlds, but before they actually start constructing their Alien Beings.

This activity will require that the students use the library resources available at the school and in the community to determine the characteristics of the planets. If possible you should examine what references the libraries in your area have. Good resources could include:

1. Encyclopedias (preferably no more than three years old)
2. *Odyssey Magazine*
3. *National Geographic* (see list below)
4. Recent books about the planets

On the day that the Alien Beings are due, they can be put on display around the room with the description in front of each one. The students should then have the opportunity to examine each other's Alien Beings to try to determine what planet they think each one comes from. This part of the activity can also be done as an oral presentation. (If the written descriptions are used during this part of the activity, students must be instructed to write them without naming their worlds.)

After the Alien Beings are reviewed, you might have the students talk about the difficulties they ran into designing life on other worlds and discuss with them the reasons our space probes have not found evidence of life elsewhere in the solar system.

Articles on the Solar System in National Geographic

Weaver, K.: "Mariner Unveils Venus and Mercury.'' (June 1975)
Weaver, K.: "First Explorers on the Moon.'' (Dec. 1969)
Schmitt, H: "Exploring Taurus-Littrow.'' (Sep. 1973)
Gore, R.: "Sifting for Life in the Sands of Mars.'' (Jan. 1977)
Gore, R.: "Voyager Views Jupiter.'' (Jan. 1980)
Gore, R.: "Saturn: Riddle of the Rings.'' (July 1981)
Weaver, K: "What You Didn't See in Kohoutek.'' (Aug 1974)

A good general book:

Miller, R. and Hartmann, W.: *The Grand Tour: A Traveler's Guide to the Solar System.* (Workman, 1981)