FATHER ZEUS

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Where have fifty years gone? It is a lifetime ago - for most of you - since Bernie Burke and I were able to recognize Jupiter as a source of radio waves. Now in this conference we see many of those who followed us in the investigation of this radiation, some making it their career. I am certainly impressed by your persistence. That the subject is still active is an indication that the radiation's properties and generation processes are not trivial, still a fascinating subject for research.

In a question period following a talk I gave in those early days at the Cosmos Club in Washington DC, I was asked if the radiation could possibly be from some intelligence there. I replied that any Jovian beings would have to have very random thought processes because as far as we could see the radiation was entirely noise, random amplitude at random phase at random interval. One of our colleagues at the Department of Terrestrial Magnetism (DTM) suggested the source was merely Thor spots.

If you have read accounts of the discovery activity [Franklin, 1959; Franklin, 1983], you know that one Monday morning Bernie noticed that the annoying noisy patches in our records had a regularity suggesting a celestial rather than a terrestrial source, but slowly moving on the sky. Howard Tatel, an associate working in the laboratory near us, suggested it was Jupiter. We never queried him about this seemingly ridiculous suggestion, but I suspect Jupiter was on his mind. He was using radio equipment on the DTM campus to search for the 21-centimeter hydrogen line that might be coming from Jupiter, a hydrogen-rich planet. A quick look in the American Ephemeris and Nautical Almanac showed Jupiter was in the region, a surprise.

That evening at home I worked out the method for checking on Jupiter as the source. Tuesday morning I made the diagram in which Jupiter's position agreed with the timing of the record. On the vertical scale I put right ascension, the longitude-like sky coordinate related to time. Across the bottom was the date. I plotted the beginning and end points at the date of each event, then enclosed them with lines. This made a path curving across the diagram. After some preliminaries, I plotted the positions for Jupiter. These points found themselves running down the middle of the path. As I plotted each point, Bernie, watching over my shoulder, said, "Wow!".

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Wednesday morning, Vannevar Bush, President of the Carnegie Institution of Washington, was in the lab, having been told of the identification. DTM Director Merle Tuve asked me to tell Bush what we had done. At the end, Bush asked me how we really knew it was Jupiter. As an astronomer, I then visualized the entire outer solar system, seeing the several retrograde loops as they grew smaller with distance. These loops, of course, are reflections of the earth's orbit around the opposition positions of the distant planets. In my mental picture, the source's position was a perfect match for Jupiter's post-opposition branch of the loop. But I knew saying, "It's obvious!" would not do. Then I said, "It has the position of Jupiter and the change of position of Jupiter." "That's good enough for me," said Bush. I had given these physicists the function and its first derivative. They needed no more.

The next meeting of the American Astronomical Society was coming up in Princeton in April, 1955, a few weeks off. We decided to keep the discovery under wraps until then. A press release was sent out with an embargo not to print anything until after Bernie had given the paper. However, as Bernie gave the report about 10:30 that morning, I was sitting in the audience reading the news in the April 6 edition of the New York Times. I guess the morning paper thought that was not beating the release time. Immediately after Bernie finished, John Kraus made some very laudatory comments, the first of many that came in the following months.

Of course, it was big news. At that time, however, the science establishment thought that giving interviews, effectively plugging one's work, was not respectable conduct. Even LIFE magazine was turned down. The media persisted, however. One was the National Broadcasting Company which had a radio program on Saturdays called *Monitor*. NBC appeared with a tape recorder, in those days about the size of a big suitcase. We decided this was OK, so it was taken out to the field and connected to the speaker circuit. This circuit was not normally part of a radio astronomy observation, but simply a means to check on the workings of the electronics.

In the literature, our telescope is described as two linear antenna arrays crossed at their centers approximately at right angles [Burke and Franklin, 1955] (see Figure 1). B. Y. Mills, of Australia's Commonwealth Scientific and Industrial Research Organization, had been visiting DTM and mentioned his design of the crossed arrays although he had not yet built it. Each array produced a fan beam that when added together resulted in a receiving lobe shaped like a pencil, because only a source seen by both fans simultaneously would be recorded. The result was to emphasize the reception from a point source. In practice, the signal from one array was switched so that it was alternately added to and subtracted from the signal from the other array. The frequency of the switch was a nominal thousand cycles per second. This audio frequency which labeled the received signal was handled by simpler electronics than the radio frequency, and was the tone heard on the speaker circuit.

For over a week, I went out to the field every day at the time Jupiter was to pass through the beam. I turned on the recorder and waited. Nothing. Then on a Friday afternoon, Jupiter performed, singing its thousand cycle song. For a full weekend, I was the only one in the world who had heard Jupiter - and who knew it.

It turns out that observers in Australia, a few years earlier, had actually heard the spitting

Figure 1: A view along one arm of the Mills Cross Array. Date unknown. Courtesy of the archives of the Carnegie Institution of Washington.

hisses of the Jupiter noise, but thought it was some sort of interference coming possibly from Indonesia. Their equipment could not discern the point nature of the source, nor its location on the sky. It took the Mills Cross to do it - and a lot of luck. Their records of these pre-discovery observations, however, were crucial to the interpretation of the nature of the source saving a lot of new observing time.

In November of 1955, the American Museum-Hayden Planetarium in New York City asked Bernie and me to come up to make a recording describing our work and illustrated with the sounds. Every January they had a program called "Twice Around the Sun" describing the discoveries of the previous year and the coming configurations of the next year. Bernie wrote a little script, and we recorded it at the planetarium facilities using a sample of the audio recording.

Bernie had errands to do in the city, but I stayed at the planetarium that afternoon to learn something of their operations. My previous visits to the Hayden had been in the audience on a couple of weekends in 1944 when I was attending the Army Signal Corps telephone school in Ft. Monmouth, New Jersey. Chairman Joe Chamberlain mentioned that they were hoping an astronomer could join their staff to insure the accuracy of their shows. Ultimately, I succumbed to the attractions of the job, always enjoying talking astronomy. I was appointed Assistant Astronomer in September, 1956, the first PhD

hired by the Hayden. I retired 28 years later, January 1, 1985, as Astronomer Emeritus and Former Chairman.

In 1955, the International Geophysical Year was in progress, and the National Science Foundation was new. I thought if I could help the public understand astronomy, they would be more inclined to approve grants for research. Some astronomy colleagues, however, regarded planetarium work as little better than prostitution. One prominent astronomer told me if I took that job, he would never talk to me again. Another told me more young astronomers should go into popularization. I felt I was firmly in the middle.

As a novelty, I hoped to be able to continue with research in this environment, so the Planetarium allowed me one fifth of my time for this endeavor. Thus I brought Jupiter with me. I received a $10,000 grant myself from the NSF. The American Museum of Natural History had a thousand acre field station on Long Island, a former estate, where I erected a simple interferometer. This was a noisy radio environment, so nothing much came from the enterprise, but ultimately I did receive a long emission from Jupiter. There were insufficient results for any formal scientific publication, but the record itself did appear as an illustration in an article I wrote for Scientific American, July, 1964. The publisher, Gerry Piel, noted that it was my only publication from this effort.

At one period in those days, the National Science Foundation had an Undergraduate Research Program. Most of those departments of the American Museum that had research projects, took advantage of the program. In this way, I had one or two qualified college students working with me each summer for a few years. All who were working on the several projects at the field station were given room and board in the estate's mansion. They had an interesting experience in field science and with each other, a memorable summer for all of us.

It was at the 1959 American Astronomical Society meetings at the Gainesville campus of the University of Florida that I was asked to tell the members how the discovery came about. This story was later published in the Astronomical Journal [Franklin, 1959]. Apparently, it was widely read, as it is mentioned in several books I know of. A few years later, in a compilation of the papers presented at a Tucson seminar on Jupiter edited by Tom Gehrels, one paper leads with the remark that the discovery "is a well-known astronomical anecdote" [Berge and Gulkis, 1976]. Martin Harwit discussed it extensively in his book *Cosmic Discovery*. At a meeting concerning astronomical history in Philadelphia in 1982 where I gave a talk on the discovery, James Van Allen came to me afterward to tell me he used the tale to tell his students how research actually took place instead of as in the usually polished versions in published papers. Well, it was fun to live through it. And to have this conference to commemorate that event.

Here and now, these evenings, look to the east. That bright object near the horizon is Father Zeus - Zeus Pater - Jupiter. On this Friday evening, the nearly full moon and Jupiter will be very close together. In time, other regions of the radio spectrum have been used to observe Jupiter. In this way it was found that Jupiter possesses a very strong and extensive magnetic field. From here as we look at the planet, it does not seem its full eleven times the width of the earth. But if we could see radiation from that magnetic field, its Van Allen belts, Jupiter would subtend a full five degrees across the

sky, ten times the apparent diameter of the nearby moon. If we could see the decametric radiation we have been discussing, it would be sporadic sparkles nearer the huge ball.

Having dinner the evening before our paper at the 1955 Princeton meeting, Bernie and I were sitting at a large table in a dining hall. Subramanyan Chandrasekar, pre-eminent astrophysics theorist, was across from us. Bernie asked him if there was any reason why there should be radio radiation from Jupiter. He said there was not. When Bernie told him we had detected it, Chandra's face became sober, but he did not reply. In those days, the realm of astrophysics did not include the solar system aside from the sun. The solar system was the realm of celestial mechanics and of observers who studied the features and their changes on the surfaces of the planets seen indistinctly through our turbulent atmosphere. It is possible that students of the history of solar system research regard that discovery in 1955 as opening a new door on solar system studies.

Bernie, as you said "Wow", little did we know that fifty years later we ourselves would become astronomical archives.

I thank all involved for the remembrance - and for this occasion to reminisce.

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