Glimpses of Mal Ruderman in JASON Over 50+ Years

by

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Mal Ruderman Festival

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Pupin Hall, Columbia University

Y'all know Mal, but what is JASON? E.g., *"JASON's chief purpose is to provide government managers with independent scientific and technical expertise to address technical problems and challenges facing the intelligence and defense communities. JASON topics are selected based on the nature of the technical issue, the expertise available to address the issue, and the availability of JASON members to participate."*[1]

JASON had its first summer study in 1960; Mal was among the original members. Charles H. Townes brought the concept to reality, with the commitment of theorists Keith A. Brueckner, Marvin L. Goldberger, and Kenneth M. Watson. The group works on many topics, both classified and open, for many departments and agencies of the U.S. Government, among them the decennial census, underwater sound, topics related to nuclear weapons.

Glimpses:

1. The CORONA-corona problem (~1960)
2. "Stratospheric Nitric Oxide Production from Past Nuclear Explosions and Its Relevance to Projected SST Pollution" (1972)
3. Alfvén Propulsion Engine – "The APE in space" (1964)
4. "Impacts of Severe Space Weather on the Electric Grid' (2011)

In all this, Lois(1927-2018) and I had the great pleasure to know Mal and Paula as warm, intelligent and knowledgeable friends, enjoying our work and many meals together.

The Scientific Community and Intelligence Collection

Academic scientists continue to play a vital role in helping the intelligence community exploit technology for national security.

Mark F. Moynihan

We have slain a large dragon. But we now live in a jungle filled with a bewildering variety of poisonous snakes.
—R. James Woolsey, former director of the CIA, at his Senate confirmation hearing, March 1993.

Jim Woolsey's statement before the US Senate presaged a dramatic shift in the way the US intelligence community collects intelligence. Before the end of the cold war, intelligence personnel almost exclusively focused on only one target: the Soviet Union. Now, however, they must pursue that bewildering variety of poisonous snakes. And quite a challenge it is. From understanding the intentions of foreign leaders, such as Saddam Hussein, to detecting modern threats, such as those posed by bacteriological and chemical warfare, the challenges faced by the intelligence community push it to the very limits of its capabilities and expertise.

The modern era of US intelligence collection began in World War II with the formation of the precursor to the Central Intelligence Agency (CIA): the Office of Strategic Services (OSS). From that point on, the US intelligence community has recognized that it cannot succeed alone. Tackling hard intelligence problems requires the best and brightest minds from inside and outside the intelligence community. Battling Woolsey's poisonous snakes is a constant and troubling reality that requires our eternal vigilance. In retrospect, Secretary of State Henry Lewis Stimson's remark, in 1929, that "gentlemen do not read each other's mail" seems to belong to a different world.

Several years ago, I took part in a CIA recruiting drive at a job fair at the University of South Carolina. The most frequently asked question from students was, Why does the CIA need scientists and engineers? Reflected in this question is the common notion of the CIA as an organization of espionage and covert operations. But if you examine CIA history, you see an organization whose mission to inform US leaders and protect US security has always depended on science and technology.

The war years

The father of the US scientific intelligence community was an industrial chemist named Stanley Lovell. One day in 1942, while crossing Boston Common, Lovell was approached by MIT President Karl T. Compton, who asked him to join the National Defense Research Committee (NDRC), a group of academics consulted by the government on the war effort. After some consideration—and the warning that if he did not he would "regret all of your life if you refuse Uncle Sam now"—Lovell left his job as executive vice president of the Beckwith Manufacturing Co and reported to NDRC headquarters in Washington, DC.

At NDRC, Lovell met Vannevar Bush, who gave his aides, including Lovell, the following challenge: "You are about to land at dead of night in a rubber raft on a German-held coast. Your mission is to destroy a vital enemy wireless station that is defended by armed guards, dogs, and searchlights. You can have with you any one weapon you can imagine. Describe that weapon."

After some thought—and rejection of outlandish ideas, such as death rays—Lovell proposed a completely silent and flashless gun. His concept was selected by Bush, and he was told to report to an office at 25th and E streets in northwest Washington. There, he met the director of OSS, Colonel William Donovan, who introduced himself and said, "You know your Sherlock Holmes, of course. Professor Moriarty is the man I want for my staff here at OSS. I think you're it." Although he objected to the characterization of himself as Holmes's evil archenemy, Lovell accepted the position knowing the importance of the war effort. Donovan stated one more thing: "No matter what you do or hear when you are with me, I must have your word of honor that you'll write nothing until 20 years from now." Lovell accepted. His OSS memoir, *Of Spies and Stratagems*, was published in 1963.

After meeting Donovan, Lovell asked a colleague what exactly his job would be. "It is whatever you can make it," was the reply. "Colonel Donovan is a lawyer, not a scientist or an inventor. Never ask him what to do. Do it and show him what you have done." Lovell's flashless gun was developed, and Donovan demonstrated it—in the Oval Office. Much to the chagrin of the Secret Service, Donovan fired several shots into a nearby sandbag and handed the weapon, still hot, to President Franklin D. Roosevelt. Although quite surprised, Roosevelt stated that he had not heard a single shot.

Thus, in the work of NDRC was born the integration of science into the US intelligence community. That partnership continues to this day, but its emphasis has shifted from tools of war to tools of knowledge—tools that provide our leaders with greater knowledge and understanding and tools that buttress arms control agreements and reduce the possibility of conflict through misunderstanding.

One such knowledge tool was the stroboscope, which was developed in the 1920s and 1930s by Harold Edgerton, a professor of electrical engineering at MIT. In 1939, the US Army Air Corps asked Edgerton to design a strobe

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_10/29/2022_

Peek 1: *"By the late 1950s, Soviet air defenses had advanced to the point that high-flying aircraft were no longer invulnerable. Indeed, a U-2 piloted by Francis Gary Powers was shot down over the Soviet Union in May 1960. Clearly, other means had to be developed to spy on the Soviet Union and its allies. Fortunately, long before the shooting down of Powers's U-2, the government had been investigating spying from space (see box below). In 1958, the government turned to satellite-based reconnaissance with a program known as Corona.*

"Developing one of the first satellites was a daunting challenge. It took 13 launches until the first successful image was taken. However, one technical problem was so serious that it endangered the success of the program. A series of bright streaks appeared across the satellite's acetate film, in some cases completely covering the film. Ironically, given the satellite's name, these streaks were coronal discharges caused by the buildup and release of static electricity aboard the spacecraft. But where did the static electricity originate? To solve the problem, scientists and engineers in the program were joined by scientists from academia, among them Luis Alvarez, Sidney Drell, and Malvin Ruderman. Working together, these scientists correctly identified that the static discharge was a result of outgassing from the rubber rollers that transported the film through the camera. They also recommended a series of corrective actions, ranging from better grounding of components on the spacecraft to vacuum testing of components before launch. These corrective actions solved the problem, and the techniques identified by the panel are used on virtually all US reconnaissance satellites to this day. (For an overview of the Corona program, see Albert D. Wheelon's article "Corona: The First Reconnaissance Satellites," PHYSICS TODAY, February 1997, page 24.)" [From M.F. Moynihan[1], Dec. 2000]

From A.D. Wheelon, *op cit:* "*A major challenge to the Corona program occurred in 1963. Some of the returned film was completely exposed— apparently by a bright source. We judged that this was caused by corona discharge in the satellite. I persuaded Sidney Drell to take leave from Stanford University to lead a team of engineers and scientists to address this problem. With Itek engineers, they traced the problem to outgassing from the rubber rollers that transported film through the camera. By vacuum testing and careful selection of rollers, the problem was solved within a year."*

[1] https://doi.org/10.1063/1.1341915

Peek 2: "Stratospheric Nitric Oxide Production from Past Nuclear Explosions and its Relevance to Projected SST Pollution[2]" (1972)

While we were writing a Report[3] to the President, H.S. Johnston and others predicted that NO_x in the exhausts of an SST fleet in the stratosphere would catalytically impair the stratospheric ozone layer, damaging both plant and animal life.

Here is a brief quote from Drell/Foley/Ruderman:

> The 1962 U.S. Pacific nuclear tests are given as totaling 37 Mt (Ref. 13), much lower in magnitude than the USSR tests. The NO injection of these 1962 U.S. tests, some 7×10^{33} molecules, is still comparable with lower estimates of the yearly output of an SST fleet. This injection is particularly significant, however, because it took place at equatorial latitudes, where sunlight immediately supports the catalytic ozone reduction of Eq. 1. In Fig. 5 we display ozone content observations at Kodiakanal (India) 10 deg N Lat and Marcus Island 24 deg N Lat in this period. We again see no evidence of ozone reduction from the tests. Even a 5 percent effect would be apparent in this very reproducible data.

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[2] IDAHQ 72-14452 "STRATOSPHERIC NITRIC OXIDE PRODUCTION FROM PAST NUCLEAR EXPLOSIONS AND ITS RELEVANCE TO PROJECTED SST POLLUTION" by H.M. Foley and M.A. Ruderman (1972) (2 MB PDF)

[3] "Final Report of the *ad hoc* Supersonic Transport Review Committee, R.L. Garwin *et al,* March 30, 1969. https://rlg.fas.org/690330-sst.pdf

Peek 3: "Drag and Propulsion of Large Satellites in the Ionosphere; An Alfven Propulsion Engine (APE) in Space[4]" (1964)

"ABSTRACT: A conductor moving across a magnetic field B in a vacuum will have an induced charge separation sufficient to cancel the electric field E = (v x B)/c seen by a co-moving observer. When the surrounding medium is a plasma there exist possible mechanisms for charge to be conducted away with a resulting d.c. current flowing through the conductor. In this paper we consider the circulation of charge by means of the generation of Alfvén waves, a mechanism which is particularly effective for very large conductors moving in or above the earth's ionosphere. When applied to a study of the Echo satellite it gives rise to a significant damping of the orbit as mechanical energy is converted to that of Alfvén radiation. The calculated drag is equal to that observed for the orbit of Echo I and attributed in earlier studies entirely to the mechanical drag of considerable nonionized atmospheric density. Perturbations in electron density associated with this current flow may in appropriate circumstance be detectable even thousands of kilometers away from such a high altitude satellite. The drag can be changed to a propulsion mechanism when a source of electrical power is available on the satellite. Up to fifty per cent of the expended power is available for pushing a space vehicle across an ambient magnetic field."

Peek 4: "Impacts of Severe Space Weather on the Electric Grid[5]" (2011)

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[4] IDA/HQ 64-3021, "Drag and Propulsion of Large Satellites in the Ionosphere; An Alfven Propulsion Engine (APE) in Space" by S.D. Drell, H.M. Foley, M.A. Ruderman (1964).(21 MB PDF)

[5] "Impacts of Severe Space Weather on the Electric Grid" by M.C. Gregg, *et al*, 2011 https://irp.fas.org/agency/dod/jason/spaceweather.pdf

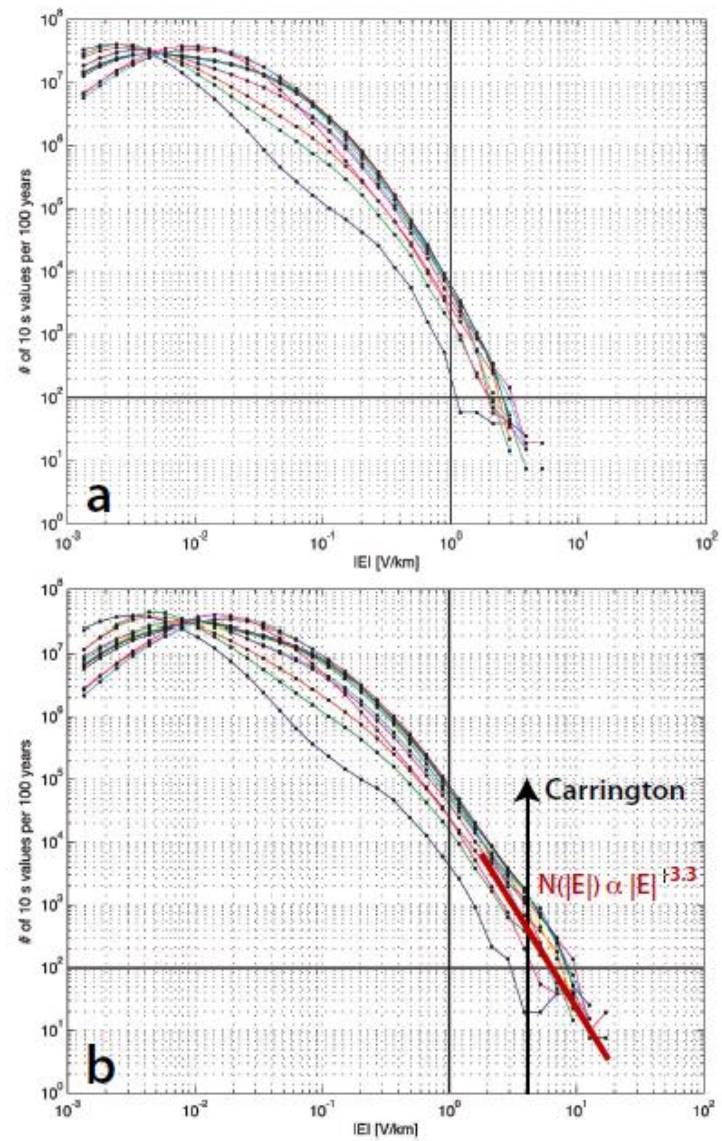

Figure 9: Number of 10 s geoelectric field magnitudes, $|E|$, produced by CME per 100 years, adapted from [41]. The estimates were made using simultaneous observations of GIC and geomagnetic fields in Finland with low and high-resistivity ground models characteristic of British Columbia (a) and Quebec (b). Each curve represents data from a different site. The arrow at 4 V/km marks the estimated magnitude of the Carrington Event, and the red line approximates power-law slopes at high magnitudes.

“The Carrington Event was the most intense geomagnetic storm in recorded history, peaking from 1 to 2 September 1859 (Wikipedia)” with induced voltage about 4 V/km (!). At the time, the only long conductors were telegraph wires. Now much of the world is powered by transmission lines hundreds of km long, with 3-phase AC transmission at 700 kV or above – “EHV” transmission lines.

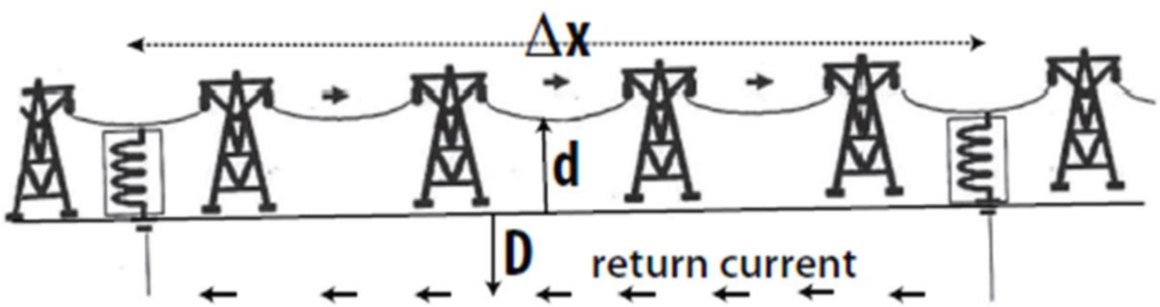

Figure 6: Schematic of a long transmission line with grounds separated by distance Δx, towers holding transmission lines d meters above the surface, and a return GIC at depth D. The magnetic field inducing the GIC is perpendicular to the page.

But how can a geomagnetic storm with peak magnetic field much less than that of the earth’s static field injure transformers that are withstanding almost a megavolt AC?

“Taking dB/dt = 10 nT/s for a strong magnetic storm, _x = 100 km, and R = 1 ohm, $I_{GIC} = 10^{-8} \times 10^{5} \times 50 = 50$ *mA when the return current is so shallow that D ~ 0. GIC of this magnitude are too small to damage grids or their components. Telegraphers discovered the importance of small loop areas when they avoided significant GIC by replacing the ground with a second telegraph wire close to the first [43]. In highly resistive ground, return flows are deep, greatly enlarging loop area but not necessarily increasing loop resistance. For D = 100 km,* $I_{GIC} = 10^{-8} \times 10^{5} \times 10^{5} = 100$ *A, far more than enough to cause serious problems.”*

Coda: I hope I’ve given you a glimpse of the topics on which Mal has been working in the summers over the decades in hardship locations such as Woods Hole, Santa Barbara, or for many of the past 40 summers, in La Jolla.

And I’ve planned for two minutes of discussion. Thank you.

/ Dick Garwin /