Air and Space this Week

Item of the Week

CARL SAGAN

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Arguably the most important and certainly the most famous scientist of the second half of the 20th Century was Carl Sagan. He was an excellent interdisciplinary scientist, not one that focused narrowly on a specific subset of a specific field. Rather, he had very broad interests and had a particular skill of connecting a variety of scientific and historical topics in a way that the public found compelling. Much more than mere "billions (upon) of billions," Sagan expanded the outlook and perceptions of millions and millions.

He would have been 90 years old this week.

EARLY YEARS

Carl Sagan was born in Brooklyn, New York City, on November 9, 1934. His father was a newly-immigrated Ukrainian garment worker. Times were tough in the Depression, and his father helped make ends meet as a movie theater usher. His mother had grown up extremely poor in NYC during WWI and the 1920s. Sagan came to believe his sense of wonder and humanity came from his father, who, despite his poverty, helped those even less fortunate and helped smooth relations between his co-workers and management. His mother would likely have made an excellent scientist, but her situation gave her no chance to flower. Although his parents had no scientific training, they evoked a sense of skepticism and wonder that served him the rest of his life.

Like so many aviators and scientists, Carl had an event in his earliest formative years that directed the rest of his life: His parents took him to the 1939 New York World's Fair. The exhibits he saw there had a profound effect on him. The time capsule he saw at the World's Fair led directly to the plaques on the *Pioneer 10* and *11* and *Voyager 1* and *2* spacecraft. His books, *Shadows of Forgotten Ancestors* and *The Demon-Haunted World*, showcase how his early life affected him.

Young Carl's interests bloomed further when he had his first visit to the public library; he would later refer to it as a "religious experience." Soon thereafter, he visited the American Museum of Natural History and Hayden Planetarium, further setting the hook and exposing him to the interconnectedness of the natural sciences. Though poor, his parents supported his learning.

Library books fed his interest, especially those by Wells and Burroughs, and he developed the intense interest in the Solar System and beyond that led to *Cosmos*.

His teenage years were marked by his exposure to "hard" science fiction in the magazines, particularly *Astounding Science Fiction*, which was more science-based than tales of martian invaders and the Princess of Helium. He was also exposed to the pseudo-science silliness of the Flying Saucer hysteria.

His academic excellence became apparent in high school. He was bored with the lack of challenge, in spite of his teachers' best efforts. He graduated in 1951, class valedictorian at age 16, and voted by his fellow students as "most likely to succeed." He decided to go to the University of Chicago, in large part because it was one of the few that would matriculate someone his age. UC was in the throes of a very beneficial upgrade, and Sagan was able to access some of the top scientists of the day.

THE UNIVERSITY OF CHICAGO

Sagan enrolled in an honors program right off the bat, working in the laboratory of H.J. Muller, the 1946 Nobel Prize winner for Medicine. He wrote a thesis about the origin of life under the supervision of Harold Urey, who had won the Nobel Prize for Chemistry in 1934. Sagan was awarded a B.A. with general and special honors in 1954, and a B.S. in Physics in 1955. He stayed at UC for graduate school, earning a Ph.D. in Astronomy and Astrophysics in 1960, under the direction of Gerard Kuiper (the "Father of Modern Planetary Science"), who was the president of the International Astronomical Union's commission on the physical studies of planets and satellites during that time. He also worked with famed physicist George Gamow, who helped develop the Big Bang Theory, and chemist Melvin Calvin, who would win the 1961 Nobel Prize in Chemistry. Fast company, indeed. Take that, Sheldon!

The 1950s were an "interesting time" in many ways, especially for scientists whose work touched on topics of interest in the Cold War. Kuiper was enlisted to work on the Air Force's "Project A119," a plan to detonate a nuclear warhead on the Moon as a way of studying the process of impact cratering and to demonstrate our military capability to the Soviets. You decide which was the most important of the two reasons. For this work, Sagan had to get a Top Secret clearance from the Air Force and a Secret clearance from NASA.

ON TO HARVARD

Sagan applied for, and received, a Miller Fellowship at the University of California at Berkeley after receiving his Ph.D. (he inadvertently caused a minor security breach when he listed some of his A119 reporting on his application, no doubt starting the interest of the FBI that would follow him for years). While there, Sagan worked on the Mariner 2 science team, wrote an important paper for the journal, *Science*, on the atmosphere of Venus, and served as a consultant to the RAND Corporation.

His *Science* paper created a stir, and Fred Whipple and Donald Menzel, prominent astronomers both, asked Sagan to present a colloquium at Harvard on the topic. It was so well received that

Harvard offered him a lecturer position. Sagan turned it down, thinking he should have been offered an assistant professorship, instead. Harvard reconsidered after Whipple and Menzel did some convincing, and Sagan joined the faculty in 1963. He did all the professorial things: teaching, research, advising students, and in addition he worked at the Smithsonian Astrophysical Observatory, also in Cambridge.

Then he was denied tenure, in 1968!

Sagan was shocked, as am I at this late date. What was their boneheaded reason?

By that time, Sagan had begun taking a much broader academic view than was typical for most professors, who were intensely interested in only one small piece of a larger discipline. He was also becoming more of an advocate of science, and was starting to garner wider public attention. He was also, no doubt, a much better teacher than any of his Harvard colleagues. Personally, I think professional envy played a big role in the non-tenure decision. Worst of all, his undergraduate benefactor, Harold Urey, strongly opposed tenure, and his Nobel status carried a lot of weight.

Who said smart people can't do stupid things?

GO BIG RED!

I personally witnessed what happens when a relatively-content academic department is spurred to growth by university management. An outside leader is brought in, and new, aggressive, faculty are hired. They bring in external funding and excellent students, and the reputation of the department in question is enhanced for decades to come.

In the early 1970's, the Geology Department of Arizona State University was small, only six faculty members. They were quite good, but there wasn't a big science push, and ASU trailed arch-rival University of Arizona in geological academics and funding. Then David Krinsley was hired as Department Chair.

Funding was made available for Dave to hire new faculty and support their research initially. External funding followed, big time, scientists like Ron Greeley, John Ferry, Paul Knauth, and others were brought aboard. Additions like Phil Christensen, Ron's post-Doc, followed. Students, too, such as the person who just retired from the Smithsonian who had been the curator of the Hope Diamond and the National Gem Collection, and the present Lead Scientist on the Europa Clipper mission.

Cornell University in Ithaca, New York, was another example. They had brought in Tommy Gold, who like Sagan, was at Harvard, although he was there in the 1950s, not the 60s. Gold had gone to Harvard in 1956 as a Professor of Astronomy, but departed in 1959, enticed by the opportunity to build a department on his own at Cornell.

Tommy Gold may have had some unorthodox ideas, some good, some bad, but he really did well in building Cornell's Department of Astronomy into a research powerhouse. He started pretty much from scratch; he and one other were the department's only faculty members!

He was tasked to build up an interdisciplinary unit for radiophysics and Space research. He worked hard to recruit Carl Sagan, and won him over after Sagan did not get tenure from Harvard. Gold also was able to land Frank Drake, Yervant Terzian, Joe Veverka, and others, and oversaw the construction of the huge radio telescope at Arecibo, Puerto Rico. He built out the Center for Radiophysics and Space Research, serving as its director until 1981. He also served a stint as Cornell's Assistant Vice President for Research (1969-1971), then held a named chair in the Astronomy Department from 1971 until his retirement in 1986. For more on Tommy Gold, see the previous Item of the Week here.

I was at Cornell from 1974-1978, and I not only got to know Tommy Gold, I got to see the transition of Carl Sagan from an outstanding faculty member to a famous public figure.

Cornell did not offer an undergraduate degree in Astronomy, even though it did allow an unusually-loose degree of freedom for undergraduates to plan their own program of study. Steve Squyres took advantage of it to eventually become the lead scientist for the Mars Exploration Rovers, *Spirit* and *Opportunity*.

The students saw that Carl Sagan was something special before the rest of the world did. Cornell did offer a few undergraduate astronomy classes, mostly for students in non-science programs to knock off distribution requirements. Sagan taught one of them, but class attendance, routinely more than twice the number of students enrolled, forced the program to use one of the largest auditoriums on campus. He began teaching Astronomy 102, which required 101 as a pre-requisite, but still they came. The class met at 8 AM on Tuesdays, Thursdays, and Saturdays, but still they came. Sagan also honed his already-formidable speaking skills by narrating community events and other non-science public speaking. That was the same time Johnny Carson, who had an interest in Science anyway, discovered that Sagan was a colorful and popular guest on *The Tonight Show*.

Sagan's links with NASA continued to grow. He had already served as a member of the science teams for *Mariner 2* (first mission to Venus) and *Mariner 9* (first important mission to Mars); he would in time serve on the science teams for *Viking* (first landings on Mars), *Voyager* (only spacecraft to Uranus and Neptune so far), and *Galileo* (first spacecraft to orbit Jupiter) missions.

He became well known for his take his childhood dream of exploring the Cosmos, from the Solar System to the Infinite. His memories of the 1939 World's Fair time capsule inspired the notion that the spacecraft launched with enough oomph to leave the Solar System should contain a "calling card" from the citizens of Earth. This sparked some public controversy. Folks scared of Flying Saucers and bogeymen from Mars worried that hungry aliens might find the spacecraft, ascertain the coded message of its source, then come our way with evil intent. That, and the humans on the Pioneer plaque weren't wearing clothes. Of course, Sagan knew that the odds of the spacecraft being found by anyone/anything were infinitesimally-small, but the purpose of the plaques was not to inform aliens, but to inspire Earthlings. In that sense, they did.

HUMANIST

Both Sagan and Drake were fascinated at the prospect of there being life elsewhere in the Universe. It led Drake to develop his famous equation and become the father of the Search for Extraterrestrial Intelligence movement. It led Sagan to publicly ponder on Europa's habitability, Titan's surface cover of organic molecules, and more. It also led him to publish *Cosmos*, and to develop it as a TV mini-series. He helped raise awareness that this island Earth was but a Pale Blue Dot in an incredibly-vast ocean of darkness, supporting numerous environmental and sustainability causes.

Sagan's work with Venus was particularly telling. How could a planet so similar to Earth have a surface environment so hostile to life? He was a major proponent of the Greenhouse Effect that we now know causes Venus to be the way it is, and like many planetary scientists now, he worried if human activity could torque Earth's surface environment to a tipping point where a runaway greenhouse would occur, killing us all. [IMHO, the geological history of Venus is one of THE most important things for we humans to know!] See the list of Sagan's books below to get a feel for how much he was concerned about such things.

Public advocacy was his mission and his passion. It may also have been, along with no small measure of envy, the reason that one other deserved scientific achievement was denied him. He was rejected as a member of the National Science Academy.

Other books followed. "Billions and Billions' became a catchword (although Sagan actually used "Billions upon billions" in *Cosmos*). He was the co-founder and chief technology officer for the planetary science research journal, *Icarus*. He co-founded The Planetary Society. He served on the Board of Trustees for the SETI Institute. He served as the Chairman for the Division of Planetary Science of the American Astronomical Society. He served as the President of the Planetary Sciences Section of the American Geophysical Union. He served as the Chairman of the Astronomy Section of the American Association for the Advancement of Science. He was the chief proponent of the concept of a Nuclear Winter and, therefore, of nuclear disarmament. He wrote a best-selling fiction novel, *Contact*, about the first contact with an extra-terrestrial intelligence, and supervised its turning into a movie, starring Jodie Foster, Matthew McConaughey, James Woods, John Hurt, and Tom Skerritt. He wrote a number of prize-winning books.

And he died too damn young.

Carl Sagan developed myelodysplasia, a form of bone marrow cancer, when he sixty years old. Three bone marrow transplant operations went for naught, and he died at the age of 62. He is buried at the Lake View Cemetery in his beloved Ithaca.

HONORS

Carl Sagan awards:

Public Welfare Medal in 1994, the highest award of the National Academy of Sciences

NASA's Ames Research Center has the Carl Sagan Center for the Study of Life in the Cosmos

Asteroid 2709 Sagan and a martian crater are named in his honor.

The landing site of the *Mars Pathfinder* spacecraft (the one with the *Sojourner* rover) was renamed the Sagan Memorial Station by NASA on July 5, 1997.

NASA Medals: Exceptional Scientific Achievement; Distinguished Public Service (twice); the NASA Apollo Achievement Award

The John F. Kennedy Astronautics Award of the American Astronautical Society

Masursky Award of the American Astronomical Society

Explorers Club's Lowell Thomas Award (1980)

Konstantin Tsiolkovsky Medal of the Soviet Cosmonautics Federation

Sagan was named Fellow of the American Physical Society in 1989

COSMOS generated many accolades:

- Peabody Award in 1980, with KCET and Adrian Malone (*Cosmos* producer)
- Emmy in 1981: Outstanding Individual Achievement
- Emmy in 1981: Outstanding Informational Series
- Hugo in 1981: Best Dramatic Presentation (he also won in 1998 for *Contact*)
- Hugo in 1981: Best Related Non-fiction Book
- Ohio State University Annual Award for Television Excellence (1981)

Pulitzer Prize for General Non-Fiction (1978) for *The Dragons of Eden*

Sagan was a big proponent of naturalistic inquiry, receiving recognition for his contributions

- Humanist of the Year for 1981 by the American Humanist Association
- Isaac Asimov Award for 1994 by the Committee for Skeptical Inquiry
- Joseph Priestley Award for the "Distinguished Contributions to the Welfare of Mankind"

Grand Cross of the Order of Saint James of the Sword, Portugal

And many, many others (see Wikipedia entry for an expanded list)

BOOKS

Carl Sagan was a prolific author. In addition to his scientific papers and reports, he wrote:

- *Intelligent Life in the Universe* (1966)
- *Planets* (1966)
- *The Cosmic Connection* (1973)
- *Communication with ET Intelligence* (1974)
- *Other Worlds* (1972)
- *Dragons of Eden* (1977)
- *Broca's Brain* (1979)

Cosmos (1980)

Comet (1985)

Shadows of Forgotten Ancestors (1992)

Pale Blue Dot (1994)

The Demon-Haunted World (1995)

Billions & Billions (1997)

The Varieties of Scientific Experience (2006)

RESOURCES

Davidson, Keay, 1999, *Carl Sagan: A Life*, New York: Wiley and Sons, ISBN 978-0-471-25286-3

Poundstone, William, 1999*, Carl Sagan: A Life in the Cosmos*, New York: Henry Holt and Company, ISBN 978-0-8050-5766-9

Spangenburg, Ray and Kit Moser, 2004, *Carl Sagan: A Biography*, Westport CT: Greenwood Publishing, ISBN 978-0-313-32265-6

Morrison, David, 2006, *Carl Sagan: The People's Astronomer*: https://ejournals.library.vanderbilt.edu/index.php/ameriquests/article/view/84/93.

Morrison, David, 2007, Man for the Cosmos: Carl Sagan's Life and Legacy as a Scientist, Teacher, and Skeptic, Skeptical Inquirer, v. 31, no. 1: https://skepticalinquirer.org/2007/01/man-for-the-cosmos-carl-sagans-life-and-legacy-as-scientist-teacher-and-skeptic.

Achenbach, Joel, 1014, Why Carl Sagan is Truly Irreplaceable, *Smithsonian Magazine*, https://www.smithsonianmag.com/science-nature/why-carl-sagan-truly-irreplaceable-180949818.

NASA Astrobiology Institute's Carl Sagan Center Dedication (11/26/2001): https://science.nasa.gov/people/carl-sagan.

Study.com: https://study.com/buy/learn/lesson/carl-sagan-biography-discoveries-theory.html.

International Space Hall of Fame: https://nmspacemuseum.org/inductee/carl-sagan.

MIT: https://www.mit.edu/people/thb/SAGAN.pdf.

Wikipedia: https://en.wikipedia.org/wiki/Carl_Sagan. (particularly thorough)

Terzian, Yervant and Virginia Trimble, 1997, Carl Sagan (1934-1996): https://baas.aas.org/pub/carl-sagan-1934-1996/release/1?readingCollection=f830c51e.

Sagan's collaboration with Soviet scientists and his anti-war stance brought the attention of the FBI. See his dossier here: https://vault.fbi.gov/Carl%20Sagan/Carl%20Sagan%20Part%201%20of%201/view

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