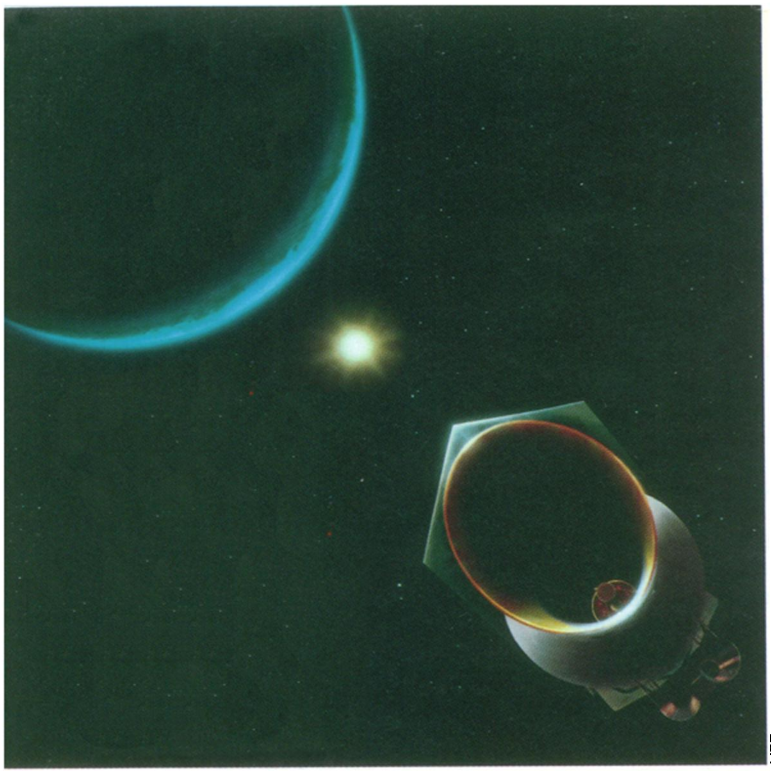

ESA

*Infrared Space Observatory.*

# Launches and Liftoffs in '95

## Focusing on the star of the solar system

By RON COWEN

From a visit to Jupiter to studies of distant quasars, 18 launches highlight the new year in space science. Although NASA craft dominate the lineup, the European Space Agency (ESA) has several key launches, including one of its most costly space probes to date, the Infrared Space Observatory. Japanese, Argentine, and Russian craft also figure in the array of launches.

In part because of holdovers originally slated for launch last year, many of the 1995 missions are devoted to studies of the sun and its interaction with Earth.

"1995 is the big year for space physics," says Louis J. Demas, chief of the flight programs branch of NASA's space division in Washington, D.C. "All the elements of the International Solar-Terrestrial Physics program should be up and operating." The program is a cooperative effort to study the sun's effect on Earth.

Mechanical and operational delays may alter flight schedules, but the following calendar provides the space agencies' best estimates for the year ahead.

### FEBRUARY

● Kicking off the 1995 schedule, the space shuttle deploys the Far Ultraviolet Imaging Spectrograph in early February. For 40 hours, this free-flying instrument will study diffuse sources of ultraviolet (UV) radiation, including the sky background, emissions from nearby galaxies, and clouds of dust and gas. The shuttle will retrieve and return the spectrograph to Earth.

● The month also includes the launch of a suite of devices designed to study infrared emissions from our galaxy. The Infrared Telescope in Space (IRTS), a Japanese-U.S. mission, carries four instruments.

Two spectrometers will record the intensity of particular wavelengths of infrared light radiated by sources in the Milky Way, while a photometer will record the overall infrared brightness of objects in our galaxy. Together, these devices and one other detector will study cool stars and map the location of gas clouds.

Mounted on an orbiting platform known as the Space Flyer, the IRTS will soar aloft on an expendable Japanese rocket and gather data for about a month. The shuttle will retrieve the satellite in the summer.

● In late February, a trio of UV detectors first flown in December 1990 will orbit Earth for 2 weeks. Collectively known as Astro 2, these instruments will take the spectra of astronomical objects and study the polarization of their light — all at far-ultraviolet wavelengths. Because such radiation can't penetrate Earth's atmosphere, ground-based telescopes can't detect it.

Flown in the shuttle's payload bay, Astro 2 will generally study fainter targets during the night portion of its orbit, when Earth lies between the shuttle and the sun, and brighter targets during the day. Astronomers on board the shuttle will point the telescopes and oversee observations, the last NASA mission to feature such hands-on studies in this century.

### MARCH

● NASA launches the third in its series of probes to measure global concentrations of ozone, the fragile blanket of gas that shields life on Earth from the most harmful type of solar UV radiation. Known as the Total Ozone Mapping Spectrometer (TOMS), this instrument gauges ozone concentrations indirectly, by comparing the amount of solar UV energy striking our planet to the amount scattered back into space by Earth's atmosphere. The greater the amount of scattered UV light, the lower the concentration of ozone. TOMS will operate for at least 2 years.

### APRIL

● Two Earth-orbiting missions hitch a ride on a U.S. Pegasus rocket. The Satélite de Aplicaciones Científicas-B (SAC-B), the first flight of an Argentine craft, carries five scientific instruments. This 3-year mission includes three spectrometers, two of them studying high- and low-energy X rays from solar flares. SAC-B also includes a telescope to record the diffuse X-ray background over a major portion of the sky and an instrument to search for the mysterious flashes of energetic radiation known as gamma-ray bursts.

These cosmic flashbulbs rank "as the most important mystery in astrophysics today," says Daniel W. Weedman, director of NASA's astrophysics division. The bursts radiate as much energy as 1 billion suns in a few seconds and then disappear without a trace. Of unknown origin, these bursts rarely, if ever, repeat and have no proven counterpart at lower energies (SN: 12/17/94, p.404).

● To study these fleeting flashes more closely, a satellite known as the High Energy Transient Experiment (HETE) shares the Pegasus launch with SAC-B. HETE carries Japanese, French, and U.S. instruments on its 3-year mission. They include a spectrometer to measure gamma-ray bursts in the energy range between 6,000 and 1 million electronvolts. Another detector will study the lower-energy, X-ray component of the flashes.

One of the most puzzling aspects of the bursts is that no one has ever seen a confirmed UV or visible-light counterpart. In the hope of observing one, HETE includes four UV cameras set to scan the sky whenever a gamma-ray burst appears.

These instruments will help pinpoint the location of gamma-ray bursts with a precision that far exceeds the capabilities of NASA's Compton Gamma Ray Observatory, which has studied the energetic flashes since 1990. "HETE is one of the big hopes for actually localizing and identifying the gamma-ray bursts," Weedman says.

### MAY

● Ulysses, which last year became the first craft to view the sun's south polar region, now embarks on a pioneering study of the sun's far north. The joint ESA-NASA mission will reach about 70° N solar latitude in May and spend the next 4 months even farther north, observing the sun at a distance of some 330 million kilometers. Researchers are eager to find out if some of the surprises about the sun's magnetic field discovered by Ulysses in the south will hold true in the north (SN: 11/19/94, p.326).

● NASA sends aloft the newest U.S. geostationary weather satellite. The high-altitude orbits of these craft allow them to rotate at the same rate as Earth and to keep a continuous weather watch over a particular region of our planet. Collectively known as the Geostationary Operational Environmental Satellite (GOES) series, the latest craft, GOES-J, will monitor atmospheric temperatures, humidities, wind velocities, and the development of storms over Earth's Western Hemisphere.

**JUNE**

● By studying the chemistry of dense interstellar clouds, astronomers expect to gain a better understanding of how these clouds collapse to form stars and, perhaps, planetary systems. Radio telescopes on Earth can't detect molecular oxygen and water vapor in interstellar clouds because their abundance in our planet's atmosphere confounds observations.

Carried above the atmosphere by a Pegasus launch vehicle, NASA's Submillimeter Wave Astronomy Satellite (SWAS) will chart the distribution and abundance of water vapor, molecular oxygen, carbon, and carbon monoxide in any large stellar nursery within 3,000 light-years of Earth.

"We know a lot about these clouds from the ground, but we don't have any idea of the abundance of oxygen or water," notes Weedman. "This is kind of the last link in the chain."

SWAS will also observe some gas-rich regions beyond the Milky Way, including its nearest neighbors, the Large and Small Magellanic Cloud galaxies.

**JULY**

● The Galileo spacecraft, en route to its December rendezvous with Jupiter, will release a free-falling probe meant to parachute into the planet's atmosphere on Dec. 7.

● Strapped in the payload bay of the shuttle, a suite of instruments known as the International Extreme Ultraviolet Hitchhiker will cast its UV eyes on Jupiter and its moons, the sun, and a host of hot stars. This joint U.S.-Italian mission is in part a test run. Using its UV imaging spectrometer, known as UVSTAR, Hitchhiker will practice making observations of Jupiter and the doughnut-shaped region of hot gas that envelops the planet and its moon Io. UVSTAR will also analyze emissions from hot UV-bright stars in the Milky Way.

The Jovian observations will take on special significance during Hitchhiker's second shuttle flight in mid-1996, when it studies Jupiter in tandem with the Galileo spacecraft. While Galileo makes a close-up tour of the giant planet and its moons, the shuttle probe will record Jovian UV emissions as seen from afar at wavelengths ranging from 50 to 125 nanometers.

Another Hitchhiker detector will measure the total amount of UV light radiated by the sun at wavelengths between 25 and 170 nm. In combination with the Jupiter observations, the solar studies may reveal how the sun's radiation alters the Jovian system.

| MONTH | EVENT |
|---|---|
| February | Far Ultraviolet Imaging Spectrograph<br>Infrared Telescope in Space<br>Astro 2 |
| March | Total Ozone Mapping Spectrometer |
| April | Satélite de Aplicaciones Científicas-B<br>High Energy Transient Experiment |
| May | Ulysses begins pass over sun's north polar region<br>GOES-J (weather satellite) |
| June | Submillimeter Wave Astronomy Satellite |
| July | International Extreme Ultraviolet Hitchhiker<br>Fast Auroral Snapshot<br>Spartan 201-3<br>Galileo releases probe |
| August | X-ray Timing Explorer |
| September | U.S. Microgravity Laboratory 2 |
| October | Solar and Heliospheric Observatory |
| November | Cluster<br>Infrared Space Observatory<br>Cosmic Dust Experiment |
| December | Polar<br>Galileo probe plunges into Jupiter<br>Galileo begins tour of Jupiter and its moons |

● NASA launches one of its small Explorer-class satellites in July to study Earth's auroras, the dazzling light displays above our planet's polar regions. The Fast Auroral Snapshot (FAST) satellite will examine the electric and magnetic fields and charged particles that lie just above the auroras, probing the processes that generate these fireworks. Designed to operate for at least a year, FAST will complement observations with higher-flying spacecraft, such as Polar (see December).

● Continuing the year's exploration of the sun, a space shuttle launches the third in a series of free-flying missions to study the solar wind and corona. Like its two predecessors, Spartan 201-3 will use UV and visible-light telescopes to monitor solar activity.

In examining the solar corona, the Spartan probe will complement studies with the more distant Ulysses craft (see May). Using the shuttle's robotic arm, an astronaut will release Spartan 201-3 and recover it some 40 hours later.

**AUGUST**

● Not everything in the universe runs like clockwork. X-ray emissions from some celestial sources vary erratically. The X-ray Timing Explorer (XTE), the first U.S. X-ray mission since the Einstein Observatory in 1979, will study variations as small as one-millionth of a second in the X-ray output of such compact objects as black holes, neutron stars, and white dwarfs in the Milky Way.

XTE also will examine X rays spewed from the hearts of distant galaxies. These galactic cores may harbor black holes more massive than 1 million suns or the dazzling beacons known as quasars. The mission has a minimum lifetime of 2 years. During its sojourn, the XTE will compile an all-sky survey of variable, bright X-ray sources in the cosmos.

**SEPTEMBER**

● The second flight of the U.S. Microgravity Laboratory rides the shuttle this month. The 16-day mission, the longest ever for a shuttle, will build upon previous studies of materials in the low-gravity environment of space. Hands-on experiments include an analysis of the growth of protein crystals and studies of surface tension in microgravity.

**OCTOBER**

● NASA and ESA may launch late this month a joint project to study how the sun transports energy from its turbulent interior to its hot outer atmosphere. Known as the Solar and Heliospheric Observatory (SOHO), this complex mission carries 12 detectors. Along with Japan's Geotail, launched in 1992, and several other satellites slated for liftoff later this year, SOHO will join a flotilla of craft studying the sun's influence on Earth.

Four months after journeying into space on an Atlas II-AS rocket, SOHO will enter a circular orbit in which the gravitational tugs from the sun and Earth balance. From this orbit, some 1.5 million km from Earth, SOHO will have an uninterrupted view of the sun.

Several of the craft's detectors will explore the processes that generate and heat the sun's outer atmosphere, or corona, and create the stream of charged particles known as the solar wind. Other instruments will attempt to peek inside the sun by studying its sound waves, much as geologists use seismic waves to "see" inside Earth.

A group of SOHO instruments will measure changes in gas motion at the sun's surface, as well as fluctuations in temperature and radiation that provide vital clues to the density and composition of gases in the sun's interior.

**NOVEMBER**

● Two small platforms, known collectively as the Cosmic Dust Experiment, ride a manned Russian craft to MIR, the Russian space station. Mounted by cosmonauts, the U.S. experiment will use special gels and foams to collect cosmic dust particles over a period of 10 months. A U.S. shuttle crew will return the experiment to Earth so scientists can analyze the composition of the dust.

● ESA launches its Infrared Space Observatory (ISO), only the second satellite devoted entirely to infrared studies. ISO will study the solar system, the birth and death of stars in the Milky Way, and quasars billions of light-years beyond our galaxy. During its 18-month survey, the observatory's helium-cooled instruments will study selected sources over a wide range of infrared wavelengths, from 2.5 to 200 micrometers.

● An ESA-NASA joint venture focuses on planet Earth. Launched by an ESA Ariane 5 rocket, four identical spacecraft collectively known as Cluster will fly in formation to study the ionized gas, or plasma, within Earth's magnetosphere. This is the region surrounding our planet dominated by Earth's magnetic field.

Ground controllers will adjust the distance between the Cluster spacecraft, depending on the size of the plasma structure under study; comparison of measurements from all four craft should yield a three-dimensional picture of the plasma. This mission is expected to last for at least 2 years.

**DECEMBER**

● Complementing the July launch of FAST and last year's Wind mission, NASA in December sends aloft the Polar satellite, which carries 11 instruments to study the solar wind's interaction with Earth's magnetic field. In particular, the craft will monitor the flow of the solar wind over Earth's magnetic poles. Polar will also photograph the northern aurora, observing the energy exchange between the ionosphere, the region just above Earth's upper atmosphere, and its magnetosphere.

● On the seventh day of December, the Galileo probe released in July will reach its final destination, parachuting deep into Jupiter. The detector-laden probe will beam data to its mother craft for about 75 minutes before meeting its demise, crushed by the pressures deep in the planet's thick atmosphere. Because Galileo's main communications antenna remains stuck, the data will be stored on the craft's tape recorder for transmission to Earth several months later.

● Just as its free-flying probe reaches Jupiter, Galileo will embark on a 2-year grand tour of the giant planet and its moons. Despite Galileo's antenna problem, which will prevent the craft from radioing to Earth as much data as intended, NASA scientists expect Galileo to accomplish about 70 percent of its original mission. □

# Health Physics

## Radon: Have its risks been overplayed?

In recent years, federal health officials have estimated that as many as 15,000 lung cancer deaths in the United States each year result from radon, a naturally occurring radioactive gas. But the authors of a major new study say they have been unable to demonstrate convincingly any association between exposure to indoor radon and this disease.

Michael C.R. Alavanja of the National Cancer Institute in Bethesda, Md., and his coworkers measured radon for a year in the homes of 1,721 Missouri women, 538 of whom had lung cancer and 1,183 of whom did not. All of the women, who were matched by age, were nonsmokers or former smokers who had given up the habit at least 15 years earlier.

In the Dec. 21, 1994 Journal of the National Cancer Institute, the researchers report that average residential radon concentrations were "exactly the same" (1.82 picocuries per liter of air) in both groups of women. However, Alavanja's team did note that among the lung cancer patients whose type of malignancy had been identified, half of those diagnosed with adenocarcinomas showed a slightly increased risk of disease with increased exposure to radon. A study of Swedish women, published earlier last year, reported a similar trend.

While a lifetime of exposure contributes to risk, such contemporary studies measure only exposures at an individual's current address, notes Jonathan M. Samet of Johns Hopkins University in Baltimore. For the statistical significance needed to assess accurately whether low residential exposures constitute no risk — or a risk very different from that posed to underground miners by high radon concentrations — the study would have required many more participants than the number used in this or any other residential-radon study to date, Samet argues in an accompanying editorial. But those numbers may soon become available, he adds, as researchers complete a spate of new studies whose data can be pooled for reanalysis.

## Tea: Chernobyl's lingering legacy

Çay (Anatolian tea that rhymes with buy) is to Turks what coffee is to Americans — the caffeinated lifeblood of society. So when cesium-137 fallout from the Chernobyl nuclear accident peppered Turkey's eastern Black Sea coast, a prime tea-growing region, concern about the potential for national exposure to radioactivity mounted quickly. Now, M. Yaşar Ünlü and his coworkers at Çekmece Nuclear Research and Training Center in Istanbul report that drinking tainted tea appears to offer a very effective pathway for picking up nuclear fallout. They describe their findings in the January Health Physics.

The Çekmece team found that new tea shoots forming at the time of the Chernobyl accident — May 1986 — incorporated enough cesium to produce a peak radioactivity of up to 25,000 becquerels per kilogram (Bq/kg) of dry leaves. By 1992, cesium activity in new shoots had dropped to 200 Bq/kg.

What does that mean for the average Turkish tea drinker? Whole-body exposures to cesium from a year's çay drinking in 1986 may have amounted to 0.66 millisieverts, Ünlü's team calculates. That's equivalent to the extra background radiation (from cosmic rays) incurred by living at Denver's altitude for 2.5 years instead of residing at sea level, explains Tom Koval of the National Council on Radiation Protection and Measurements in Bethesda, Md. By 1992, fallout contamination of new Black Sea tea shoots had dropped to levels that would yield an annual cesium dose just one-tenth that delivered by equivalent çay consumption 6 years earlier.