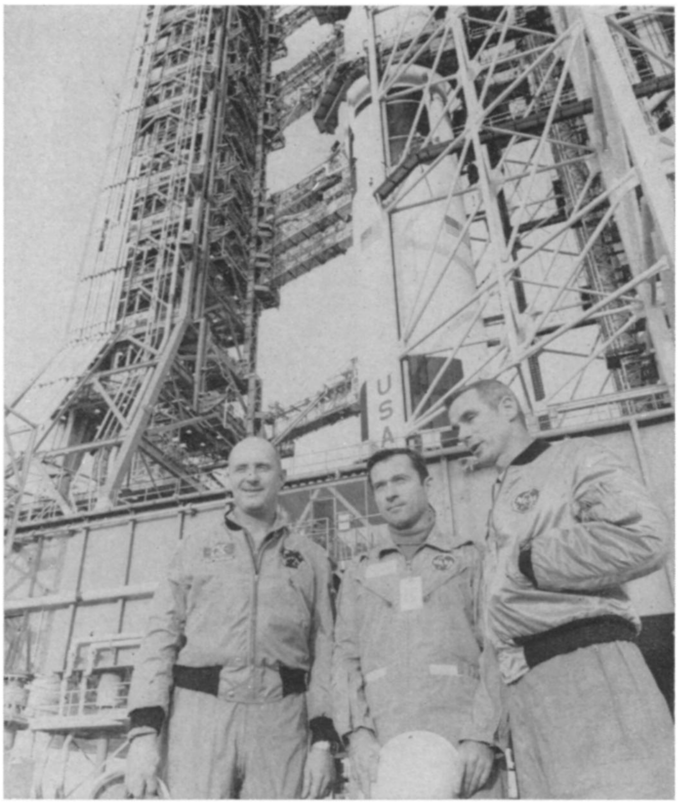
APOLLO 10

Dress rehearsal for a lunar landing: "We have arrived"

Getting there was no problem for the team that will lead the way for America's moon landers


NASA

Stafford, Young, Cernan: A necessary mission.

The second manned mission to orbit the moon, an almost step-by-step full dress rehearsal of the coming lunar landing, was once not even supposed to happen. As recently as last summer the National Aeronautics and Space Administration planned for Apollo 10 to land on the moon.

But the lunar module, which had been having weight and other problems practically since its inception (SN: 3/1, p. 218) kept having them. As a result it didn't go on Apollo 8, as planned. Instead, Apollo 8 Astronauts Frank Borman, James Lovell and William Anders won the Christmas honor of being the first men to visit the moon (SN: 1/4, p. 7), a feat permitted by NASA's confidence in the already-tested Apollo command and service modules.

By Apollo 9 in March, the LM was ready, and passed its complicated test—a mission trickier than even its moon-orbiting predecessor—with flying colors (SN: 3/22, p. 277). The stage was set for Apollo 10, but this time, thanks to one lunar flight already in the books, the lunar module's second voyage was aimed at the moon.

There were two reasons cited for the flight, labeled "The F Mission."

Most important was the need for additional experience with the tricky LM, a goal rated even higher than returning once more to the moon before attempting to land. In fact, said NASA Apollo Spacecraft Program Manager George Low at Cape Kennedy before the launch, it would be conceivable for the LM to pass its tests, permitting a lunar landing attempt with Apollo 11, even if Apollo 10 for some reason could not go to the moon and remained in orbit around the earth.

However, the one-flight delay of the LM's introduction also represented a twist of fate that kept Astronauts Thomas Stafford and Eugene Cernan of the Apollo 10 crew from becoming the first men to set foot on the moon. Instead the F Mission plan called for them to separate from the command module, approach to within nine miles of the lunar surface on the same course as planned for the landing misson, but then to ascend again and dock without ever covering the final 50,000 feet.

"I'd be fooling if I said I wasn't disappointed at not making the landing," said Gemini 9 veteran Cernan a few weeks ago. But he added, "If I didn't think our mission was necessary I would have fought harder to make the first landing."

The second reason for the return moon-orbiting flight was to learn more about the variations in the moon's gravitational field, with their resulting effect on navigation. The lunar orbiter program, which ended almost a year and a half ago, first showed scientists their lack of knowledge about the moon's gravity and led to the discovery of the mysterious mass concentration beneath the lunar surface.

Apollo 8 revealed that the navigational inaccuracies got considerably worse at lower altitudes, says scientist-astronaut Harrison H. Schmitt, who worked with both Apollo 8 and 10 crews before their flights. "Until we really fly a manned or unmanned geodetic spacecraft with respect to the moon—that is, relate the lunar gravity potential field to the lunar surface, and very accurately—we are always going to be faced with a navigational problem around the moon," he says.

The presence of a pilot in the LM will compensate for most of the orbital wandering, but the inaccuracies will pose problems for computers trying to predict ahead of time where the spacecraft will be at a given moment. Here, analysis of tracking data from Apollo 10 will help a great deal, Schmitt said before the flight. It will cut errors in predicting orbital heights from some 13,500 feet during Apollo 8 to as little as 1,800 feet with similar improvements in predicting horizontal distances to points around the moon's surface.

Three weeks before the launch, spacecraft commander Stafford and lunar module pilot Cernan had come down with influenza, but rest and comparatively reduced training schedules—"We've been able to cut back to an eight- or nine-hour day," said Head Astronaut Donald "Deke" Slayton—got them back well and on their feet.

The spacecraft and launch vehicle also seemed to be in a cooperative mood. Two days before the May 18 launch a minor problem with a fuel pressure regulator was easily corrected and later a blown fuse in a liquid oxygen pump was replaced without any delay in the final 28-hour countdown, thanks to the countdown's built-in delays or holds.

The only problem that threatened to affect the flight was a porous metal plate in the water evaporator used to help control the temperature of the crew's space suits. The plate, which needed to stay wet to keep the evaporative cooling process going, kept drying out. Finally, however, engineers satisfied themselves that the plate would remain wet, after it successfully passed three check tests in a row and with about 19 hours remaining until liftoff all systems were go.

The giant Saturn 5 booster lifted off more accurately than any earlier Apollo launch, 0.569 seconds off the scheduled 12:39 EDT mark on May 18.

One by one the Saturn booster's stages and adapter sections separated, or staged, and fell away as the spacecraft climbed into a parking orbit around the earth. ("Babe," said Cernan, as the booster's main section plummeted toward the Atlantic, "You ain't seen nothing till you've seen that S-1C stage.") Then, exactly as scheduled at 2 hours, 33 minutes and 26 seconds after liftoff, the engine of the still-attached third-booster stage was reignited to kick Apollo 10 out onto its course toward the moon.

As the flight progressed toward midweek, it continued to be a gem.

As on Apollo 9, the command and service modules (dubbed Charlie Brown by the astronauts) separated from the lunar module (Snoopy), turned around in space and returned to dock with the LM and pull it free of the booster. Linked together, they continued on their way in an almost trouble-free flight that progressed well for Wednesday's arrival in lunar orbit and Thursday's critical maneuvers of the LM.

"You can tell the world we have arrived," Young radioed jubilantly to earth after the spacecraft finished its first orbit around the moon Wednesday.

Periodically during the journey, spectacular color television presentations showed the earth, astronauts and spacecraft, all looking well, and all in all, by midweek the promise for a successful mission was golden. ◇

X-RAYS AND GAMMAS

Broad-band pulsar in the Crab

In making astronomical discoveries it always helps to know where to look. Radio pulsars were discovered more or less fortuitously (SN: 3/16/68, p. 255), but after several of these were identified, their locations became objects of intense search by observers using other portions of the electromagnetic spectrum.

Astronomers first concentrated on a search for pulsations in visible light. It took nearly a year from the announcement of the first radio pulsar to the confirmed and accepted discovery of an optical pulsar. When the optical identification came, it was for the fastest of the pulsars, NP-0532 in the Crab nebula (SN: 2/1, p. 111).

Finding an optical signal from a pulsar gave hope that they might also give off signals at yet shorter wavelengths, the X-ray and gamma-ray ranges.

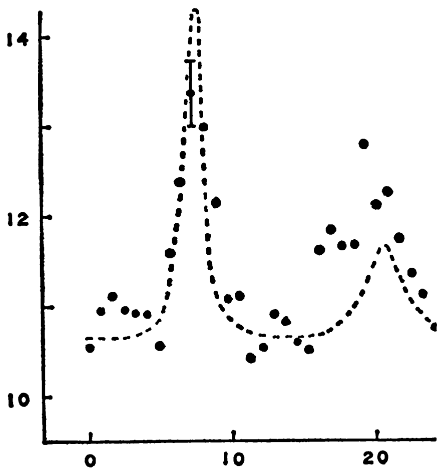
At the time the optical pulsar was announced, X-ray astronomers from the Naval Research Laboratory were about to send up a rocket in an attempt to study the X-ray spectrum of the Crab nebula, which was known to be an X-ray source. "We had to make sure whether there was or was not a pulsating source," says NRL's Gilbert Fritz. So they added to their experiment equipment that would find pulsations if they were there.

At the same time Dr. Robert C. Haymes of Rice University and two of his graduate students, Gerald J. Fishman and Frank Harnden Jr., were reminded of gamma-ray records of the Crab that they had from a balloon flight of June 4, 1967. "We didn't expect gamma-ray pulsars," says Harnden, "but as soon as we heard of the optical, we started to look."

Both efforts have been successful. The NRL group, which includes, besides Fritz, Drs. R. C. Henry, J. F. Meekins, T. A. Chubb and Herbert Friedman, flew their rocket on March 13 and found evidence of a pulsed X-ray signal coming from the direction of the Crab (SN: 5/10, p. 455). The signal came in at energies between 1 and 13 kilo-electron volts (keV).

The Rice group found a pulsed gamma signal at energies greater than 35 keV, the low-energy threshold of their detectors. This corresponds to wavelengths of less than about a third of an angstrom. (Some people call this range hard X-rays rather than gamma rays.)

In these parts of the spectrum, the pulsar accounts for something like 5 percent of the Crab's X-ray brightness.



NRL and Science

NP-0532 light (dashes) X-ray (dots)

The period of both signals is about 33 milliseconds, the same as that of the optical and radio pulses of NP-0532, and both groups identify their discoveries with it.

If these discoveries are confirmed, they mean that the one pulsar NP-0532 is emitting signals over a range of wavelengths from gamma rays at a fraction of an angstrom through X-rays (several angstroms), light (thousands of angstroms) to radio (10-millions to billions of angstroms), and all these signals are pulsed at an identical rate.

Given such a situation, the simplest possible way to explain it is to find one physical phenomenon that can produce all the radiation and ascribe the pulses to some mechanism, such as the rotation of an emitting body. Radiation produced by charged particles in a magnetic field, so-called synchrotron radiation, can appear in all these wavelengths and a plasma of such particles attached to a rotating neutron star has already been used in various ways to account for the radio (SN: 1/4, p. 9) and optical (SN: 3/1, p. 207) signals.

Prof. Thomas Gold of Cornell University, who has put forth a model of a pulsar as a rotating neutron star surrounded by a plasma trapped in a radial magnetic field, is quite pleased with the new discoveries. "Had the Crab not been an optical and X-ray pulsating device, it would have been a definite embarrassment to the theory," he says.

In Dr. Gold's theory the plasma particles are confined in sectors of the magnetic field as if they were between spokes of a wheel. The farther they get from the surface of the star the faster they go, until they approach the speed of light. At this point they break loose from the magnetic field and fly off into the rest of the nebula.

But the speed-of-light boundary will