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.

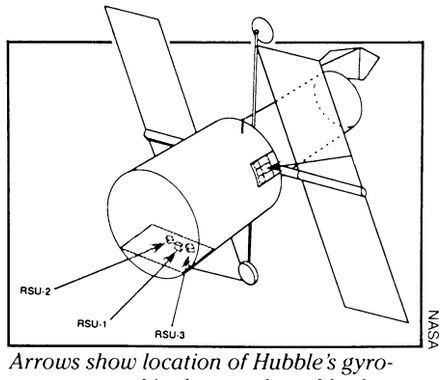
These malfunctions puzzle NASA, particularly since the agency's calculations, based in part on experience with the International Ultraviolet Explorer (IUE) satellite, had indicated that the gyroscopes would last 14 years, Campbell observes.

"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.

Earlier this year, a group headed by Malcolm G. Dunlop of the Medical Research Council's Human Genetics Unit in Edinburgh, Scotland, reported a less specific way to screen members of FAP-prone families. To assess the colon cancer risk of 41 volunteers from seven such families, these researchers looked for a set of six previously discovered "marker" genes thought to lie near the gene causing FAP. Their blood test, called a genetic linkage analysis, yielded accurate positive or negative results for more than two-thirds of the volunteers but was inconclusive for the remaining participants (SN: 2/16/91, p.103).

Dunlop calls the discovery and isolation of the APC gene "an amazing achievement," particularly considering the enormous size of the gene, which consists of more than 8,500 DNA nucleotides. But he cautions that developing a test to detect every possible cancer-causing mutation in such a gene will be "a logistical nightmare."

"There might be 100 different mutations in this gene that could cause cancer," Dunlop says. "It's not time to get rid of linkage studies yet."

Kinzler agrees, but adds that "it should be possible to find all of the mutations eventually." He says he expects that the gene's discovery will ultimately enable researchers to develop drugs that combat colorectal cancer by mimicking the effects of the normal gene, whose function so far remains unknown. — *C. Ezzell*

Security, temperament tip early coping

Psychologists generally hold that a preschool-aged child who greets a brief separation from his or her mother with a tantrum or by blocking the mother's exit exhibits clear signs of insecurity and overdependence. But a long-term study of 98 mother-child pairs indicates that such reactions sometimes reflect sound psychological growth among youngsters temperamentally inclined toward emotional distress.

Mothers of "temperamentally vulnerable" infants who respond to outbursts with immediate gestures of comfort — rather than ignoring or downplaying the squalls — may promote healthy expressions of negative feelings, such as sadness and anger, by age 3, assert psychologists Margaret Fish of Marshall University School of Medicine in Huntington, W. Va., and Jay Belsky of Pennsylvania State University in University Park.

From home observations and mothers' reports when infants reached 3 months old, Fish and Belsky rated 60 of the 98 youngsters as "more distress-prone." Mothers and babies visited Belsky's lab near the infants' first birthday; the researchers rated the security of each child's relationship with the mother based on responses to a series of brief separations, during which the child sat in a playroom with a female experimenter. At 3 years of age, children returned to the lab for a 23-minute separation from their mothers, followed by a 10-minute block-building task with the mother present.

The vast majority of tantrums that caused mothers to return before the end of the planned, 23-minute separation occurred among 3-year-olds with histories of both secure maternal relationships and emotional volatility, the investigators report in the just-released July AMERICAN JOURNAL OF ORTHOPSYCHIATRY. Moreover, these children displayed considerable comfort and motivation when subsequently confronted with the block task. In contrast, distress-prone children with insecure maternal links often tolerated the entire separation and expressed substantial anxiety, discomfort and withdrawal during the block task.

Temperamental but secure children feel confident they can satisfy their needs by expressing distress in appropriate situations, thus reaping the added benefit of improved performance on a challenging task, the researchers theorize. These youngsters' insecure counterparts may suppress distress responses and pay an emotional price later on, they add. — *B. Bower*

El Niño episode brews in the Pacific Ocean

After fooling several researchers and a few computers last year, Mother Nature has cooked up an El Niño warming in the Pacific Ocean. The climatic event started off slowly, but experts say it could intensify in the next few months, altering weather patterns around the globe.

"In the last three or four months, there's been a good trend toward an El Niño and probably at this point we'd have to say that at least a weak one is in progress," says Vernon Kousky of the National Weather Service's Climate Analysis Center in Camp Springs, Md.

The term El Niño refers to an abnormal warming of equatorial waters in the central and eastern Pacific Ocean. Changes in atmospheric pressure patterns accompany the warming, and the two phenomena can warp world weather for 12 months or more. El Niño events tend to dry out Australia and India while bringing rains to the west coast of South and Central America. They also suppress Atlantic hurricanes, says William M. Gray of Colorado State University in Fort Collins.

Several classic El Niño characteristics have developed in recent months, sparking the interest of meteorologists. Surface waters in the equatorial Pacific have warmed 1 to 1.5°C above normal in a broad belt stretching from 170°E to 5°W. Also, the normally strong easterly winds (blowing toward the west) have weakened, inhibiting the usual upwelling of cold water along the South American coast. Such changes prompted the Climate Analysis Center to issue advisories in mid-June and mid-July, announcing the beginning stages of an El Niño.

At present, though, several important El Niño features have yet to materialize. Thunderstorms and atmospheric convection have not moved from the west into the central Pacific and warm water has not appeared immediately along the west coast of South America. Kousky says the next few months should reveal whether the El Niño will intensify or not.

Despite its currently weak state, the warming may already have enough strength to affect distant weather. Partly because of the developing El Niño, Gray forecasts a lower-than-normal number of Atlantic hurricanes this year.

The appearance of the warm waters comes as welcome news to Stephen Zebiak and Mark A. Cane of the Lamont-Doherty Geological Observatory in Palisades, N.Y., whose computer model began predicting one year ago that an El Niño would occur around now. Zebiak and Cane have a model that mimics both ocean and atmospheric currents. Most researchers believe changes in the interaction between ocean and atmosphere drive the development of El Niños.

A statistics-based model at the Scripps Institution of Oceanography in La Jolla, Calif., also called for an event developing during the summer, says Tim P. Barnett. The Scripps model forecasted a weak El Niño, like the one currently in progress. But if the warming intensifies significantly, Barnett says he will have to call this forecast a bust. He plans to run another forecast using more recent weather data to see if the model predicts anything more substantial.

James J. O'Brien at Florida State University in Tallahassee says his dynamical-statistical model called for slightly warm conditions but did not forecast an El Niño this year.

Modelers agree that weak events are the most difficult to predict. Last year, the central Pacific warmed slightly and human forecasters at the Climate Analysis Center issued an advisory, alerting scientists to the beginning of a possible El Niño (SN: 3/3/90, p.135). O'Brien's model and a German one even predicted an El Niño episode for that year. But the warming trend reversed, leaving both human forecasters and those computer models out in the cold. — *R. Monastersky*