nomenon in which the light from small particles on the windshield of a car at night is scattered forward into the passengers' eyes, and not back out from the window.

The photopolarimeter revealed that there are three complete rings at Neptune, and one wide sheet of very thin ring material. Carolyn Porco, from the University of Arizona, summarized the ring findings, stating that the three rings are 26,000 miles, 32,000 miles, and 39,000 miles from the planet. The sheet or plateau of ring material stretches between about 32,000-36,000 miles. The middle ring was entirely new, as it did not correspond to any of the ground-based observations. The photopolarimeter indicated that the middle and inner rings are between 40-60% dust.

The more mysterious outer ring is 60% dust in the clumpy "arc" regions, and perhaps 30% dust in the barely visible, non-arc regions. This ring, which had been seen only as arcs from Earth, turned out to be very thin in some regions, and quite clumpy in others. Scientists reported that this structure was reminiscent of the braided outer F ring of Saturn.

Don Gurnett reported that when the plasma wave experiment "looked" at the rings, it found that there were many small particles detected in the 10-15 minutes before the rings' place crossings, both inbound and outbound. A dense core of particles was detected for 10 minutes during the crossing, but in addition, for two hours before Voyager crossed the ring plane, the instrument indicated a region of low-density matter which indicated that Neptune has a "halo" of dust particles around it.

There is little question that, like Saturn's rings, the rings, the plateau, and the halo features of Neptune constitute a dynamic system. Unlike Saturn, however, no gaggle of numerous small satellites, which could "shepherd" the rings and hold them in place, has yet been found at Neptune. As Carolyn Porco stated, scientists still do not understand the dynamics of Saturn's F ring. Now, they have Neptune's ring system to try to figure out, as well.

Triton: 'Like a Mars orbiting Jupiter'

On Aug. 22, when only the fuzziest pictures of Triton had been sent by Voyager, imaging team head Bradford Smith prophetically stated to the press that the interesting methane bands in the atmosphere, and albedo (light reflectance) pattern of Neptune's moon was like Mars. As Voyager came closer, other features started to appear, including a darker equatorial zone, a bluish area bright in ultraviolet emission, and a mottled region. Considering that the haze and atmosphere on Saturn's moon Titan (the only other moon in the Solar System with an atmosphere) prevented Voyager from photographing its surface, scientists were hoping the details starting to emerge from Triton were not just atmospherics.

The day after the closest fly-by of Neptune and then of Triton five hours later, Larry Soderblom of the U.S. Geological Survey, stated at the science briefing: "What a way to leave the Solar System!" The relation of the two is "like Jupiter being orbited by Mars," he stated, as he showed pictures with evidence of volcanism, fractures, regions turned into flat planes from flowing material, a network of ridges, a bluish fringe around the south pole, frosted regions, haze, and volcanic calderas with multiple layers of material.

Bill Sandel, from the University of Southern California, reported the next day that for ten years, ground-based observations had seen the signature of methane at Triton, but it was unclear whether the methane is in the atmosphere or on the surface. From Voyager's ultraviolet instrument readings, he reported, we now know that the atmosphere of Triton is mostly molecular nitrogen, with some ionized nitrogen, as well. From stellar occultations, which observe how the atmosphere absorbs starlight, Voyager revealed that the methane is just above the surface.

On Aug. 27, three days after closest approach, Soderblom reported more detail on the geological terrain of Triton. There is evidence of both global "oceanic" flooding on Triton, he said, as well as localized eruptions of liquid from inside the moon. In calderas, which are the craters on the top of volcanos, there are multiple levels, as if molten fluids had risen and then solidified on the floor of the crater, then melted and froze again repeatedly. Similar layering from melting

'America's destiny to pioneer in space'

At a press conference held at the Jet Propulsion Laboratory on Aug. 26, Dr. Leonard Fisk, NASA Associate Administrator for Space Science and Applications, stated that the Voyager 2 Neptune encounter was the "end of an era," because "it is the last time we will see a planet for the first time." (Pluto is not considered a regular planet of the Solar System.) Over the next decade, he said, NASA will send spacecraft to four planets, not to fly by, but to go into orbit. After being launched from the Space Shuttle on May 4, the Magellan spacecraft is on its way to Venus, where it will map the planet's shrouded surface using radar that "sees" through the clouds.

On Oct. 12 the Shuttle is scheduled to launch the Galileo spacecraft which will orbit Jupiter and send a probe into its atmosphere. Galileo was on its way to the launch pad at Cape Canaveral at the moment Voyager was at Neptune. The Cassini mission to Saturn will send a probe into the atmosphere of its moon Titan, and will orbit the ringed planet. The Mars Observer, scheduled for a September 1992 launch, will also be an orbiter, perhaps

looking for suitable landing sites for future manned missions. Next year NASA will launch the long-awaited Hubble Space Telescope which, while it orbits the Earth, will see more detail in planetary space than any telescope before it. It will be able, for example, to see Jupiter in the same detail as the Voyagers did on their quick fly-bys. Thirty-five science payloads carrying hundreds of experiments will go into space during the next five years. This is "the highest launch rate for science missions," he said, "in the history of the space program."

The day before, Vice President Dan Quayle, who heads the National Space Council, spoke to the employees at JPL who had made the Voyager mission possible. After congratulating the staff—they had just learned hours earlier that the encounter had been "picture perfect"—Quayle stated, "It is America's destiny to discover and pioneer in space." Quayle stated that the space program "leads to economic growth," and is a "high-yield investment in America's future." He stressed that America must reassert its leadership in space. The Moon, he said, could be a springboard to take us farther into the Solar System, and Mars is a "perfect laboratory." During a press conference following his speech, Quayle stressed that although the administration is interested in international cooperation, and that he would discuss space exploration during his trip to Japan in mid-September, "America should be number one; the U.S. will take the lead."

The following day, speaking after Dr. Fisk was Dr. Lew Allen, the director of the Jet Propulsion Laboratory. Allen directly addressed the unfounded fears of the space science community that an aggressive manned space program would squeeze out their unmanned scientific research—a fear which is often fed by the likes of space quack Carl Sagan, who has for years insisted that the manned program has no scientific value, but is basically a publicity stunt. Allen stated that JPL will be an "enthusiastic participant" in the space initiative outlined by President Bush, to go back to the Moon and on to Mars. Who knows, he mused, some day "we may do science at a lunar base."

Until now, only the inner planets, our Moon, and Mars, have had our intelligence, in the form of robotic spacecraft, observe them over time. The Voyagers' grand tour of the outer Solar System was a once-in-a-lifetime opportunity, and had given us an enticing first quick look at the giant outer planets. In the next Golden Age of space science, more will be learned about places we intend to visit ourselves, such as the Moon and Mars, and about the farthest objects in the universe, through a series of great observatories in space. But we will also have a chance to revisit Jupiter and Saturn, among the gas giants, and revise what we have learned from the Voyagers' eyes and ears.

and freezing is seen at the poles of Mars. Soderblom put forward a theory that a few dozen feet below the surface of Triton, nitrogen may exist in liquid form. For years, scientists thought that the temperature of Triton would be at the triple point of nitrogen—the point where it can exist in gaseous, liquid, and solid form, like water on Earth, and that they might see lakes of liquid nitrogen on the surface. However, since Triton's surface temperature is apparently only *30° above absolute zero*, the nitrogen exists only in solid form under ambient pressure. But under the surface, the pressure might be great enough to liquefy the nitrogen. If there were a break somewhere on the surface, and a localized drop in pressure, the liquid nitrogen could "explode" through a volcanic-type vent, spewing plumes of nitrogen vapor and crystals upward.

In the south polar region of Triton, Voyager did spot 20-30 plumes of darker material in the atmosphere. Scientists, including those who have been working to understand the volcanoes on Jupiter's moon Io, quickly tried to estimate the conditions under which nitrogen volcanoes on Triton might exist. Unlike Io, the volcanic activity on Triton would not be driven by heat, but could be described as an artesian volcano, where pressure causes a phase-change and eruption. Quick calculation showed that liquid nitrogen exposed to a vacuum would produce a discharge at about 800 feet per second, which would extend about 25 miles, composed 80% of ice particles, and 20% of vapor. If a wind were blowing at about 320 feet per second, it has been estimated, the material would form plumes. These plumes may become dark, Soderblom speculated, when the ice particles pick up methane from the throat of the volcano.

Radio science data revealed that Triton's atmosphere extends to an altitude of about 220 miles, similar to Earth. The moon's density indicated that, like Pluto, it is about two-thirds rock. The atmospheric pressure is about one one-thousandth that of Earth, and its extremely low temperature makes it the coldest object yet observed in the Solar System.

Are the volcanoes still active? That question may not be able to be answered with Voyager's data. Scientists still do not even know if the volcanoes are active on Mars, where we have not only produced close-up images, but have even landed two spacecraft!

Without doubt, Triton is one of the most interesting places in Earth's family of heavenly bodies. Although we will not send spacecraft there again soon, we can expect more surprising revelations about this frozen but dynamic world, as scientists pore over the wealth of data returned by Voyager for years to come.