Gyroscope flaws: Hubble spins its wheels

New equipment problems on the Hubble Space Telescope — this time electrical rather than optical — suggest the troubled craft may soon require more than corrective lenses to function properly. The failure of two Hubble gyroscopes in the past eight months and a recent electrical glitch in a third have prompted NASA to consider an emergency mission to replace these devices, which help orient the craft in space.

If two more of Hubble's six gyroscopes fail, the craft will lose its keen sense of direction — a feature vital to pointing the telescope accurately, explains John Campbell at NASA's Goddard Space Flight Center in Greenbelt, Md.

Hubble's latest woes began Dec. 3, when a feedback circuit on one of the gyroscopes ceased working. Researchers could no longer measure the gyroscope's rate of rotation — a key to gauging changes in the craft's direction. On June 29, just days after two brief malfunctions, an electronic component in a second gyroscope died. NASA scientists believe charged particles in Earth's atmosphere may have damaged one of this instrument's transistors, since the first sign of trouble occurred immediately after Hubble exited the South Atlantic Anomaly, a region of intense radiation. Researchers weren't unduly alarmed by this failure, Campbell notes, since a spacecraft needs only three gyroscopes for orienting itself and Hubble still had four working units.

Then, on July 26, electric current running through a third gyroscope suddenly increased slightly. This minor glitch has forced scientists to seriously consider sending a shuttle mission — which must be scheduled one year in advance — to replace the gyroscopes before any other problems arise. Campbell says NASA scientists will decide in September whether to request such a mission, after a panel of experts estimates the likelihood of additional failures.

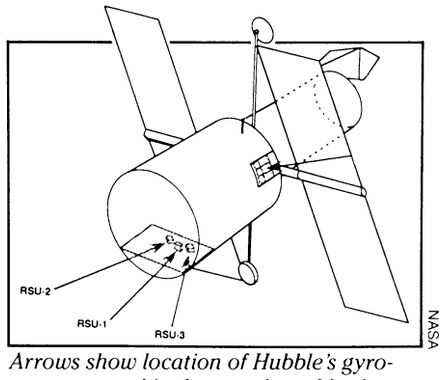
These malfunctions puzzle NASA, particularly since the agency's calculations, based in part on experience with the International Ultraviolet Explorer (IUE) satellite, had indicated that the gyroscopes would last 14 years, Campbell observes.

"Obviously, those calculations ain't worth a damn," asserts Goddard telescope engineer Henry Hoffman. "History demonstrates they don't last that long." The Hubble gyroscopes were spares, Hoffman explains, built in 1975 for IUE and given electronic upgrades in the late 1970s and the 1980s. Of six nearly identical gyroscopes in the IUE, two failed within five years of the craft's 1978 launch. Only two of IUE's devices still operate; a highly accurate sun sensor on the craft takes the place of the third gyroscope normally needed to control motion, Hoffman says, and a star tracker could likely substitute if another IUE gyro falters.

Hubble's sun sensor, by contrast, lacks the accuracy to stand in for a gyroscope, he notes. He contends NASA should have learned a lesson from IUE and equipped Hubble with instruments that could pinch hit for a failed gyro. While no one expected the devices to falter after just 15 months in orbit, he says, "I'm never surprised when one fails. Gyroscopes are always the weak link."

Pierre Bely, an engineer with the Space Telescope Science Institute in Baltimore, recalls that when scientists designed Hubble in the early 1970s, they expected frequent shuttle flights to repair parts. "Gyroscopes were meant to be replaceable," he says.

Campbell notes that the 15-year storage of the gyroscopes' mechanical parts and the wear-and-tear on circuitry during testing may have contributed to their short life in space: The two devices that failed on Hubble experienced the most electrical testing.



Arrows show location of Hubble's gyroscopes, stored in three replaceable shoebox-sized modules, in its equipment bay.

NASA already plans a shuttle mission late in 1993 to make changes that will compensate for the telescope's flawed primary mirror. But the potential severity of Hubble's gyroscope situation, as well as another problem — vibrations created by the craft's solar panels — may warrant a separate repair mission one year earlier, Campbell says. — *R. Cowen*

Gene discovery: Key to colon cancer test

Two international research teams, working independently, have isolated the gene that, when defective, causes cells of the large intestine to form polyps that may become cancerous. The discovery is expected to lead to a more definitive test for an inherited predisposition to precancerous colon polyps. It should also improve scientists' understanding of all forms of colorectal cancer, the researchers say, and may one day enable physicians to use a genetic strategy to battle the disease.

The two teams located the gene underlying familial adenomatous polyposis (FAP), an inherited disorder affecting 1 in 5,000 people in the United States. The researchers named the gene APC, for adenomatous polyposis coli. Beginning in their late teens or twenties, people who have inherited a defective copy of this gene from one or both parents develop hundreds or thousands of tissue blebs, or polyps, in the colon. Because their colon polyps are very likely to develop into cancer, most members of FAP-prone families undergo annual colon examinations, and many of those with large numbers of polyps have the colon surgically removed.

The researchers report the discovery of the APC gene in four papers: two in the Aug. 9 SCIENCE and two in the Aug. 9 CELL. Both groups concentrated their searches on a small region of chromosome 5 called the q21 band, which is missing in some people with FAP.

One group pinned down the APC gene by finding many of the genes from band q21 that are "turned on" in normal colon cells, and then determining which of those genes were damaged in patients with FAP and in patients with colorectal cancer but not FAP. The team, led by Bert Vogelstein and Kenneth W. Kinzler of the Johns Hopkins University School of Medicine in Baltimore and by Yusuke Nakamura of the Tokyo Cancer Institute, describes its work in SCIENCE.

The other group, whose results appear in CELL, took the opposite approach. The U.S. and French investigators, led by Ray White at the University of Utah Health Sciences Center in Salt Lake City, found the APC gene by searching for common mutations in the chromosome 5 q21 band of two FAP patients. To confirm that the gene shared by the two patients indeed underlies FAP, they identified APC mutations in four additional, unrelated patients with FAP.

Both teams speculate that a defect in the gene serves as the first half of the one-two punch that results in colorectal cancer. Under this scenario, cancer-prone polyps develop in people who inherit a defective APC gene and in people whose normal APC gene suffers environmentally inflicted damage. Whatever its source, the APC defect primes these individuals for a second genetic error — possibly involving the oncogenes p53 or ras (SN: 9/17/88, p.187) — that converts their polyps to cancer.

"We think a mutation in the APC gene is one of the early changes that take place in all colon cancers," Kinzler says. "It's certainly the earliest [cell change] we've found so far," agrees White. Both researchers assert that the gene's discovery will improve screening for colon cancer.