# Air and Space this Week

## Item of the Week

# ED STONE

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**KEY WORDS: Ed Stone Voyager JPL**

*I was all set to write about the Manned Orbital Laboratory Program this week, but the passing of Ed Stone, who for 50 years managed the incredibly-successful Voyager program, is too important a person not to honor immediately! Three previous Items of the Week spotlight the Voyager missions (here, here, and here); now it's time to find out more about the amazing scientist behind them!*

## THE A-V STUDENT

Edward Carroll Stone, Jr., was born in Knoxville, Iowa, on January 23, 1936. His family owned and operated a small construction company in nearby Burlington. His father instilled in young Ed a joy of learning about how things work by having him help work on the car and other equipment of the day. Ed quickly learned how to operate, trouble-shoot, and repair all sorts of electrical devices.

Remember back in the day, when in-class 16mm movies became available? Teachers needing a break, or were in over their head, had a new tool to help them out with subject material. But those old-style projectors were a bit touchy to operate and maintain. Like today, the young kids had the skills, and became the squad operating the school audio-visual equipment. Ed Stone was one of the best in junior high school. He would earn spending money in high school working at a local department store and playing French horn in the hometown band.

Ed went on to the local community college, earning an AA in Physics. His work and grades were good enough to allow him to enroll in the Physics program at the University of Chicago, in 1957.

## UNIVERSITY OF CHICAGO

The University of Chicago admission put Ed in a position to succeed, and while there he enjoyed a "nicety of timing" that would shape his career. *Sputnik 1* launched on October 4, 1957 (the very same day *Leave it to Beaver* premiered!). That changed everything, especially in the world of Physics. The Space Age had begun, along with its Cold War manifestation.

Ed was already interested in cosmic rays, the enigmatic high-energy particles from interstellar Space. He was able to join a team at University of Chicago that was designing and building instruments to be flown on our first satellites. His junior high AV stint paid off!

Ed's dissertation advisor was John A. Simpson, had worked on the Manhattan Project in WWII, and was co-founder of the Bulletin of the Atomic Scientists after the War. Simpson was a big proponent of the peaceful use of nuclear power under strict international control. He was intensely interested in the exploration of the Solar System, too, and an expert on cosmic rays. Some of the instruments that he and the UofC team built were for NASA, and some were for the military/CIA.

Reconnaissance of activities in the Soviet Union was a high-priority objective of the military/CIA, especially after the USSR exploded their atomic, then hydrogen, bomb, and launched Sputnik. Francis Gary Powers proved that reconnaissance flights over the USSR were impractical, and some of the other balloon-based programs yielded only Roswell fairytales rather than solid reconnaissance. Digital imaging had not been invented yet. The Corona program was a satellite series that could acquire high-resolution visual photographs, and drop them in a re-entry capsule to retrieved by a hook-trailing aircraft flying over very deep water (no USSR recovery if the hook was missed). Rube Goldberg would be proud, but the system worked. Corona was, understandably, very secret, and given the code-name "Discoverer."

A high school chum of my father had joined the CIA after college, and we found out later that he had been one of the Corona program managers in the early 1960s. He's gone now, but I had the pleasure of meeting him a few years back, and enjoyed dinner in his home. He had some photographs on one wall that looked like the wildest lightning storms I had ever seen. I asked him about them, and he told me it was Corona film that had been damaged by cosmic rays while in orbit.

The first instrument flown that Ed personally designed actually flew on *Discoverer 36*, launched on December 12, 1961. It wasn't meant to conduct reconnaissance on the USSR directly; rather, it was designed to measure the cosmic radiation environment where Corona satellites operated in the hope of finding ways to proof Corona film from cosmic ray damage.

His career was off to a flying start, and he took some time to marry Alice Trabue Wickliffe in 1962.

## CALTECH, JPL, AND VOYAGER

Dr. Stone's work on cosmic rays and satellite observations earned him a spot on the faculty at Caltech in 1964. He continued to work with NASA on a number of spacecraft projects, including a plan for a "Grand Tour" of the Solar System. [In case you didn't know, JPL is of NASA, but not part of NASA. What I mean is that JPL is managed by Caltech, using mostly NASA funding, but not by NASA directly. There is considerable "cross-talk" amongst the three.]

The folks that design the trajectories that spacecraft need to use to reach other planets had already learned how to use the gravity of one planet to re-direct a spacecraft to a more distant

one. We had already sent successful probes to Venus and Mars, and were now ready for a more advanced exploration satellite than the early Pioneers and Mariners, especially for objects more distant from the Sun than Mars is, where RTG, rather than solar, power is required. *Pioneer 10* and *11* led the way, flying by Jupiter, and Jupiter and Saturn, respectively. Technological and engineering advances would make a bigger, better, fly-by series of spacecraft possible. They would be called Voyagers.

The trajectory planners were investigating how to get a meaningfully-sized payload into the outer Solar System as quickly as possible. They found an upcoming planetary alignment, one the occurs only every 176 years, that would allow a spacecraft to fly by each of the four gas giants in succession, using the gravity of each one to send it one to the next one. The launch window was in 1977.

Making a spacecraft with state-of-the-art instruments, that can meet durability, weight, and other engineering constraints, in time to make the launch window was no mean feat. And one of the most key persons to make it happen was Ed Stone, chosen as the Voyager Project Scientist in 1972, a post he would hold for **50 years**!

The design, engineering, and construction of *Voyagers 1* and *2* was a huge undertaking, and expensive, too. Under Dr. Stone's most-able leadership, those efforts were made successfully.

However.

Congress was in a cost-cutting mood in the mid-1970s, and NASA was struggling for funding. The hey-day of Apollo was over, and the final three Moon shots were scrapped, even though their Saturn V rockets were already built. The Shuttle Program was starting up, taking up much of the available funds. Congress bought into the goal of returning to Jupiter and Saturn with a more advanced spacecraft that *Pioneers 10* and *11*, but would not authorize the funds needed for the full Grand Tour concept.

Undaunted, Dr. Stone and his team forged ahead, hopeful that with successful fly-bys of Jupiter and Saturn in the books, Congress could be convinced to keep the *Voyagers* operating for the rest of the Tour. And that's the way it worked out.

The mission requirements were to launch the two *Voyagers* to fly-by Jupiter and Saturn, with a focus on both planets, the four Galilean satellites, and Saturn's large moon, Titan, the only moon in the Solar System with an appreciable atmosphere.

*Voyager 2* was actually launched before *Voyager 1*, but the latter was on a faster trajectory and would arrive at Jupiter first, hence the numbering. If, and only if, *Voyager 1* was successful at Saturn, then the trajectory of *Voyager 2* could be tweaked to allow the Grand Tour. If *Voyager 1* failed to meet the requirement to get a good look at Titan, then *Voyager 2* would be maneuvered to do it, at the cost of not being in a position to go on to Uranus.

The fly-by of Saturn by *Voyager 1* did work well, so *Voyager 2* could be made to get the gravity assist it needed at Saturn to go on. Worthy of note is that there was some luck involved. The booster for *Voyager 1* underperformed. It had just enough oomph to make it to Saturn and accomplish the Voyager primary objectives, but had that booster been used for *Voyager 2*

rather than *Voyager 1*, *Voyager 2* would not have been able to go on to Uranus and beyond no matter how it flew-by Saturn!

NASA extended the mission so that *Voyager 2* could visit Neptune and Uranus; it is still the only spacecraft ever to have encountered the ice giants. Both spacecraft are so far out there is nothing to photograph, at least after *Voyager 1* sent back the Solar System "Family Portrait" in 1990 (which showed Earth as a "pale blue dot")!

The *Voyagers*' mission was extended again to give additional value to the overall Voyager program. Astronomers and heliophysicists wanted to know about the conditions at/near/past the "heliopause," the spherical region around the Sun where the solar wind is stopped by the interstellar medium. Both *Voyagers* have their Cosmic Ray Subsystem, Low-Energy Charged Particles" detector, and Magnetometer instruments in operation, and *Voyager 2*'s Plasma Science instrument is still operating, too. Collectively, these instruments are providing valuable information on the nature of the heliopause and interstellar Space.

I will refer you to three other Items of the Week for info on how the Voyagers were successful, how the great "called shot" discovery of active volcanism on Jupiter's moon, Io, was predicted and found in the same week, how they laid the groundwork for subsequent missions, and how the pubic could explore in real time with the scientists during the fly-bys.

Availability of electrical power will limit the remaining operational lifetimes of the *Voyagers*. Both spacecraft have three radioisotope thermal generators aboard, which generate electricity from the heat of radioactive decay (for more on RTGs, see here). Alas, all the Voyager RTGs have only a few years at most before their power output decays too low to operate, even though NASA recently made alterations to the Voyager operation plan that will add some years to the *Voyagers*' operations. For more info, see here. After that, they will become V'gers.

The *Voyagers* have grossly exceeded pre-mission expectations, but their success has not been free of glitches, especially as the spacecraft age.

A while back there were news items about problems with communicating with *Voyager 2*. An inadvertent command caused its main communication antenna to lose lock on Earth. It could not receive commands or transmit data back to Earth. The Deep Space Network was able to detect a carrier wave signal showing that the spacecraft was still operational, but misaligned. NASA then broadcast a "reorient yourself" command with a signal powerful enough for *Voyager 2*'s misaligned antenna to still receive. The spacecraft performed the desired maneuvers (it does so quarterly as SOP, to ensure precise alignment) and full communications were restored.

*Voyager 1* had a serious communications problem five months ago. It could send and receive signals from Earth, but a failed computer chip in its internal Flight Data System resulted in sending out messages with no science or engineering data. For more on the details of the problem, see here.

An amazing amount of engineering sleuthing identified the problem area and devised an ingenious work-around. The new code required to restore the system was sent out to *Voyager*

*1* on April 18. Waiting to see if the change worked must have tried the engineers' patience, because the round-trip time for signals from Earth to Voyager and back would take almost two days! But on April 12, meaningful data was being received successfully. Both spacecraft can now continue to be useful in learning about interstellar Space for at least a few more years.

## DEPARTMENT CHAIR (1983-1988)

Dr. Stone became Chair of Caltech's Division of Physics, Mathematics, and Astronomy in 1983. He was still spending time on Voyager's fly-bys (Uranus in January, 1986, and Neptune in August, 1989), but he still found time to play a significant role in the establishment of the Laser Interferometer Gravitational-Wave Observatory, which would later actually detect gravitational waves ("ripples" in the fabric of space-time caused by titanic collisions between large objects). He also oversaw the construction of the W.M. Keck Observatory on Mauna Kea, home of twin 10-meter telescopes with segmented adaptive-optic mirrors. Dr. Stone also established Caltech's Space Radiation Lab, for the study of high-energy astrophysics using Voyager and a variety of other subsequent missions, and UV astrophysics using data from the GALEX satellite. And, by the way, while all this was getting accomplished, he was overseeing 11 teams of scientists working on NASA missions.

## JPL DIRECTOR (1991-2001)

When the Voyager planetary fly-bys were over, Dr. Stone's schedule relaxed a little, but not much and not for long. He became the Director of JPL in 1991, a post he would hold for a full decade. During his tenure, the pace of Mars exploration recovered from the loss of the *Mars Observer* flagship mission, with the *Mars Pathfinder* mission in 1996 and the launch of the *Cassini* spacecraft to Saturn, a follow-up of the *Voyager* fly-bys, comprising a successful orbiter and a Titan atmospheric probe that made it to the surface and returned data from there. His managerial expertise also allowed for a redesign of the *Spitzer Space Telescope* that saved that project. He also worked on a number of other NASA projects, including the *Parker Solar Probe*, giving him the distinction of working on the spacecraft closest to the Sun and the spacecraft furthest from the Sun!

Dr. Stone was named the David Morrisroe Professor of Physics and served as Vice-provost for Special Projects at Caltech during his final years there.

## RECOGNITION

As you might imagine, Ed Stone has been one of the key figures in Space exploration for most all of the lives of the professionals now studying our Solar System. His passing on June 9, 2024, at age 88, was a blow to us all – like losing a grandparent or parent.

Laurie Leshin, the present JPL Director, said, "Ed will be remembered as an energetic leader and scientist who expanded our knowledge about the universe — from the Sun to the planets to distant stars — and sparked our collective imaginations about the mysteries and wonders of

deep space. Ed's discoveries have fueled exploration of previously unseen corners of our solar system and will inspire future generations to reach new frontiers. He will be greatly missed and always remembered by the NASA, JPL, and Caltech communities and beyond."

Nicola Fox, presently NASA's Associate Administrator for the Science Mission Directorate, said, "Ed Stone was a trailblazer who dared mighty things in space. He was a dear friend to all who knew him, and a cherished mentor to me personally. Ed took humanity on a planetary tour of our solar system and beyond, sending NASA where no spacecraft had gone before. His legacy has left a tremendous and profound impact on NASA, the scientific community, and the world. My condolences to his family and everyone who loved him. Thank you, Ed, for everything."

Dr. Stone was quite aware of how the public was responding to the success of Voyager. In addition to the Al Hibbs Show, "Ed's approach showed us how much public interest there really was in what Voyager was doing, but it also resulted in better science. You need more than one piece of information to make a picture, and hearing about other scientists' data helped us interpret our own," said Tom Krimigis of the Johns Hopkins Applied Physics Laboratory, a PI on one of *Voyager 2*'s instruments from the beginning.

Dr. Stone won many awards over his storied career, including the National Medal of Science, delivered by President George H.W. Bush, and the 2019 Shaw Prize in Astronomy, for his leadership on the Voyager Project (a $1.2M award!).

Caltech established a new faculty position, the Edward C. Stone Professorship, in 2023.

He will be missed by all of us.

## REFERENCES


**Ed Stone**

JPL announcement: https://www.jpl.nasa.gov/news/ed-stone-former-director-of-jpl-and-voyager-project-scientist-dies [includes a video piece made in 2018 when *Voyager 2* made interstellar Space]

Caltech: https://www.caltech.edu/about/news/edward-stone-1936-2024

*Aviation Week*: https://aviationweek.com/defense-space/space/longtime-voyager-project-scientist-jpl-director-ed-stone-dies

*New York Times*: https://www.nytimes.com/2024/06/14/science/space/edward-stone-physicist-dead.html

*L.A. Times*: https://www.msn.com/en-us/news/technology/ed-stone-jpl-director-and-top-scientist-on-voyager-mission-dies-at-88/ar-BB1o3d0Y?ocid=BingNewsSerp

Space.com: https://www.space.com/ed-stone-nasa-voyager-mission-project-scientist-obituary

John A. Simpson's Obit: https://chronicle.uchicago.edu/000921/simpson.shtml

**Voyager: NASA**

JPL: https://voyager.jpl.nasa.gov

Mission Status: https://voyager.jpl.nasa.gov/mission/status

NASA Voyager Publication Bibliography: https://science.nasa.gov/mission/voyager/bibliography

NASA FACTS:
https://web.archive.org/web/20090328090432/http://www.jpl.nasa.gov/news/fact_sheets/voyager.pdf

**Voyager: NSSDC**

Voyager Project: https://nssdc.gsfc.nasa.gov/planetary/voyager.html

*Voyager 1*: https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1977-084A

*Voyager 2*: https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1977-076A

NSSDCA Photo Gallery: https://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-voyager.html

**Voyager: Other**

A full-scale mock-up of the Voyagers is on display in the Kenneth C. Griffen Exploring the Planets Gallery at the Smithsonian National Air and Space Museum:
https://airandspace.si.edu/multimedia-gallery/griffinetpmockupjpg

Bell, Jim, 2015, *The Interstellar Age: Inside the Forty-Year Voyager Mission*, ISBN 978-0-18615-6

*Journal of Geophysical Research* special edition, *Voyager Missions to Jupiter*, *JGR*, vol 86, no. A10, September 30, 1981

*Journal of Geophysical Research* special edition, *Voyager Mission to Saturn*, *JGR*, vol 88, no. A11, November 1, 1983

A variety of NASA videos related to the Voyager Project can be found by searching "Voyager NASA Special Publications."

**NOTE: You can find a Catalog of NASA Special Publications, NASA SP-449, prepared in 1981, at: https://ntrs.nasa.gov/api/citations/19810013465/downloads/19810013465.pdf**

Wikipedia: https://en.wikipedia.org/wiki/Voyager_program

**And Finally …**

JPL broadcast the fly-bys by *Voyager 2* of Saturn, Uranus, and Neptune, live, with "Voice of JPL" Al Hibbs moderating. You the viewer saw images coming in via the Deep Space Network in real time, the same as the scientists. Most. Exciting. TV. Ever. For more about Al Hibbs and his program, see: https://www.airandspacethisweek.com/assets/pdfs/20191014 Al Hibbs - The Voice of JPL.pdf! Be sure to see my retirement video about the Al Hibbs Show.

**Voyager: A+StW**

https://www.airandspacethisweek.com/assets/pdfs/20210830 Two Accomplishments at Saturn.pdf

https://www.airandspacethisweek.com/assets/pdfs/20211003 Triton.pdf

https://www.airandspacethisweek.com/assets/pdfs/20221010 Cassini Mission.pdf

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