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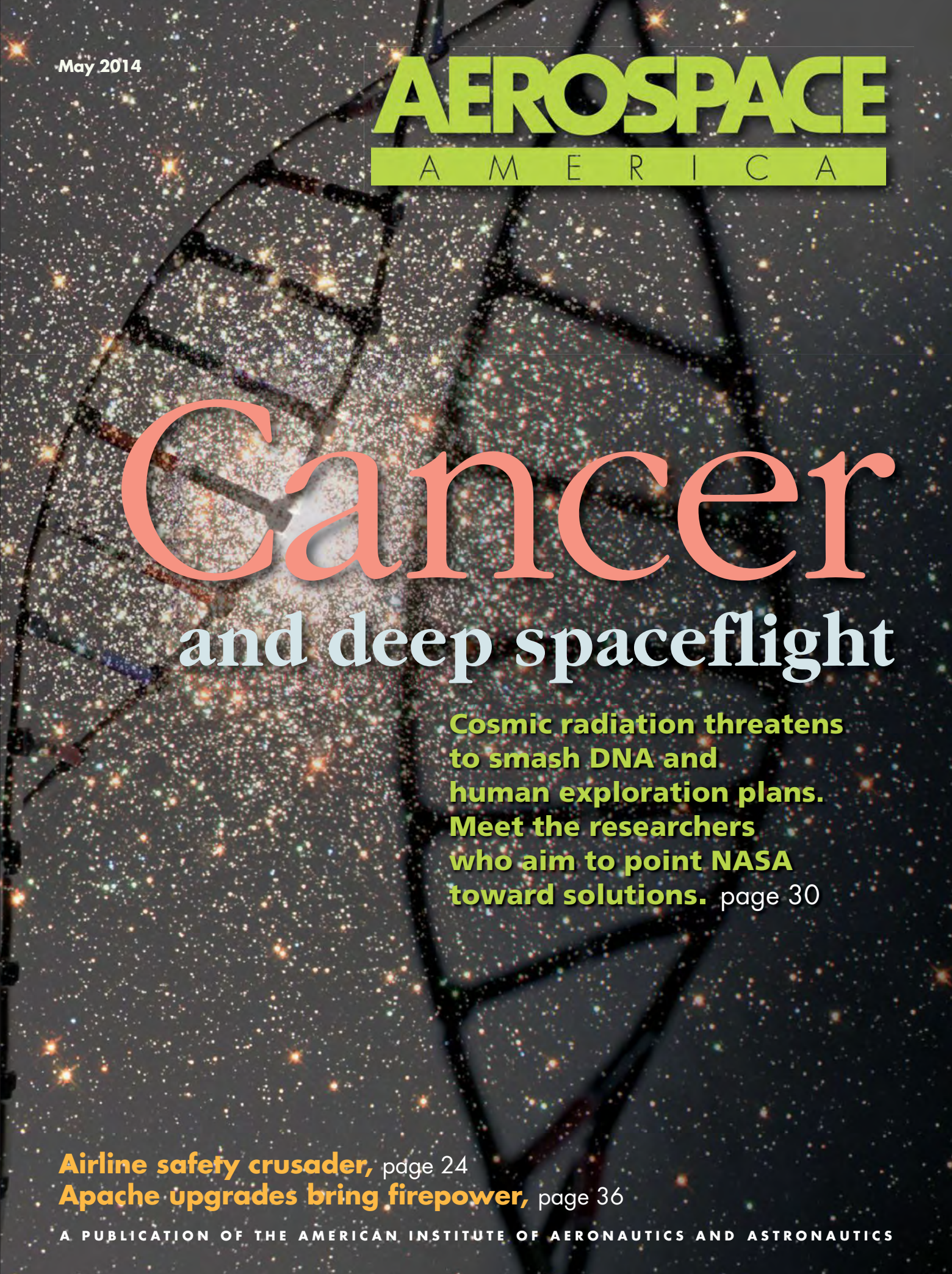

Cancer and deep spaceflight

Cosmic radiation threatens to smash DNA and human exploration plans. Meet the researchers who aim to point NASA toward solutions. page 30

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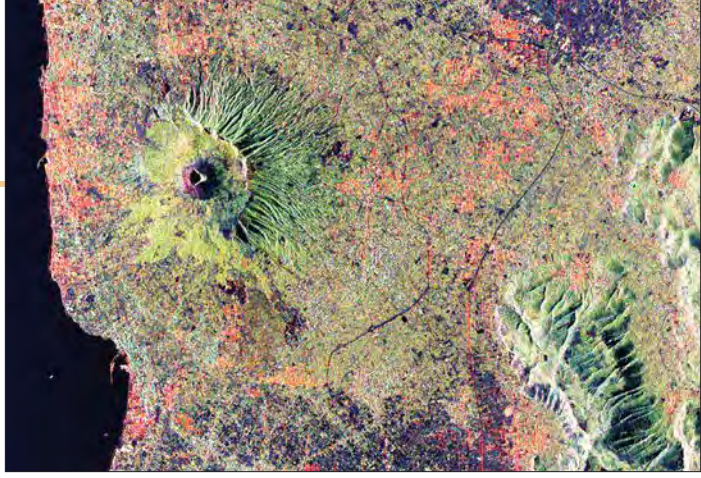
Fresh look at Earth

Twenty years ago, six astronauts aboard the shuttle Endeavour recorded stunningly detailed radar images of Earth's geology, biosphere and oceans. One of those aboard was Tom Jones, who looks back on the STS-59 mission and its significance.



NASA

Italy's Mt. Vesuvius in a 1994 image from the Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar, SIR-C/X-SAR. Radar echoes were stored on tapes aboard shuttle Endeavour for processing later.

For 11 days in April 1994, a thousand-mile vista filled my office window. Each time I glanced outside, I plunged into a view saturated in geography, science, culture and history. It was my introduction to spaceflight.

The scientific target of my first space mission was our own familiar Earth. Yet from the space shuttle Endeavour, circumnavigating the globe every 90 minutes at an altitude of 222 kilometers, it was a world of endless wonder. From our unique vantage point, we would scan our changing planet with the Space Radar Laboratory-1. The science team in Houston used our payload computers to command three flat radar transceivers mounted on a massive truss in the payload bay. This radar instrument was known as SIR-C/X-SAR, short for Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar. The radars bounced a sharp beam of radio energy off the varied surface below, collecting echoes for processing into imagery. This prototype radar imaging system, a joint product of NASA's Jet Propulsion Lab and the German and Italian space agencies, would examine more than 400 science targets across the globe and show details as small as 25 meters across. The objective was to demonstrate the broad utility of a space-based SAR, synthetic aperture radar, in experiments across the range of Earth sciences.

Endeavour would provide power, aim the flat, 12-meter-long SAR antennas at science targets, and record and transmit imaging data. Our crew would provide onboard troubleshooting, data recording, and visual observations of the science sites in parallel with the radar. After return to Earth, SRL-1 would be adjusted, repaired and launched again.

For me, a planetary scientist and pilot, helping operate one of the most sophisticated observatories ever flown in orbit was a fantastic opportunity. But on my first trip, the stakes were high: I would have to perform my crew and scientific duties with near perfection, all while adapting to a strange and unfamiliar environment. Watching me would be my family, my crew, Mission Control and all of NASA. A single question dominated my thoughts during two and a half years of training: Would I measure up?

When Bob Sieck, our launch director, cleared us for launch with a "Vaya con Dios," I added my own plea to heaven for success and safety. Endeavour's twin solid rocket boosters exploded into life at T-minus-zero, kicking us with a massive jolt that was nevertheless a welcome relief from the tensions of the countdown. We were on our way: I felt our ship roll toward our 57-degree launch azimuth, even as 7 million pounds of thrust rattled our cabin and pierced its walls with a spine-tingling scream of power.

When the spent boosters tumbled away at Mach 3, some 30 miles up, I reached out instinctively to grip the gloved right hand of Linda Godwin, my friend and payload commander, seated just to my left. A couple of minutes later, Endeavour's commander, Sid Gutierrez, called down to me on the middeck intercom: "Congratulations, Tom! You're now an astronaut!" The others — Jay Apt, Kevin Chilton and Rich Clifford, along with Sid and Linda — had all been to space before, and now I'd qualified for my own NASA wings. But a successful mission and return still lay 10 days and 7 million kilometers ahead.

We'd grown up on this world, but none of us had really seen it until we witnessed its beauty and complexity from above.

Eight and a half minutes after launch, we soared into orbit with main engine cutoff. I toyed with my first moments in free fall by removing my left glove, turning it loose to tumble a foot from my face. For just a moment, I was a kid waking up on Christmas morning.

Play could come later. Our mission clock was running, and all hands turned to outfitting Endeavour for orbit and activating the SRL. We raced to doff our suits, stow the cabin seats, and equip the flight deck for science operations. The flight plan and the digital readout of the bulkhead clock were our relentless taskmasters, driving us daily from the first insistent beep of our wakeup alarm until our designated bedtime, 16 hours later.

On the job in orbit

That first night in orbit, I'd struggled to shake off adrenaline and catch five hours of restless sleep while our crew's Red Shift — Sid, Linda and Kevin — activated the payload bay radars and an accompanying atmospheric carbon monoxide sensor. Jay, Rich and I, on the Blue Shift, relieved them some 12 hours after launch. Our orbital routine was 12 hours on, 12 hours off.

On Earth, Jet Propulsion Lab controllers, along with their German and Italian colleagues and partners, commanded each radar data take. On orbit, our responsibility was to point Endeav-

our precisely at each target, keying dozens of entries into the flight computers, a process repeated 412 times during the mission — a shuttle program record. Sid once remarked to the press that his biggest challenge as commander was ensuring we set up and initiated each of these maneuvers flawlessly, so as not to miss a single science opportunity for the SRL's far-flung experimenters. We all enjoyed this chance to "fly" the orbiter so precisely, setting up the targeting coordinates, getting confirmation from Mission Control, then watching the thrusters pirouette the orbiter to track the target and reduce radar image smear caused by Earth's rotation.

Radar echoes at L-, C- and X-band were processed into a flood of imagery streaming in at 150 megabits per second, triple the speed at which Endeavour could radio it to Earth. So my crew pampered and fed three Schlumberger high-speed data recorders adapted from military reconnaissance aircraft. These recorders, installed on the aft flight deck, each filled a 50-gigabyte cassette in about 30 minutes.

We fed the machines a steady diet of these overgrown VCR tapes, stowing precious stacks of the full ones in our middeck lockers. It was a mundane job in some ways, but absolutely vital and time critical: None of us wanted to lose a data take because a tape wasn't loaded and ready. Some data was piped to the ground, but two-thirds had to be stored on 110 cassettes, each of which was literally worth more than a million bucks, representing a discrete fraction of the resources invested in the SRL mission by NASA and its partners. We couldn't see this valuable imagery in real time, so the science team in Houston regularly relayed samples up by fax, giving us a good sense of the variety and quality of the data we were getting.

Without question, our most rewarding duty on STS-59 was to operate our flight deck camera suite — 14 still, movie and video cameras used to document environmental conditions and help interpret the radar imagery. We worked hard to cover each daylight target with video and wide- and narrow-angle still imagery. Obtaining those 14,000 images forced us to become very familiar with our home planet's features. Our months of geography and Earth science studies, learned in the classroom and the field, paid off as we swept across active volcanoes, migrating dune fields, fertile farm districts, tectonic faults, sunlit ocean currents and the circular scars of asteroid and comet impacts. We'd grown up on this world, but none of us had really seen it until we witnessed its beauty and complexity from above.

As on any spaceflight, we encountered the unexpected. Three days in, our galley rehydration station was injecting our drink packages with air as well as water, bloating the stomachs of several astronauts. Flight controllers improvised a repair technique using spare rubber washers from the toilet system. A stray grain of asteroid dust or space junk pitted the outer pane of our side hatch window. A short circuit sent sparks and smoke swirling from a camera power cable; we installed a spare. One of the C-band antenna panels failed late in the mission, but its loss didn't appreciably affect image quality, and it was replaced after landing in time for SRL-2 in September. Near the end of our flight, one of our high-rate recorders dropped offline, but Jet Propulsion Lab controllers re-routed the radar data to the remaining pair without missing a beat. In scanning a carefully chosen 12 percent of the planet, the SRL-1 team returned 47 terabytes of imagery, enough to fill 20,000 paper encyclopedia volumes (remember them?).

For me, STS-59 was 11 days of a flat-out, scientific sprint, but I was in love with spaceflight. Who wouldn't be, as each day brought dozens of opportunities to explore this marvelous globe anew.

Hundreds of space shuttle crewmembers experienced similar rewards during the program's 30-year span. The International Space Station is a much more capable laboratory, but cannot match the orbiter fleet in variety and number of payloads, probes, satellites and experiments deployed, many returned to be refurbished and flown again. Today we lack the regular access to orbit provided by the Space Transportation System, and its ability to integrate, launch and execute a completely different scientific mission every few months. As a spacefaring nation, we need more than space taxis to our orbital outpost. We need a far-reaching vision, and the versatile vehicles to carry it out at new and distant scientific frontiers.

Flat radar antennas in Endeavour's payload bay are lit by the aurora australis, or southern lights, in a photo from the flight deck.

As Endeavour's tires touched Earth again after 11 days, 5 hours and 49 minutes in space, perhaps my biggest satisfaction had come from being part of a team of six — professionals and friends aloft, and hundreds of ingenious, talented scientists and engineers on Earth, all working toward a new understanding of our home world. When I stepped from Endeavour with my crewmates on that day in 1994, I knew that whatever my future held, no terrestrial worries or challenges could ever take back that sense of accomplishment. I thank all those who made that voyage possible.

Tom Jones detailed STS-59's journey with the Space Radar Lab in "Sky Walking: An Astronaut's Memoir."

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