



Alan Stern reviews spacecraft instructions outside New Horizons' mission control room.

PHOTO: PAUL FETTERS

# MISSION CONTROLLER

How Alan Stern's tenacity, drive, and command got a NASA spacecraft to Pluto

By Eric Hand

**T**he video cameras are poised. Alan Stern is loath to miss a cue. Dressed in all black, he strides across the parking lot. Short in stature, Stern has legs that move faster than most people's, and a mind that is generally several steps ahead, too. The camera crew, from the Japanese network NHK, is one of four following Stern, a planetary scientist from the Southwest Research Institute (SWRI) in Boulder, Colorado. They draw a bead on him for an early morning establishing shot. Stern executes a quick flyby. "Hi, Mom," he says, giving a thumbs-up as he enters the space science building at Johns Hopkins University's Applied Physics Laboratory (APL) in Laurel, Maryland.

Above him in the atrium dangles a half-

size replica of New Horizons, a NASA spacecraft. Its life-size twin is now cruising through space nearly 5 billion kilometers from Earth, adding more than a million kilometers to its journey each day. The spacecraft is surprisingly small, not much bigger than Stern. But, like him, it is packed with purpose. It is swaddled in layers of foil to protect its instruments and computers from the searing cold. Solar panels would be pointless so far from the sun, and so an engine of radioactive plutonium pulses inside. The backside is dominated by a large radio dish, necessary to talk with Earth across an expanse that takes 4.5 hours for light to traverse.

New Horizons is closing in on Pluto, once thought to be the last of the planets and a lonely outpost on the solar system's edge. Discovered in 1930, Pluto has re-

mained something of a cipher, despite the best efforts of telescopes in space and on the ground. Its changing atmosphere and variegated surface remain mysterious, and even its size is not precisely known. In 2006, Pluto was demoted to a dwarf planet, a move that still annoys Stern. Yet in a karmic reversal, Pluto's scientific and public popularity—its brand, Stern might say—has soared. Pluto is now not the final stop in the solar system, but a gatekeeper to a new frontier: the Kuiper belt, a region of thousands of small icy bodies beyond Neptune's orbit that was theorized by astronomer Gerard Kuiper in 1951 but confirmed only in 1992. No longer the smallest of the planets, Pluto is the king of the Kuiper belt.

On 14 July, New Horizons will zoom past it—50 years to the day after Mariner 4 flew

past Mars and returned the first pictures from another planet. Stern has been working toward this moment for half of that half-century: 10 years to muster political and scientific will for a mission, 5 years to build the spacecraft, and nearly 10 years to make the trip. He is the principal investigator for the \$700 million mission—the largest and most expensive one ever controlled by a non-NASA employee. Now he is 99% of the way there.

Stern has traveled from Boulder to APL on this day in May to kick off the final science team meeting before the encounter. In a conference room, 50 people hunch over their laptops. On a screen overhead, a video rouses the team: an electronic anthem mashed-up with snippets of control room dialogue from the Apollo 11 moon mission. “Guidance? Go! Control? Go!” shout the ghosts of mission controllers past. Hal Weaver, the project scientist for the mission and a laid-back foil to Stern and his intensity, says, “Alan is going to have this choreographed.” In the 30 days prior to reaching Pluto, Stern wants different pep songs played each morning.

Stern takes the podium. Although everything is going great, he says, there are things that could still go wrong. “If it’s bugging you, let’s make sure we bring it up,” he says. His words are cautious, but his tone—commanding, emphatic, confident—is devoid of doubt. “We have the eyes of the world on this mission. It is unlike any other mission in recent history in terms of the expected level of attention. And in addition, we only get one shot at it. It’s not an orbiter. It’s not a lander.” It’s a flyby, at Mach 42, and Stern must wring as much out of the short-lived encounter as possible.

Landings on planets (and comets) advertise their complexity with parachutes and airbags, harpoons and retrorockets. Even orbiters, with the tricky, fiery burn of orbital insertion, contain an element of drama. In comparison, a flyby seems a walk in the park—just gravity in motion, and a few clicks of a camera shutter. So you’ll forgive Stern for emphasizing how complicated the flyby actually is. In the 9 days of “core encounter”—7 days before closest approach on 14 July to 2 days after—New Horizons will run through 20,799 commands. It must scan the path ahead for hazardous debris, make minor trajectory corrections, and point instruments for 461 scientific observations as it passes within 12,500 kilometers of Pluto’s surface. In the hours just after closest approach, the spacecraft must pass through two tiny keyholes in space—the shadows of

Pluto and its largest moon, Charon—so that it can use the eclipsed sun as a backlight to examine the thin ring of atmosphere around each body. As it leaves the system of five moons (at last count), New Horizons will continue to stare, and image Pluto’s dark side by Charon’s moonlight. “Despite the fact that we’ve done a lot of practicing, we can’t simulate everything,” Stern says. “My biggest concern is what we haven’t thought of.”

There are 249 contingency plans in place, attempts to identify—and then mitigate—all known risks. They include not just risks to the spacecraft, like clouds of debris lurking among Pluto’s moons, but also those on the ground. Should something happen to the main mission control room, for example, New Horizons can be operated from a backup building at APL. There is even a backup to the backup: The team has prepped a minimalist control room—basically a New Horizons-compatible computer—



Scientific enthusiasm at age 6.

at the Jet Propulsion Laboratory (JPL) in Pasadena, California.

And, oh, the practicing. Stern boasts of having performed 35 operational readiness tests—dress rehearsals for various aspects of the mission. In the biggest of these tests, 2 years ago, the spacecraft was put through the motions of its 9-day encounter, somewhere in the void between Uranus and Neptune, its instruments successfully returning precisely framed pictures of empty space. It’s not just about smooth operations; the team has also practiced making a splash. There have been three so-called *New York Times* readiness tests, in which the science team interpreted fake data on the fly, under time constraints, and produced press releases meant to be headline-worthy. To help, Stern hired six journalists, had them sign nondisclosure agreements, and embedded them within the science team. “I’d never heard of it,” Weaver says. “Several of us pushed back and said, ‘You know, we’re literate people. We can write our captions.’” Stern was unpersuaded.

One does not get to the edge of the solar system by leaving things to chance. “This mission would not be flying unless he had shoved it down the throat of NASA,” says Stern’s longtime SWRI colleague, Hal Levison. “His force of will and his tenacity played a role in what’s happening right now.”

**SOL ALAN STERN WAS BORN** on 22 November 1957, in New Orleans, Louisiana, the first of three children for Leonard and Joel Stern. He was a fussy baby, difficult to put down to bed. Taking him outside to see the moon seemed to induce sleep. “After many, many repeated applications of that, the first word out of his mouth was ‘moon,’” says Leonard Stern, his father. “Not ‘mama’ or ‘dada,’ but ‘moon.’”

His fascination with celestial objects was galvanized by the space race of the 1960s. He sneaked out of bed to watch late-night TV broadcasts of the Gemini and Mercury

flights. He exhausted the local library’s selection of space books. He devoured the science fiction of Isaac Asimov and Arthur C. Clarke. But he wanted more. “During one of the Apollo missions, I saw Walter Cronkite showing off the flight plan,” he says. “It just mesmerized me. All this detail! That’s what I wanted.” He requested the materials from NASA, but was told he had to be a journalist or an author. So in the early 1970s, he wrote a book—about a hypothetical mission to a comet. His grandfather’s secretary typed up the 100-plus pages, and Stern sent it off to NASA. “Next thing

you know, a box this big shows up at my house, filled with Apollo manuals.” By then, the family had moved to Dallas, Texas, and Stern was enrolled at St. Mark’s, a prep school with a planetarium, an observatory, and an astronomy club. “That is all my brother ate, drank, slept, and breathed,” recalls his brother, Leonard “Happy” Stern. “Everything in his being was about how to be in space.”

He was gaining other skill sets, too. In 1976, while NASA was landing the Viking probes on Mars, Stern finished his freshman year at the University of Texas (UT), Austin, and took a summer job selling Collier’s Encyclopedias. After a tutorial from his father, a salesman for a chemical company, he spent a couple of months crisscrossing the state, knocking on doors. He netted several thousand dollars, enough to trade in his beat-up Buick Skyhawk for an Oldsmobile Cutlass.

Stern has told his father that 80% of what he does now is a sales game. “He learned that selling those encyclopedias, and he’s



Stern trains for suborbital space flight in an F-104 jet in 2012.

never forgotten it," Leonard says. Stern demurs. "I object to putting [the Pluto mission] on par with selling encyclopedias," he says. "If you equate the two, it does a disservice to all the other people involved."

Articulate in front of a microphone and at ease in front of a camera, Stern is an eager media subject, sometimes to the irritation of his colleagues. "He likes to generate press for himself, and he is sort of making [the mission] about him," says Levison, one of the few people confident enough in his friendship with Stern to say so. Stern is aware of the criticism, and he declared his qualms about this profile at the outset. "There has to be a recognition that it's not the Alan Stern mission," he said.

Besides honing his talent for persuasion, the young Stern was becoming a careful planner. After graduating from UT in 1978 as a physics major, Stern re-enrolled as a master's student, and roomed with his brother. Happy Stern recalls discovering Alan's day planner. It included not only a 5 a.m. wake up, but also entries, 5 minutes apart, for showering, brushing his teeth, and combing his hair. "You don't think this is a little strange here, pal?" Happy asked him. To this day, Stern carries a sheet of SWRI stationery with him 7 days a week, a black-inked to-do list on which every entry is to be scratched out in red ink by bedtime.

**STERN GOT HIS FIRST TASTE** of Pluto while a graduate student. Charon had just been discovered in 1978, and astronomers had seen hints that Pluto has an atmosphere—one that would experience strong seasons because of Pluto's highly elliptical orbit and

large tilt to the sun. For his master's thesis, Stern modeled the range of atmospheric possibilities. The scope for creative work was enticing, he says. "It was like a green field. You could go anywhere with this."

Stern pursued a double master's, in aerospace engineering and planetary science, in hope of becoming an astronaut candidate. He also became a certified pilot and flight instructor. He met his wife, Carole, while teaching a ground-school flying class, and later proposed to her under the Saturn V rocket on display at NASA's Johnson Space Center in Houston, Texas. "You don't forget that, I'll tell ya," she says.

Stern never made the cut as an astronaut, in part because of a detached retina. So he did the next best thing: He built instruments for astronauts. By 1983, he was working as an engineer at the University of Colorado's Laboratory for Atmospheric and Space Physics. He became the project scientist for Spartan Halley, a small satellite designed to study Halley's Comet, and the principal investigator for the Comet Halley Active Monitoring Program, an experiment in which a crew member aboard the space shuttle would take pictures of the comet with a specially adapted 35-millimeter camera. Both instruments were loaded on the space shuttle Challenger for launch on 28 January 1986.

"Dick Scobee, Ron McNair, Judy Resnik, [Ellison] Onizuka, Mike Smith." Stern recites the names of five of the seven crew members who died that day when Challenger dis-

integrated just after launch, people he had trained and knew well. Stern was in Florida for the launch. Then he saw the disaster replayed again and again on the news. "Even if you tried, you couldn't get away from this," he says. It was not just a human loss for Stern, but also a professional disaster, his brother says. "Now he doesn't have a plan, and my brother had a plan for brushing his teeth. I think he was a little lost then."

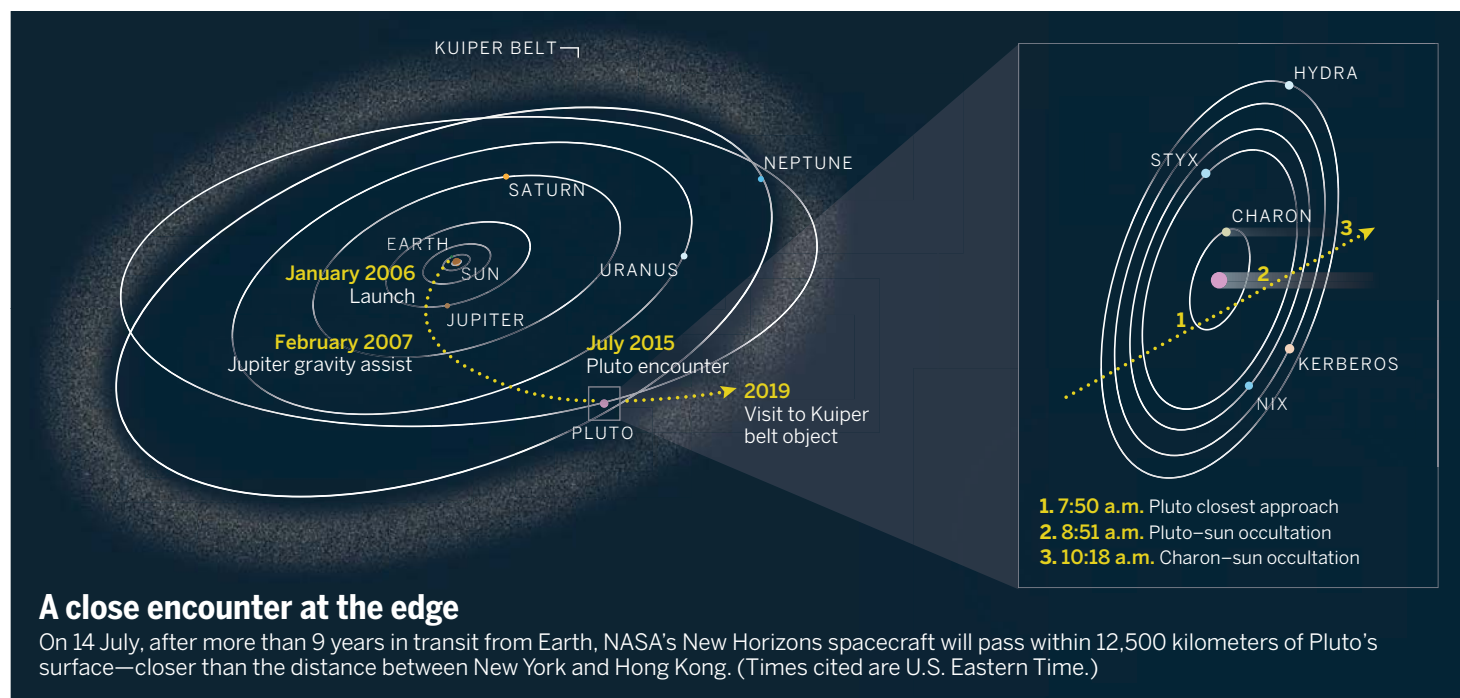
Stern did not stay down for long. He published his first book, one that seemed to be something of a therapy session. It was called *The U.S. Space Program After Challenger: Where Are We Going?* Then he went back to school. He finished his Ph.D. in 1989, in just 3 years, writing a dissertation on the evolution of comets and their detectability around other stars. The scientifically minded engineer had become a scientist for life.

Not only that, but also a scientific empire builder. Knowing he was not cut out for an academic job—you can imagine his patience tested by faculty senate meetings—Stern found a home at SWRI headquarters in sleepy San Antonio, Texas. SWRI, a soft-money research institute, did most of its business with the Department of Defense. Stern made a pitch to his bosses to stake out a new SWRI outpost in Boulder, devoted to space science. Stern arrived in 1994—just him, a postdoctoral researcher, and a secretary. His first recruit was Levison, an expert on modeling planetary orbits and collisions. "A lot of people [at SWRI] were nervous



Pluto on 18 June at a distance of 31.5 million kilometers.

PHOTOS: (TOP TO BOTTOM) STARFLIGHTERS, INC.; NASA/JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY/SOUTHWEST RESEARCH INSTITUTE



## A close encounter at the edge

On 14 July, after more than 9 years in transit from Earth, NASA's New Horizons spacecraft will pass within 12,500 kilometers of Pluto's surface—closer than the distance between New York and Hong Kong. (Times cited are U.S. Eastern Time.)

about taking that sort of risk," Levison says. "Alan in his mastery of politics made it all work." The SWRI Boulder operation today employs 55 scientists and takes in \$40 million a year in revenue.

**AS STERN'S STAR ROSE**, so did Pluto's. For the first 4 decades after its discovery, little could be said about Pluto except that it was small, reddish, and frigid. Even its orbit—observed so far only a third of the way through its 248-year circuit of the sun—was poorly understood. After Charon's discovery, astronomers could watch its dance with Pluto to calculate both bodies' masses. Then, in 1985, Charon and Pluto began eclipsing each other. Ground-based telescopes could barely resolve the two disks, but by measuring the peaks and dips of reflected light as the two orbs passed in and out of each other's shadows, astronomers discovered that Pluto was about half as big as previously thought, and brighter than Charon. In 1988, Pluto eclipsed a distant star, and the light shining around Pluto's edges afforded the first definitive evidence of an atmosphere.

Then came a sign that Pluto was not alone: the 1992 discovery of the first Kuiper belt object (KBO). Pluto, it seemed, represented a much larger class of icy bodies. And because KBOs are thought to be unaltered since the birth of the solar system 4.5 billion years ago, Pluto held the potential of unlocking insights into the earliest days of planet formation.

By the mid-1990s, astronomers were clamoring for a visit, and soon. In 1989, Pluto reached perihelion—the closest point

to the sun in its elliptical orbit. Scientists wanted to get there before Pluto began its slow retreat from the sun and temperatures plummeted, collapsing its atmosphere into frozen nitrogen. What's more, a spacecraft launched between 2001 and 2006 could take advantage of Jupiter's gravity for a slingshot effect that would shave years off the trip.

The Pluto Kuiper Express, a mission concept led by JPL, got the farthest. But in 2000, NASA science chief Ed Weiler canceled the mission when its projected costs surpassed \$1 billion. Later that year, Weiler was persuaded to try something different: a Pluto competition. A competition for low-cost planetary missions led by principal investigators from outside NASA, called Discovery, had already yielded innovative proposals costing just hundreds of millions of dollars, well short of the billion-dollar budget of a flagship NASA mission. With target costs in the half a billion dollar range, a Pluto competition would sit somewhere between a Discovery mission and a flagship. NASA announced the competition on 20 December 2000.

Stamatios "Tom" Krimigis, then the space department head at APL, leaped at the chance. At that point, only JPL had been trusted to build and operate NASA's big planetary missions. But in 1996, APL had launched NASA's first Discovery mission, an asteroid orbiter. With JPL's budget-busting tendencies, Krimigis knew that APL would have a chance. And he knew exactly who should lead the proposal: Alan Stern. "He was the personification of the Pluto mission," Krimigis says. "He was single-minded,

and I liked his style."

The duo inked an agreement 2 days after the NASA announcement and began assembling their team. The final proposal was due on 18 September 2001—1 week after the terrorist attacks in New York City. With APL shut down, Stern created a "war room" in a nearby hotel to put the finishing touches on it. In the end, though, it wasn't much of a competition, Weiler says. "Alan was the clear winner."

That was just the beginning of the fight. The Bush administration had installed a new NASA administrator, Sean O'Keefe, who was no fan of the mission, and was instead pushing the idea of nuclear fission-powered spacecraft. When the federal budget request for 2003 came out, in February 2002, the administration had zeroed out the Pluto mission, effectively canceling it.

Weiler challenged Stern to rally planetary scientists' support for the mission in the decadal survey, a once-a-decade, prioritized wish list that's meant to reflect science's unified voice. For months, Stern lobbied tirelessly. When the report appeared in July 2002, the Pluto mission held the top spot in the medium-size mission category, ahead of missions to the moon and to Jupiter. "That's what really broke the logjam," Weiler says. "My administration was not going to fight that."

Stern's team raced to build New Horizons before the gravity assist window closed. The finished spacecraft carried seven instruments, including a student-built interplanetary dust counter and a sensor to mea-

### VIDEO

For a video interview with Alan Stern, see <http://scim.ag/AlanStern>.

sure the energy of particles escaping from Pluto's atmosphere. Novelties were also stowed aboard: cremated ashes of Pluto's discoverer, Clyde Tombaugh; an old U.S. stamp of Pluto with the caption "Not yet explored"; a piece of SpaceShipOne, private space company Virgin Galactic's first suborbital space vehicle; and two quarters: one from Maryland, whose Senator Barbara Mikulski had given the mission crucial support at its lowest ebb, and one from Florida, where then-Governor Jeb Bush had signed off on the launch of the plutonium-laden spacecraft.

On 13 January 2006, Stern, wearing a clean-room suit and a radiation counter, went to the top of an Atlas V rocket to take one last look. The probe had just been filled with plutonium. Stern posed for a picture, and New Horizons was shut within the payload bay. The Atlas had been souped up with extra boosters and a never-before-used third stage. Six days later, it launched like a bottle rocket, going supersonic within 30 seconds. "This was not a stately shuttle launch," Stern says. New Horizons left Earth faster than any spacecraft ever before.

**WITH 9 YEARS TO GO** until Pluto arrival, Stern suddenly had a lot more time on his hands. But not for long. In 2007, NASA Administrator Mike Griffin asked Stern to come to Washington, D.C., to lead the

ing it to hold \$4 million of money planned for two operating rovers, Spirit and Opportunity, as a reserve for Curiosity. Stern was soon accused of shutting down the beloved older rovers. Griffin, learning about the letter from the media, reversed the decision.

Stern says the \$4 million was just a footnote; he and Griffin disagreed more generally over how to apportion the pain of Curiosity cost overruns. "I said, 'You need to find someone else who can deal with that, because I can't stomach it,'" Stern says. He offered his resignation, and Griffin accepted it.

Weiler returned to Washington to resume his old job. Stern had overestimated the power of the position, Weiler says: "He had a hard time realizing you get to make very, very few decisions."

It was the second time in Stern's life that he had suffered a big loss. Once again, he dusted himself off. He returned to SWRI as a half-time employee. His other time was spent consulting for commercial space companies such as Virgin Galactic and Blue Origin and also setting up a few of his own—some of which have raised eyebrows (see sidebar, right).

But for now, Stern's focus is squarely on Pluto. He will be living out of a hotel near APL for the coming weeks, enduring 4:30 a.m. wake-ups and battling his inbox, which at its peak reaches 500 emails a day. At the science team meeting, Stern is about to leave the podium and retreat to a corner table. There, flanked by his assistant, he will whipsaw between email, Twitter, Facebook, and Space.com, one eye always on the proceedings. But before he sits down, he leaves his troops with one last thought. "I said this when we won the project," he says. "It's true again. Our time is finally here."

**STERN'S RESTLESSNESS** has many people wondering what he will do after the Pluto mission. That won't be for a while. In August, the team will choose the mission's next target: a small KBO. There are two candidates, each about 50 kilometers across and reachable in 2019. New Horizons' next milestone will occur in the late 2040s, when it crosses the edge of the solar system, where the thin wind of particles from the sun peters out—though the spacecraft's plutonium engine will have faded away a decade earlier. After exiting the solar system, New Horizons will wander the galaxy interminably, a relic that will outlive Earth, when the sun goes red giant and swallows it up.

Leonard Stern sees a similar inexhaustibility in his son. "I don't see Alan cutting back. He's just not built that way. I think he thinks there's just so much more that he needs to know. Nobody's driving him but himself." ■

## Alan Stern's worldly ventures

By Eric Hand

**A**lan Stern's salesmanship helped get New Horizons to Pluto. He has a few other things for sale as well: a trip to the moon for \$1.55 billion, and naming rights to a crater on Mars for \$5. Those are the signature products of Golden Spike and Uwingu, two of his companies. Golden Spike plans to send a two-seat lander to the moon, staging material in Earth orbit using commercial rockets. Governments with space ambitions—the target customers—have not lined up to buy tickets, but Stern insists that the company has made progress. "Absence of evidence is not evidence of absence," he says.

Uwingu has had more immediate impact, albeit on a smaller scale. Uwingu raises money for space research through campaigns, such as selling naming rights to martian craters on an unofficial Uwingu map (the bigger the crater, the more expensive the name). Founded in 2012 with a nearly \$80,000 crowd-sourcing campaign, Uwingu is a for-profit company. Half of the revenues go into a fund for scientific grants—between \$130,000 and \$150,000 in 2014, Stern says.

Stern and other workers each pay themselves about 1% of the other half of the take. "It's a very small amount of money," he says. Asked if the naming campaigns are a way to poke at the authority of the International Astronomical Union, which is officially in charge of crater names and which rankled Stern by reclassifying Pluto as a dwarf planet in 2006, he says, "honestly, I get a chuckle when I hear that."

Ralph McNutt, a New Horizons scientist at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, says that as an entrepreneur, Stern takes the buckshot approach, throwing up ideas, unsure which ones will stick. "If anybody can pull a rabbit out of the hat in all of this, it's Alan," he says. "But sometimes, I'm not sure if there's a rabbit." ■



Stern speaks to the New Horizons science team in May.

agency's \$5 billion science division. Upon arrival, Stern asserted his vision of fiscal discipline. He came down hard on missions such as the exoplanet-hunting Kepler telescope, denying it extra funds. He tried to discipline NASA's costly array of Mars missions, too.

Curiosity, the \$2.5 billion, JPL-built Mars rover, was running hundreds of millions of dollars over budget in an effort to meet a 2009 launch window. Stern wanted to limit the pain to JPL and, more generally, to the Mars program, to ensure that other science wouldn't suffer. In March 2008, he had a subordinate dispatch a letter to JPL order-