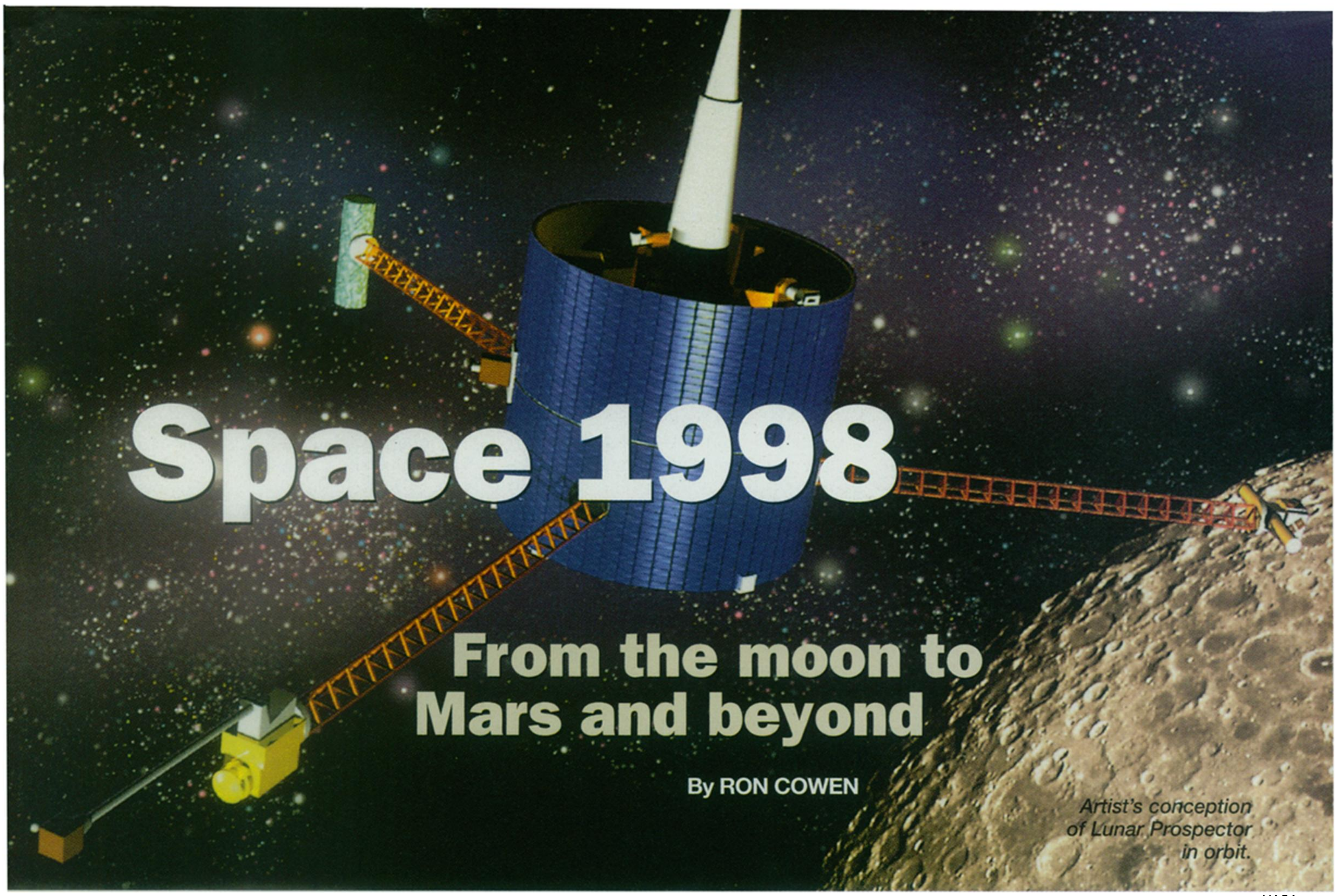

Space 1998

From the moon to Mars and beyond

By RON COWEN

Artist's conception of Lunar Prospector in orbit.

NASA

In space, small is in. The majority of missions scheduled for launch this year are downright diminutive, and most carry only a handful of instruments. Even the $1.4 billion Advanced X-ray Astrophysics Facility, the last of NASA's great observatories, is a scaled-back version of its former self.

Three of the missions this year rely on the services of a small launch vehicle called the Pegasus XL, and the space agency is hoping that problems with the vehicle are a thing of the past (SN: 1/18/97, p. 42). Early last year, NASA put a moratorium on Pegasus flights after several mishaps. The last four launches with Pegasus have been successful, however.

The following is a tentative schedule of spacecraft launches. Given the vicissitudes of equipment and weather, it is subject to change.

January

● This week, NASA heads back to the moon. The tiny Lunar Prospector, small enough to fit in the backseat of a car, may determine within its first month of operation whether the permanently shadowed craters at the moon's poles contain water ice. Radar measurements made with a previous lunar-orbiting craft, Clementine, found hints of frozen water, but the finding remains controversial.

Like Clementine, Prospector can't look for water directly. However, its neutron detector can infer the abundance of hydrogen. Cosmic rays striking atoms on the moon's surface create a steady stream of neutrons, which are efficiently scattered into space by hydrogen. If Prospector finds an unexpectedly large amount of hydrogen, it's likely that the excess is tied up in water.

Prospector is expected to orbit the moon at an altitude of 100 kilometers for 1 year. If enough fuel remains, the craft will ultimately swoop down to an orbit just 10 km above the lunar surface. Prospector's gamma-ray spectrometer will determine the abundance of radioactive trace elements and more common elements, such as iron and silicon.

A magnetometer will measure the strength of magnetic fields at orbiting altitude, while an electron reflectometer measures fields at the surface. These readings will help pinpoint the size of the moon's core and its electrical conductivity, providing a test of the most popular theory of the moon's formation. According to the theory, a body at least as big as Mars slammed into Earth early in its history, and some of the debris from that collision coalesced to form the moon. In this picture, the abundance of magnetic materials in the moon, including iron, should not differ significantly from the amounts in Earth's mantle.

To determine the geologic activity of the moon, an alpha particle spectrometer will measure the rate at which radioactive gases are released from the surface. By measuring where and when gases are vented, scientists hope to determine the frequency of moonquakes and other disturbances. These gases—believed to consist mostly of nitrogen, carbon monoxide, and carbon dioxide—could become key resources if a lunar base is established.

By monitoring shifts in the frequency of radio signals emitted by the craft, ground controllers can track changes in Prospector's velocity as it orbits the moon. The information will allow scientists to construct a detailed gravity map, revealing concentrations of mass beneath the surface.

The public can view data from Prospector at the same time that mission scientists receive it by visiting the NASA Web site at http://lunar.arc.nasa.gov.

March

● TRACE (Transition Region and Coronal Explorer) will explore the link between small-scale magnetic fields rooted in the surface of the sun and the structure of hot gases in the sun's upper layers. The craft will accomplish this task by taking simultaneous high-resolution images of three regions: the sun's visible

Month	Event
January	Lunar Prospector
March	Transition Region and Coronal Explorer
July	Deep Space 1 Satélite de Aplicaciones Científicas-A
August	Topographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources Planet B
September	Wide-Field Infrared Explorer
October	Far Ultraviolet Spectroscopic Explorer Flight test of a cryogenic cooler for the Hubble Space Telescope's infrared camera
November	Advanced X-ray Astrophysics Facility
December	Mars 98 Orbiter

surface; the extended layer of gas above it, known as the transition region; and the outer atmosphere, or corona.

Carried aloft by a Pegasus XL, TRACE will enter into an orbit that will keep it on the sunlit side of Earth and enable it to stare continuously at the sun for 8 months of its 1-year mission. Its ultraviolet detectors will image magnetic field structures on the solar surface as small as 750 km across and record changes in those structures on a scale of seconds.

In concert with the SOHO craft, launched 2 years ago, TRACE will track the magnetic fields from the base of the convection zone, deep within the sun, all the way up to the corona. It will also record the disturbances triggered by these fields, such as the blobs of ionized gas ejected from the corona.

July

- NASA plans to launch the first craft in its new millennium program, a fleet of low-cost, rapidly designed space explorers. Deep Space 1, the program's first deep-space craft, will visit a near-Earth asteroid, fly past the moon, and encounter a comet—all while testing several new technologies. Deep Space 1 will be the first craft of any kind to rely on an onboard, autonomous navigation system, which will enable it to modify its orbit and encounter celestial bodies with minimal assistance from ground controllers. Instead of being weighed down with fuel, the craft will, in part, employ solar power to propel itself.

In January 1999, the craft will fly within 10 km of the near-Earth asteroid McAuliffe, the closest a satellite has ever come to a solar system body. The asteroid is named for Christa McAuliffe, the schoolteacher who died in the 1986 explosion of the space shuttle Challenger. During the flyby, the craft will take images and spectra, measuring such properties as mineral composition, size, shape, and brightness. It will also search for changes in the solar wind, the stream of charged particles blown from the sun, in the vicinity of the asteroid.

Swinging past Mars for a gravity assist in April 2000, Deep Space 1 will study the composition of the Red Planet's surface and atmosphere. With luck, it may also view the two Martian moons, Phobos and Deimos. Two months later, the craft is scheduled to fly past Comet West-Kohoutek-Ikemura, taking close-up portraits and studying the shroud of gas and dust that surrounds the comet's icy nucleus.

- Launched from the cargo bay of the space shuttle, Satélite de Aplicaciones Científicas-A will test several new devices for the Argentine and U.S. space programs. These include a global positioning system that will measure the orientation of the craft without input from the ground, a solid-state camera for digital space photography, silicon solar cells, a magnetometer, and an instrument designed to track the migration of endangered whale populations in the Southern Hemisphere.

August

- A student-designed mission to survey Earth's upper atmosphere is scheduled to be flown on a Pegasus XL. Known as TERRIERS (Topographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources), the project includes both a small research craft and ground-based instruments that together will generate a three-dimensional image of the ionosphere. Boston University students helped develop the satellite's instruments, which will take daily measurements of extreme-ultraviolet emissions from the ionosphere. One of a series of student research projects sponsored by the University Space Research Association in Columbia, Md., the mission is expected to last 1 year.

- Japan plans to launch its first interplanetary spacecraft, Planet B, scheduled to arrive at Mars in October 1999. The craft will study the upper atmosphere of the Red Planet, measure magnetic fields, and examine the interaction of the solar wind with the atmosphere. The lightweight, 186-kilogram vehicle carries 15 instruments and is expected to last 1 Martian year—nearly 2 Earth years.

September

- Ablaze with light, starburst galaxies give birth to one-third of all stars produced in the universe today. The telescope WIRE (Wide-Field Infrared Explorer), set for launch on a Pegasus XL, will conduct a 4-month study of these highly active galaxies. By measuring how their density and luminosity change over time, the detector may provide clues about the evolution and origin of galaxies, as well as quasars, which have been linked to starburst galaxies. Because intense star birth may be a signpost of the formation of galaxies, WIRE will also search for fledgling galaxies, known as protogalaxies.

Most of the energy emitted by starburst galaxies is absorbed by dust and then radiated in the infrared. WIRE will record this radiation at two infrared bands—one centered at 12 micrometers (μm), the other at 25. Featuring a 28-centimeter mirror and no moving parts, the tiny telescope will be cooled by frozen hydrogen to reduce its own infrared radiation, which could overwhelm faint emissions from distant starburst galaxies.

Expected to survey about 100,000 galaxies scattered across several hundred square degrees of the sky, the telescope can detect starburst galaxies as far away as 5 billion light-years. It may also record extremely luminous galaxies that are much more distant, dating from a time when the universe was only about 10 percent of its current age.

October

- Eyeing the nearby universe in the far ultraviolet, a telescope called FUSE (Far Ultraviolet Spectroscopic Explorer) will examine the composition of interstellar gas as well as survey a variety of other astrophysical environments, including the outer atmospheres of cool stars and planets, the centers of active galaxies, and quasars. Recording the emission and absorption of ultraviolet light with wavelengths from 90 to 120 nanometers, FUSE will fill the gap between the Hubble Space Telescope, which detects only the near ultraviolet, and the Extreme Ultraviolet Explorer.

During its 3-year mission, FUSE will measure in the nearby universe the abundance of deuterium, an isotope of hydrogen created in the Big Bang. In addition, FUSE is the first satellite with enough sensitivity to determine the structure of the interstellar medium in nearby galaxies, such as the Large and Small Magellanic Clouds. The telescope will also study nova and supernova explosions, testing theories of how these explosions synthesize heavy elements and examining how supernova shock waves heat surrounding gas.

- A shuttle flight will test the spaceworthiness of a cryogenic cooler that astronauts plan to install on the Hubble Space Telescope in 1999. The cooler, which operates mechanically rather than relying on frozen nitrogen or some other ice, would extend the lifetime of Hubble's infrared camera, NICMOS. Soon after the camera was installed in 1997, the dewar that houses it and maintains its frigid operating temperature developed a leak (SN: 5/3/97, p. 272). Without repair or replacement, NICMOS is expected to last for only 1.6 years rather than the 4 to 4 1/2 years planned. The shuttle test will determine the new cooler's ability to maintain temperatures within a narrow range under zero-gravity conditions.

November

- Dubbed the Hubble Space Telescope of the X-ray universe, the Advanced X-Ray Astrophysics Facility (AXAF) takes a one-way ride on the shuttle. AXAF was originally intended to last for 15 years, including periodic repair missions by astronauts. Budgetary constraints reduced the scope of the project to only 5 years, with no servicing missions planned.

While orbiting Earth, AXAF will produce ultrasharp images and high-resolution spectroscopy at low X-ray energies, ranging from 100 to 10,000 electronvolts. Among its goals is investigating the existence of black holes a few times the mass of the sun, determining how much of the total mass in the universe is in the form of hot gas, searching for dark matter in galaxies, making a determination of the age of the cosmos independent of the distances of galaxies, and testing theories of stellar evolution and supernova explosions.

December

- The second wave of an armada of U.S. craft bound for Mars begins its journey this month. Mars 98 Orbiter is scheduled to reach the planet in September 1999 and start its main mission 2 months later. From a nearly circular polar orbit 400 km above the planet, the orbiter will monitor the climate for an entire Martian year. The craft's pressure-modulated infrared radiometer, the duplicate of a device lost on Mars Observer (SN: 9/4/93, p. 149), will measure the distributions and time variations of temperature, pressure, dust, water vapor, and condensates in the atmosphere. Another tool, the Mars color-imaging system, will monitor the interaction of the atmosphere with the surface. Data from both instruments may indicate the most likely places for subsurface reservoirs of water. The orbiter may also serve as a relay station for future Mars landers. □

Letters continued from p. 3

useful for a system made up of software modules with conventionally engineered, preassigned functions. However, it is doubtful that such an approach would be suitable for the kind of neural network intended to simulate "how people think and how the brain works," as one researcher puts it.

This is because cognitive behavior most likely emerges from a large, distributed network of local processes; each one of these deals with low-level data unrelated to the sort of variables that would be meaningful to an investigator. In other words, major problems of internal representation remain unsolved for natural cognitive systems.

Paul B. Post
Norwalk, Conn.

Power lines

Enjoyed the eye-opening "Must We Pull the Plug?" (SN: 10/25/97, p. 266).

The cumulative demand of all our "leaky" appliances is indeed shockingly high, but aren't the digital clocks in many of these gadgets taking the place of many plug-in wall or shelf clocks? Also, today's quartz wall clocks are often battery-powered, eliminating a few more "watts from the wall."

It would be interesting to see research comparing the energy draw from those bygone electric clocks with the "leakage" powering the VCR and microwave clocks that replaced them!

Tom Robinson
Chicago, Ill.

I've always used powerstrips with wall packs so I can power them off completely. I also use surge protectors for computers and my entertainment console, which, when I remember to do so, I also power off.

Bernie Rice
Park Forest, Ill.

What good would it do to charge a battery to power memory chips and so on while an appliance is in the "off" position? The power ultimately has to come from the power station anyway. All the battery would do is make it less efficient than direct operation.

Walt Gray
Richland, Wash.

If appliances were required to carry a notice of their standby wattage, it would give manufacturers an added incentive to demand innovative power-saving designs from their engineers.

Standby power drain is not new. Ever since they came out early in the century, doorbells have depended on continuously energized transformers, and the power company uses such transformers throughout the grid. Increased transformer efficiency would help.

Homer B. Tilton
Tucson, Ariz.

The researchers are concerned about small energy consumers that account for about 5 percent of the power consumed by a typical household.

I am more concerned about the 95 percent that accrues through normal usage when appliances are turned on. I can turn off TV sets when they are not being watched. I have no way to make them more efficient.

Virgil H. Soule
Frederick, Md.