Air and Space this Week

Item of the Week

TOMMY GOLD

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"Tommy was not shy, he was very confident, which made him an influential spokesman for Cornell. He was largely responsible for making modern astronomy at Cornell the first-rate program it is today. … Though Gold viewed himself as simply fulfilling the role of a scientist, he was labeled as a nonconformist for developing and supporting contrary theories that went against conventional wisdom. Sometimes he proved correct." Quote from: https://www.astronomy.com/science/thomas-gold-19201502004.

I had the pleasure of taking a seminar class from Dr. Gold, and I attest that the above quote is true. He is one of the most powerful intellects I have ever encountered. He did have some frankly-crackpot ideas, but his grasp of fundamental math, physics, and other important disciplines required all to at least pay attention to his point of view. He was, truly, a "Renegade Genius!"

I cited Tommy Gold's thought on the dustiness of the lunar surface in last week's Item about the lunar Surveyor program, and I realized he was too important and influential scientist not to get the full Item treatment himself.

Thomas Gold was born in Austria on **May 22, 1920, 104 years ago last week**. His father ran one of Austria's largest mining and metal fabrication companies, but those industries crashed when Tommy was a boy, and with the rise of Hitlerism, they had to flee to Switzerland, and then to England when Germany invaded Austria. Initially, he was considered an "enemy alien" and interred, where he met another budding scientist by the name of Hermann Bondi, and then in Canada.

Gold returned to England after the War began, receiving a degree in Physics. He ended up on a project to study radar ground clutter in the fall of 1942, along with Bondi and another scientist, Fred Hoyle. These three were amazing theoreticians, and routinely discussed cutting-edge topics in cosmology, math, and astrophysics. But the War came first, and Gold took a leadership role in the construction of radar systems, devised a plan where landing craft could use radar to navigate during the D-Day invasion, and discovered that the Germans had developed the submarine schnorkel, enabling them to use diesel engines while submerged.

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Hoyle and Bondi returned to Cambridge after the War, but Gold stayed with military technology, helping to develop and construct the largest magnetron yet built. He also developed somewhat of an ego, but could back it with a brilliant understanding of basic physics.

ODD IDEA #1: "REGENERATION AND THE HUMAN EAR"

Gold remained friends with his colleagues from the wartime naval radar research days, especially R.J. Pumphrey, who had been a zoologist at the Cambridge Zoological Laboratory before the War. The two began to investigate the operation of the human ear's cochlea. They found that resonance in the cochlea was greater than that expected from damping of the resonance due to the viscosity of the fluid within the cochlea. Gold came up with the idea that the ear operates by "regeneration," an electromechanical action that accentuated the resonance, work that won him a prize fellowship from Trinity College, a junior appointment at the Cavendish Laboratory, and great criticism from Georg von Bekesy, the 1961 Nobel Prize winner, who disputed Gold's idea. A decade later, additional research conclusively showed that microscopic hairs in the cochlea provided the feedback necessary to generate the observed resonance. Score one for Tommy!

ODD IDEA #2: THE STEADY-STATE THEORY OF THE UNIVERSE

Gold, Bondi, and Hoyle stayed in touch with one another, and ended up publishing an alternative to the Big Bang model of the Universe. Gold and Bondi accepted the notion that red-shift data showed the Universe was expanding, but they did not like the notion that the Universe has a beginning but no end. They, like many, believed that the Universe was homogeneous and isotropic (alike in all places), and the only way they saw that to be possible, and have the Universe be eternal, was for there to be spontaneous creation of matter to fill the void left by expansion; there was no beginning, Big Bang or otherwise, and no end – the Universe expanded but the spacing of the stars and galaxies did not change. Their paper, and one by Hoyle, laid out the "Steady-State" model of the Universe. The S-S model fell out of favor when the 3K background radiation pervading Space was discovered and S-S couldn't explain it, but the Big Bang model could. Further, quasars, very high-energy objects, only appeared at the greatest distances, hence, greatest ages, implying that the Universe has not been more-or-less constant with time. But their thinking showed that the three were willing to buck scientific orthodoxy with challenging new ideas. Gold was now 1 for 2 in odd, innovative ideas.

DR. GOLD COMES TO AMERICA

Gold left Cambridge in 1952 to become the chief assistant to the Astronomer Royal, Harold Spencer-Jones, then moved to Harvard in 1956, when HSJ retired. He moved to Cornell in 1959, jumping at their offer to Chair their Astronomy Department and to set up an interdisciplinary unit within it dedicated to radio-physics and Space research. Problem was, there was only one other faculty member there at time. No problem. Gold hired Carl Sagan and Frank Drake, among others, and oversaw the construction of the Arecibo radio telescope in Puerto Rico!

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Tommy Gold at this time was key in the establishment of the Cornell-Sydney University Astronomy Center, along with Harry Messel. Messel was born in back-country Manitoba, and served as a paratrooper for Canada during WWII. He held a series of fellowships in Physics, and by 1952 was the Head of the School of Physics at the University of Sydney, among other positions, one of which was his founding the International Science School (a different ISS!) in 1958, an organization that encouraged scientifically-capable students in the third and fourth year of undergraduate study. He, like Gold, had an ego, and had strong opinions, and they got along famously. Messel gained some notoriety in 1958, when he was able to receive data from *Sputnik 2* when it was over high-southern latitudes, where the USSR had no means of communicating with it. He asked the Russians for the decrypt codes and they said nyet; they asked him for the data and he said "Go to Hell!"

Dr. Gold was intensely interested in the interaction between material ejected from the Sun by flares and geomagnetic storms in Earth's atmosphere. He was the one who coined the term "magnetosphere" for the zone above the ionosphere where the magnetic field of the Earth had dominant control over the motion of gas and charged particles. He collaborated with Fred Hoyle again, showing that solar flares were produced by magnetic activity.

ODD IDEA 3#: NATURE OF "PULSARS"

Jocelyn Bell (Burnell), a Cambridge post-Doc in radio astronomy, working under the mentorship of Antony Hewish, discovered a radio source that showed extremely-regular pulsations with a period of 1.337 seconds. The signal from this newly-named "pulsar" was powerful, and its period never varied. The discovery would win the Nobel Prize for Hewish, but no such recognition came Bell's way, a significant injustice now acknowledged by just about everyone, but a topic for another day.

Tommy Gold proposed that the radio signals came from a rapidly rotating neutron star, an idea that was so heretical that he was not allowed to present it at the first international science conference convened to report on pulsar research. However, Gold had the Arecibo radio telescope at his disposal, and used it to detect a pulsar at the heart of the Crab Nebula in Taurus, the remains of a supernova that had occurred in 1054 CE, observed by the Chinese. and the Anasazi at Chaco Canyon in New Mexico. Astronomers had accepted that the supernova that produced the Crab had also become a neutron star, making the link between pulsar and neutron star widely accepted. That linkage is said to have paved the way for Stephen Hawking's research in black holes. The "batting average" for Gold is now two for three.

ODD IDEA #4: A DUSTY MOON

Dr. Gold began serving as a consultant to NASA during the earliest days of the American Space program, including service on the President's Science Advisory Council in the late 1950s. He was a bit of a thorn in NASA's hide because he would often point out that NASA could get more of a scientific-bang for the money being expended in the run up to Apollo. He was right about that, of course, but he was ignorant of the political and inspirational side of the Moon Race.

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Gold thought about the lunar surface environment a great deal. He knew it was ancient, and that impact events pulverized its surface all during that time, concluding that the surface of the Moon would be dust covered, perhaps deeply so. He maintained that view during the Ranger program, which showed that the lunar surface was covered by a material too fine for the Ranger's cameras to resolve, but there were also many small craters and many rocks on the surface (which would have argued against a dust layer that had the properties of a fluid). One of the stated scientific objectives of the Surveyor program was to land spacecraft on the Moon to investigate and assess the bearing strength of the lunar surface.

The five successful lunar landings by Surveyor spacecraft showed that it could easily support the weight of a lander. NASA gave Gold a sort-of consolation prize, creating a stereoscopic camera on a stick that the astronauts could use to take very detailed close-ups of the lunar surface material. The National Air and Space Museum has a training model of the camera in its collection, on display in the new Destination Moon gallery. Gold was right in that the surface of the Moon was covered in many places by a "regolith" of finely-crushed rock, but was wrong in its potential depth and fluidity. I'll give him a partially correct on this one, so he's now 2.5 out of 4.

ODD IDEA #5: NATURAL GAS, PERHAPS OIL, HAS A NON-BIOLOGICAL ORIGIN

Tommy Gold's love of the oddball theory continued. Some were odder than others. He came up with the notion that natural gas and even oil was not the byproduct of the decay of buried biological material but was rather the outgassing of material incorporated into the Earth during its formation. His ideas gained little traction, until the energy crisis of the 1970s, and the discovery of abundant life around deep-water hydrothermal vents in 1977. The food chain for the life that was found in more and more deepwater springs sties was based not on photosynthesis, but on chemosynthetic microbes, leading Gold to return to his biogenetic theory of oil and gas formation. His thinking was bolstered by the correlation between the areas on Earth where oil and gas are produced and areas of high tectonic activity. He even attempted to drill deep holes in search of oil and gas where no biological origin would have been possible. Alas, "correlation" does not mean "causation!" Gold is now 2.5 out of 5. Hey, a .500 batting average would get you into the baseball Hall of Fame, but….

I was an undergraduate student at Cornell when all of this hoo-hah about abiogenic oil and gas was happening. Although I majored in Physics, my minor was Geology, and I took a class in Petroleum Geology during my junior year. One of the questions on its final exam was to refute the idea of a "noted Cornell astrophysicist" about the non-biological origin of oil!

Undaunted, Tommy Gold took the idea of deep-ocean life a step further in 1992, when he published a paper entitled, "The Deep, Hot Biosphere," in which he envisioned the widespread presence of microbial life deep within the Earth's interior. Since such life would be isolated from the surface environment, it could be expected to be found on other planets. Gold followed that extension with a book of the same name as the paper, writing that "Hydrocarbons are not biology reworked by geology, but rather geology reworked by biology."

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I'm going to call this one a miss, even though scientists have found life in places never before thought possible, including deep underground. Batting average: 2.5 for 6. That's still a .417 BA, better than Ty Cobb's .367 and even Josh Gibson's .372!

THAT SEMINAR COURSE

I had taken a freshman seminar course in Philosophy at Cornell where one of the books we contemplated was Plato's *Phaedo*. It is one of the best-known works of Plato's "Middle Period," concerned with the immortality of the soul and our imperfect perceptions of perfect "forms." What I remember most (and this was a few decades ago) is the style of Plato's writing, a dialectic between Socrates and two Thebans, Cebes and Simmias. Socrates would hold forth for several pages, pausing only to allow C and S say a short, "I see how that is so"-type remark, followed by a few more pages of Socrates. T'was heavy going.

I would have reason to recollect that learning style when I took a seminar course from Tommy Gold my senior year. There were only two students in the seminar. I was there to take advantage of being able to learn at a genius' knee, and the other was from the Agriculture College who needed to fulfill a course distribution requirement.

Dr. Gold's office was very deep, but very narrow, with his massive desk at the far end of a room longer than most hallways. Two overstuffed chairs were set at an angle in front of it. He would hold forth on the most interesting ideas at great length, and we would listen with an occasional "I see." He had just developed a most ingenious graph of size versus mass for everything in the Universe (obviously with logarithmic scales!); it was most impressive and I don't know why it wasn't more widely distributed. He spoke of many things, and our minds soared.

The office was kept warmer than it should have been, the meetings lasted 90 minutes, and the chairs were quite comfortable. I am embarrassed to admit that we both occasionally dozed a bit, in spite of the fascinating nature of the presentation. We had a system set up, however. Because the chairs were set at an angle to the desk, it was easy to keep an eye on one another. Whenever one of us started to nod, the other could kick the shin of the nodder without Dr. Gold seeing it. As long as the awakening start was not too abrupt, Dr. Gold was none the wiser. The system worked well until….

Class was normally held during the week. But on one occasion, Dr. Gold had to travel, and rescheduled the seminar meeting to Monday morning at 8 AM, after one of the major social weekends of the year. I'm sure you see where this is going. It had been a long weekend, and it was a long walk up Library Slope to get to Gold's office, and we both were tired. After each of us had received a few surreptitious kicks, we both nodded off simultaneously. The next thing I felt was the cap of Dr. Gold's pen hitting me right in my open mouth. I awoke with a small jolt, spit out the cap, kicked my buddy, and tried to look like I'd been awake all along. Dr. Gold showed no outward sign of displeasure, and didn't miss a beat in his monolog!

I couldn't always follow the quickness of Dr. Gold's thinking or the leaps from in-depth topic to in-depth topic he managed to make, but I did come away from the seminar with a deep

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appreciation of how a brilliant mind, unfettered by convention, could contemplate and create Great Things. May there be more like him!

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