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A Special Issue on Halley's Comet

Editor's Note: We have now entered what comet expert John Brandt of NASA has called "the golden year of comet exploration.'' The *International Cometary Explorer* (*ICE*) spacecraft has now had a close encounter of the best kind (the real kind) with Comet Giacobini-Zinner and has returned a host of useful scientific information. Telescopes on Earth (and aboard several spacecraft) will be turning more and more frequently toward the faint fuzzy patch in the sky which is Halley's Comet, approaching us from the realm of the outer planets.

This issue is devoted to the coming of the comet and to how you can prepare yourself and your students for finding, observing, and — most importantly — understanding the most famous of all celestial visitors. In this year of incredible "Halley hype,'' teachers will have an even greater responsibility than usual to help the students bring the real science and exploration into focus. The astronomers who work on this newsletter very much hope we can be of some small assistance to you in this important task.

Comets Events Schedule: 1985-86

Sep. 11, 1985
: The U.S. Spacecraft *ICE* flew through the tail of Comet Giacobini-Zinner, becoming the first man-made craft to encounter a comet.

Oct. 20-21, 1985
: Peak of the Orionid meteor shower, when the Earth encounters the dusty debris left along the orbit of Halley's Comet from its previous passes. (View from a dark site after midnight.)

Oct. 29, 1985
: Anniversary of Edmond Halley's birth (in 1656)

Nov. 27, 1985
: Halley's Comet will be closest to the Earth on its journey *inbound* toward the Sun. (However, this will not be one of the best times to see it!)

Jan. 1, 1986
: Halley's Comet "crosses'' the Earth's orbit on its way toward the Sun. (It is north of the plane of the planets' orbits as it does this.)

Jan. 24, 1986
: While Halley's Comet is too close to the Sun for observation, we can turn our attention to the Voyager 2 spacecraft's closest encounter with the planet Uranus.

Feb. 9,1986
: Halley's Comet perihelion (its closest point to the Sun). The comet is 88 million km (55 million mi) from the Sun, between the orbits of Mercury and Venus.

[During March of 1986, five spacecraft will fly by the comet and study the nucleus (the dirty snowball, just a few miles across which is the main body of the comet), the coma (the much larger cloud of evaporated gas and dust, formed by the Sun's radiation), and the tail (the long streamers of comet material pushed away from the nucleus by the Sun's radiation and wind). Several of the spacecraft are equipped with excellent cameras that will send back historic first photographs of what a comet looks like close-up, as well as a steady stream of other scientific data.

Note: All the spacecraft encounter dates below are tentative and subject to minor revision.]

Mar. 6, 1986
: Expected date of closest flyby of *VEGA 1* (U.S.S.R.), the first spacecraft to reach Halley's Comet. Flyby distance will be about 10,000 km (6,000 mi).

Mar. 8, 1986
: Planet A spacecraft (Japan) has its closest fly-by of Halley's Comet; distance = 100,000 to 200,000 km (60,000 to 120,000 mi)

Mar. 9, 1986
: *VEGA 2* has its closest flyby of Halley's Comet. Will try to get within 3,000 - 6,000 km (2,000 - 4,000 mi) of nucleus.

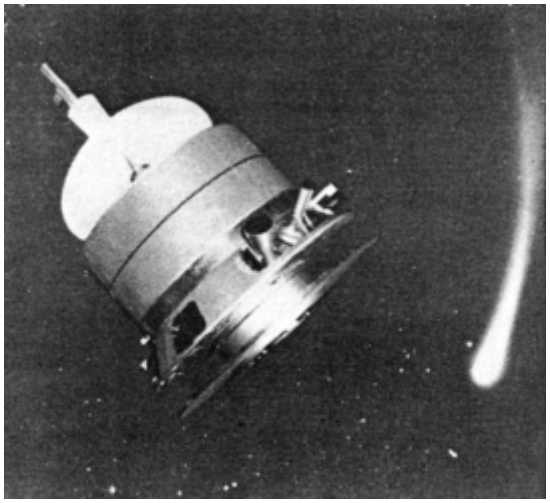
Mar. 10, 1986
: Halley's Comet passes through the plane of the Earth's orbit traveling southward. This is why all the flyby's are occurring this week; it takes less energy if a spacecraft doesn't have to fly above or below that plane.

Mar. 11, 1986
: *Sakigake* spacecraft (Japan) has its closest flyby of Halley's Comet (at a significantly greater distance than the other craft.)

Mar. 14, 1986
: *Giotto* spacecraft (European Space Agency) has its closest flyby of Halley's Comet. Its designers hope it will come within 500 km (300 mi) of nucleus, if spacecraft can survive that close an approach, traveling at a speed of about 150,000 mph relative to the comet.

Mar. 7 - 14, 1986
: Astro 1 payload aboard the Spacelab module on the space shuttle. Complex series of instruments observe Halley's Comet (and other astronomical objects) from orbit.

Apr. 11, 1986
: Halley's Comet passes closest to the Earth on its outbound journey (and the closest it comes during this passage). Comet will be 63 million km (39 million mi) from us. [Its closest known approach was 3 million mi on Apr. 10, 837 A.D.]



The European Space Agency's Giotto spacecraft (above) will, if all goes well, come within 500 km of Comet Halley's nucleus on March 14,1986.

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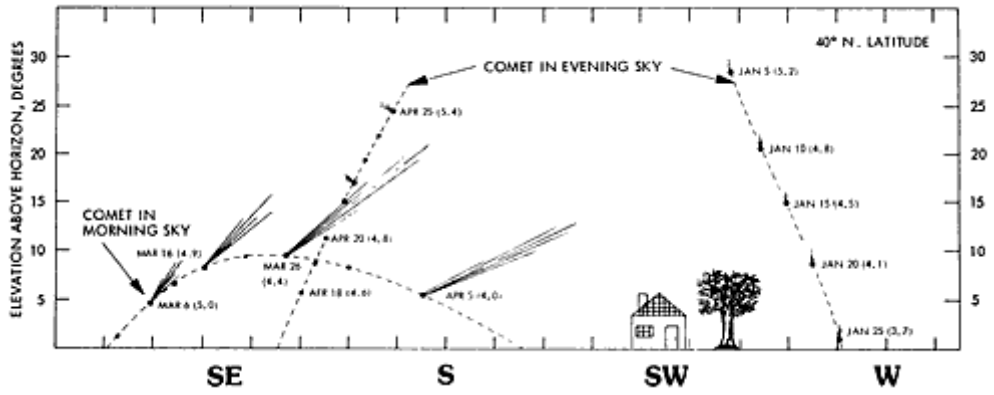
July 28, 2061
: Perihelion during the next pass of Halley's Comet (calculated by Donald K. Yeomans, JPL)

March 27, 2134
: Perihelion during the following pass of Halley's Comet (D. Yeomans)

May 7, 2134
: Halley's Comet will get within 13.9 million km (8.6 million mi) of Earth; should be spectacular in the sky! (D. Yeomans) [Students should be sure to leave word for their great-great-grandchildren.]

Where to look for Halley's Comet



This diagram shows where Halleys Comet will appear in the sky as seen from mid-northern latitudes. For January and late April, the comet is shown where it will be at sunset; for late March to early April, it is shown at sunrise. The tail is shown pointing in the proper directions, but its length is an estimate only (for clear, moonless, and very dark skies away from city lights.) (Chart adapted from one in The Comet Halley Handbook by D.K. Yeomans.)

Best Times to See Halley's Comet (from the Northern Hemisphere)

As many of you may have heard by now, this will be the worst pass of Halley's Comet in 2000 years as far as viewing the comet is concerned. (Just our luck!) From most urban areas, the faintness of the comet in the sky and the brightness of city lights will conspire to make the comet impossible to see with the naked eye. Also the comet will be low on the horizon from most of the U.S., so you will need to find a location with a clear view of the horizon (not generally an easy task, since even low buildings and trees may get in the way.) See the accompanying Halley observing chart.

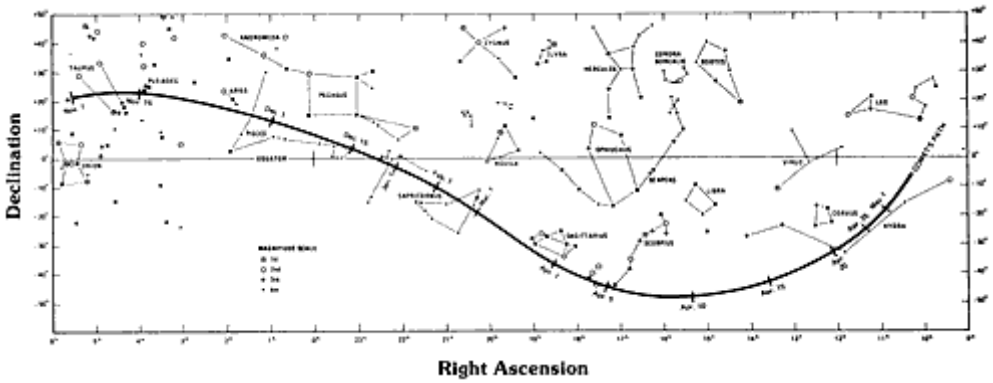
Our suggestion is that families should try to find a good dark, country location to view the comet on a weekend camping trip, for example. The best instrument will usually be a pair of binoculars, since most typical telescopes restrict your held of view too much to be useful for comet viewing.

Dec. 30, 1985 - Jan. 10,1986
: Comet visible through a good pair of binoculars in the constellation of Aquarius in the evening's Southwestern sky, above the bright planet Jupiter. The Moon's light will not interfere during this period, but the comet tail will not be all that impressive.

Mar. 15 - 20, 1986
: Comet is very low in the morning sky towards the southeast. Must look in the morning twilight before sunrise. Comet appears to be "in line'' below Saturn and Mars and may have longest tail. View is better the farther south you are!

Apr. 6 - 10, 1986
: Comet is very, very low towards the south in the morning sky; you must have an unobstructed view of the horizon towards the south. (Not visible from the Northern parts of the U.S. at all; better the farther south you are.) The comet will be at its brightest during this time (still not very bright).

Path of Halley's Comet Between November 1985 and May 1986



This chart shows the path of Comet Halley through the constellations from November 1985 through May 1986. We should note that current estimates are that the comet may not be visible to the unaided eye in most areas before January or after April. Also, during February the comet will be behind the Sun and thus not visible from Earth.

Declination, the north-south coordinate, is expressed in degrees north (+) or south (-) of the celestial equator. Right Ascension, the east-west coordinate, is expressed in hours (24 hours all the way around) eastward from the point in Pisces where the Sun crosses the celestial equator at the spring equinox.

(Chart adapted from one in The Comet Halley Handbook by D.K. Yeomans.)

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Activity Corner

Making A Comet in the Classroom

by Dennis Schatz, Pacific Science Center, Seattle

A dramatic and effective way to begin a unit on Halley's Comet is to make your own comet right in front of the class. The ingredients for a comet are not difficult to find and watching a comet being "constructed'' is something the students will remember for a long time.

The "ingredients'' for a six-inch comet are:

2 cups water
2 cups dry ice (frozen carbon dioxide)
2 spoonfuls of sand or dirt
a dash of ammonia
a dash of organic material (dark corn syrup works well)

Other materials you should have on hand include:

an ice chest
a large mixing bowl (plastic if possible)
4 medium-sized plastic garbage bags
work gloves
a hammer, meat pounder, or rubber mallet
a large mixing spoon
paper towels

Dry ice is available from ice companies in most cities (look under "ice'' in the Yellow Pages for a local source.) Day-old dry ice works best, so you might want to buy it the afternoon before the day you do the activity. Keep the dry ice in an ice chest when transporting it and in your refrigerator's freezer compartment overnight. Most ice companies have a minimum on the amount of ice they will sell (usually 5 pounds). But having extra dry ice on hand will be useful because some will evaporate and also because it is advisable to practice this activity at least once before doing it with the class.

Here are the steps for making a 6-inch comet (students make good baker's assistants for this exercise):

1. Cut open one garbage bag and use it to line your mixing bowl.
2. Have all ingredients and utensils arranged in front of you.
3. Place water in mixing bowl.
4. Add sand or dirt, stirring well.
5. Add dash of ammonia.
6. Add dash of organic material (e.g. corn syrup), stirring until well mixed.
7. Place dry ice in 3 garbage bags that have been placed inside each other. (Be sure to wear gloves while handling dry ice to keep from being burned.)
8. Crush dry ice by pounding it with hammer.
9. Add the dry ice to the rest of the ingredients in the mixing bowl while stirring vigorously.

10. Continue stirring until mixture is almost totally frozen.
11. Lift the comet out of the bowl using the plastic liner and shape it as you would a snowball.
12. Unwrap the comet as soon as it is frozen sufficiently to hold its shape.

Now you can place the comet on display for the students to watch during the day as it begins to melt and sublimate (turn directly from a solid to gas -- which is what carbon dioxide does at room temperature and comets do under the conditions of interplanetary space when they are heated by the Sun.)

The comet is reasonably safe to touch without getting burned by the dry ice, but it is still best to have a spoon or a stick for the students to use while examining it. As the comet begins to melt, the class may notice small jets of gas coming from it. These are locations where the gaseous carbon dioxide is escaping through small holes in the still-frozen water. This type of activity is also detected on real comets, where the jets can sometimes expel sufficient quantities of gas to make small changes in the orbit of the comet.

After several hours, the comet will become a crater-filled ice ball as the more volatile carbon dioxide sublimates before the water ice melts. Real comets are also depleted by sublimation each time they come near the Sun. Ultimately, old comets may break into several pieces or even completely disintegrate. In some cases, the comet may have a solid rocky core that is then left to travel around the comet's orbit as a dark barren asteroid.

Editor's note: Dennis Schatz is the author of a marvelous new student (and teacher) activity book about Halley's Comet discussed elsewhere in this issue.