# THE BIRTHPLACE OF PLANETARY RADIO ASTRONOMY: THE SENECA, MARYLAND OBSERVATORY 50 YEARS AFTER BURKE AND FRANKLIN'S JUPITER RADIO EMISSION DISCOVERY

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**Abstract**

Burke and Franklin's discovery of radio emissions from Jupiter in 1955 effectively marked the birth of planetary radio astronomy. The discovery was made near Seneca, Maryland using the Department of Terrestrial Magnetism/Carnegie Institution of Washington's (DTM/CIW) Mills Cross Array. Fifty years later no evidence of this 96-acre X-shaped array of dipoles remains. The site, now known as the McKee-Beshers Wildlife Management Area, is owned by the State of Maryland Department of Natural Resources. This workshop and Radio Jove (`http://radiojove.gsfc.nasa.gov`), a NASA/GSFC education and public outreach project, have put special emphasis on making this event known to the scientific community and the general public. We describe some results of our search through the DTM/CIW archives, our success at having the state of Maryland officially recognize this historic site, our own visit to the site to look for evidence of the array, and other efforts at commemorating this anniversary.

## 1 Introduction

On April 6, 1955, at a meeting of the American Astronomical Society, Bernard Burke and Kenneth Franklin of the Carnegie Institution of Washington announced their discovery of strong, sporadic radio emissions from the planet Jupiter. This discovery, made at an observatory near Seneca, Maryland, was widely reported in the popular press and among the scientific community. Several institutions began Jupiter radio observing programs across a wide portion of the radio spectrum. Other observers went back through their records to find pre-discovery Jupiter radio data [Shain, 1956].

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Kraus [1956] noted, “The discovery by Burke and Franklin (1955) of radio emissions from Jupiter has opened a new field of radio astronomy”. Carr, Desch, and Alexander [1983] wrote, “The accidental discovery of the low-frequency Jovian radio emission by Burke and Franklin [1955] holds a special place in the history of solar system exploration. This discovery antedated many of the established historical landmarks, including the discovery of the Earth’s radiation belts [Van Allen et al., 1958], the verification of the existence of a solar wind [Neugebauer and Snyder, 1962], and even the dawn of the space age itself in 1957. It foreshadowed a revolution in the thinking about the nature of planetary bodies and especially of their magneto-plasma environments.”

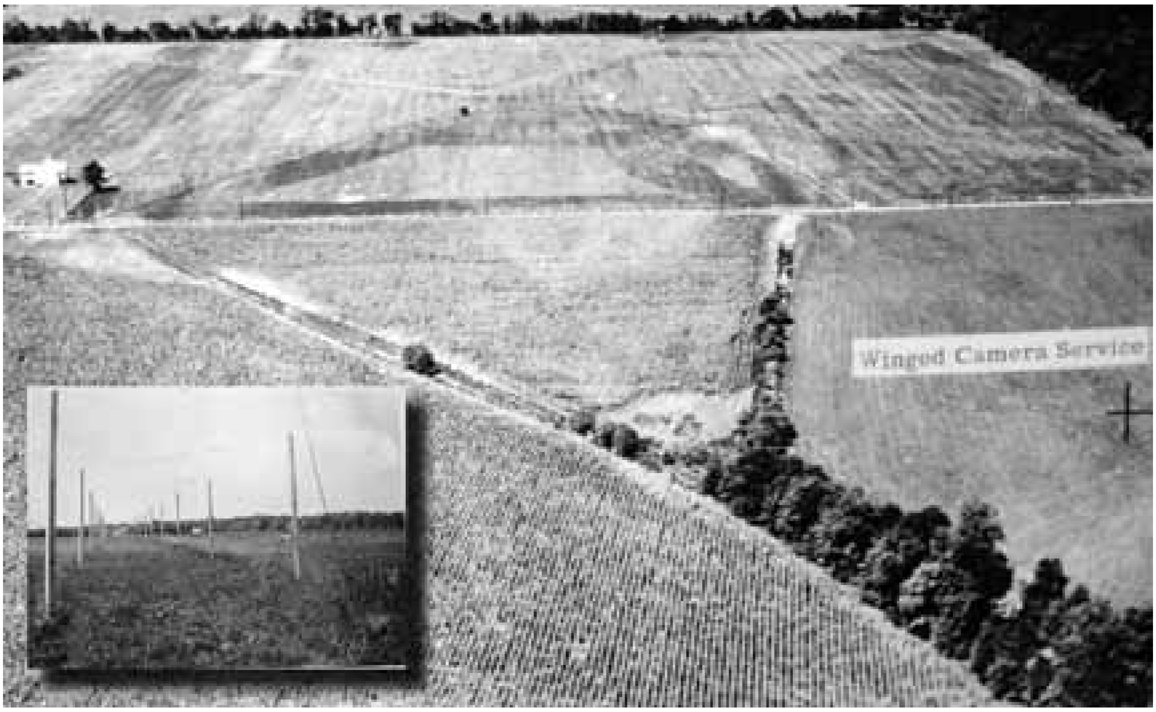


*Figure 1: A view of the DTM/CIW Mills Cross Array looking towards the West. Date uncertain. The Mills Cross can be faintly discerned as the ’X’ shaped pattern in the background beyond the road that extends from left to right across the image. Inset: A view along one arm of the array. Images courtesy of the Archives of the Carnegie Institution of Washington.*

The Mills Cross Array (see Figure 1) described in Burke and Franklin [1955] and elsewhere [Burke, 1956; Burke et al., 1954; Burke et al., 1955; Franklin, 1959] was built at the DTM installation on River Road near Seneca, Maryland and began operations on July 20, 1954. The array was based on the antenna design of Mills and Little [1953], utilized a phase-switched receiver and operated at a frequency of 22.2 MHz. The switching frequency was nominally about 1000 Hz [Franklin et al., 2005]. The antenna system consisted of a pair of 2048 feet (624 meter) long linear dipole arrays each consisting of 64 equally-spaced dipoles [Burke et al., 1954] arranged to form a slightly flattened X.

April, 2005 marked the 50th anniversary of Burke and Franklin’s disocvery of Jovian radio emissions. Several different events were organized to celebrate this anniversary. In this article we will discuss our work in searching for the original location of the Mills Cross

Array and our efforts to bring attention to this anniversary and the field of planetary radio astronomy in general to students, teachers and the general public.

## 2 The search for the Mills Cross Array

Our search for the Mills Cross Array began with a study of materials from the archives of the Carnegie Institution of Washington(CIW). Shaun Hardy, CIW librarian generously assisted us in our search by providing photos of the early radio astronomy equipment owned by the DTM, a map of the Seneca Observatory, copies of newspaper clippings and the press release for the Jupiter radio emissions discovery. The press release and the CIW Yearbooks made it clear that the array was located at the Department of Terrestrial Magnetism (DTM) installation off of River Road near Seneca, Maryland. The map, dated January 1956, was mostly of a region along the northern bank of the Potomac river in Montgomery County, Maryland. Upon this map were handdrawn markings and margin notes indicating the locations of antennas and other features. We assume that the margin notes were written by Merle A. Tuve, director of the DTM at the time, from the initials 'MAT' in the margin. The markings were relatively crude and gave no clear indication of the Mills Cross Array site. A comparison of this map with current maps clearly shows that this area is now part of the State of Maryland Department of Natural Resources McKee-Beshers Wildlife Management Area. Figure 2 shows an overlay of a portion of the 1956 map with a recent (1988) aerial photo. There is excellent agreement between the map and photo especially of the shorelines and islands in the Potomac. To further refine our estimate of the Mills Cross Array location, we recognized several features that are common in the recent aerial photo (Figure 2) with the photo taken decades earlier (Figure 1). The road or trail and the Y-shaped line of trees in Figure 1 appear to be the same features seen clearly in the lower left photo of Figure 2. If these are the same features the array would be located in a heavily marked-up region on the map just to the right of center (the white X in the right panel of Figure 2 indicates the probable array location). In August 2004 and January 2005 we visited the site, which showed no indication that this area once had been a radio observatory. We found that the Y-shaped feature is part of a stream channel. The entire area now consists of wetlands as well as alternating narrow bands of forests and plowed land. On our January visit, while exploring within one of the narrow forested regions, we discovered the foundation of a small structure located where we would expect the house on the far left of Figure 1 to have been located. From these lines of evidence we conclude that the center of the Mills Cross Array was located as indicated by the white X in Figure 2 at latitude 39.078° and longitude -77.394°.

## 3 Bringing Jupiter to the Public

Based on our archival research and in-person site investigation (which provided a measure of "ground truth" to our research) we submitted an application to the Maryland Historical Trust for a roadside historical marker. The application discussed not only our evidence for the placement of the marker at this site but also the historic significance of

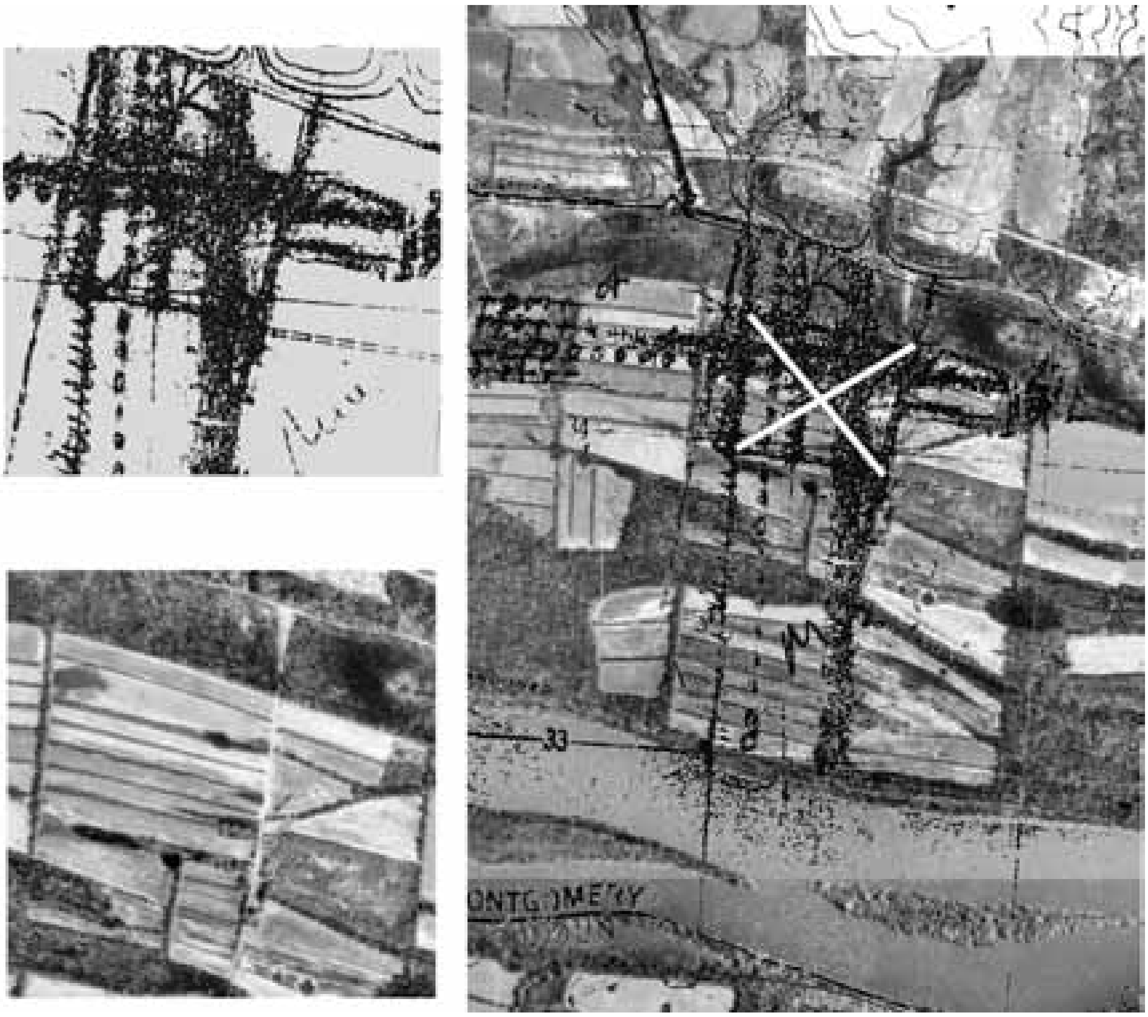


*Figure 2: Right: An overlay of a handdrawn map of the Seneca Observatory antenna locations c. 1956 on a photograph of the McKee-Beshers WMA taken in 1988. The white X indicates our identification of the Mills Cross array site. Upper Left: A close up view of the portion of the map which we have identified as the array site. Lower Left: The same region without the overlay showing the trail (running top to bottom right of center) and the Y-shaped line of trees (right of center) the location of which matches that in Figure 1. Map courtesy of the Archives of the Carnegie Institution of Washington. North is towards the top in the figure.*

the site to citizens of the state of Maryland. The application noted that not only was this discovery important in the history of astronomy and our understanding of planetary magnetospheres and space plasmas, but that the state of Maryland continues to be the site of important research in magnetospheric physics. The application also cited the work of NASA's Radio Jove education and public outreach project in teaching students and the public about science by enabling them to make their own observations of Jovian and Solar radio bursts with antennas and receivers they build themselves. Radio Jove (http://radiojove.gsfc.nasa.gov), based out of NASA/Goddard Space Flight Center in Greenbelt, Maryland, has distributed over 800 kits to students and radio amateurs in nearly every state and 30 countries. The roadside historic marker application was accepted in November 2004 and on April 6, 2005 the marker (see Figure 3) was placed along River Road at an unpaved parking area about 13.8 miles from the River Road exit of the Washington Beltway and about 1 mile from the array location.

Other events that took place at this time to recognize this anniversary included an international teleconference with Drs. Burke, Franklin and over 50 students, radio amateurs and scientists. This teleconference was recorded; we are working on posting segments of it on the Radio Jove website and will be donating a copy of the recording to the CIW archives. On April 5 and 6, two episodes of an astronomy radio program broadcast in the United States, *StarDate* (in English) and *Universo* (in Spanish), featured stories on Jupiter radio emissions and its discovery. This 6th International Workshop on Planetary and Solar Radio Emissions featured several talks and posters that discussed the history of Jupiter radio astronomy research and had Dr. Burke as an invited speaker. In September of this year the Department of Terrestrial Magnetism will be sponsoring a series of talks and a reception for Drs. Burke and Franklin at their campus in Washington D.C.

## 4 Conclusion

This anniversary is occurring at a time of renewed interest in low-frequency radio astronomy and of an exciting new age of exoplanetary research. Radio astronomy had its birth at 20 MHz with Karl Jansky's discovery of the galactic background radio emission. Limitations in spatial resolution and the effect of Earth's ionosphere made progress in low frequency radio astronomy difficult. Cutting-edge research in this portion of the radio spectrum was virtually abandoned until the development of techniques to overcome the ionospheric distortion. The 74 MHz system on the Very Large Array, and new projects like the Low Frequency Array (LOFAR), the Long Wavelength Array (LWA), the Mileura Widefield Array (MWA) and the Giant Meterwave Radio Telescope (GMRT) are providing ever greater sensitivity and spatial resolution in this region of the spectrum.

We have sent several planetary radio astronomy experiments on probes to the outer planets. A wealth of new insights into planetary magnetospheres has been gained over the last three decades from these missions. We can expect more surprises from the data coming back from the Cassini mission to Saturn. The most studied planetary magnetosphere of course is Earth's and a flotilla of spacecraft continue to provide details on the complicated interplay of our magnetosphere, the Sun, and interplanetary space plasmas [Lang, 1997].

The discovery of exoplanets is providing new views on planetary system formation and evolution. These new planetary systems are dominated by Jupiter-sized or larger planets orbiting very close to their parent stars. There has already been evidence of at least one case of magnetic interactions between an exoplanet and its parent star [Skolnik et al., 2003]. A search for Jupiter-like radio emissions has recently taken place at the UTR-2 in the Ukraine, [Ryabov et al., 2004]. Certainly the search for exoplanetary radio emissions is an important objective for the new arrays mentioned above.

This anniversary allows us to put into context these exciting developments. We can look back at where this field had been, recognize the achievements of the past 50 years and

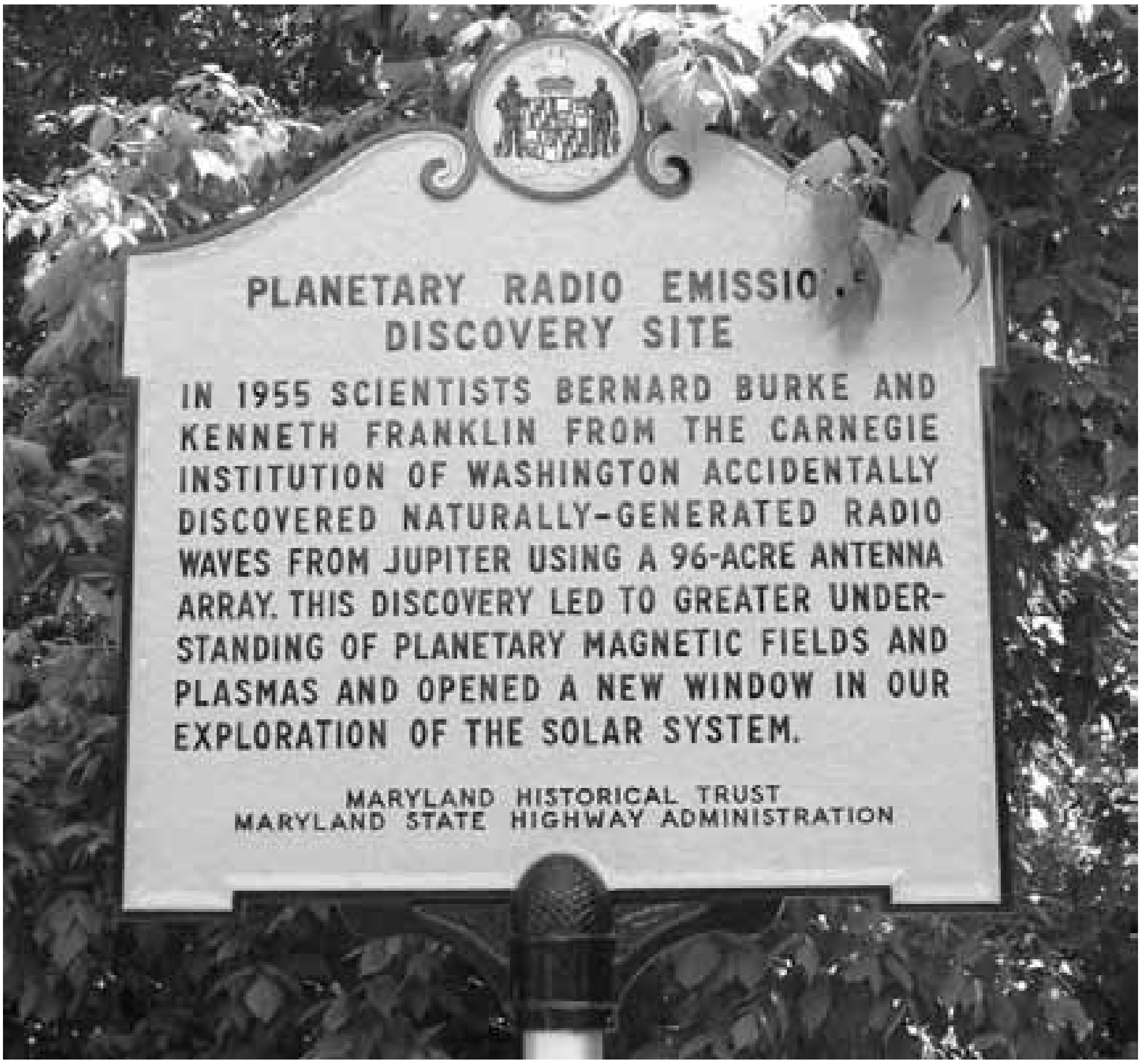


*Figure 3: The roadside historic marker installed in April 2005 by the state of Maryland near the former Seneca Observatory site.*

anticipate the first detection of radio emissions from an exoplanet. The anniversary also can serve to educate the youth and the general public. Just as this discovery inspired scientists 50 years ago we may use this anniversary to inspire a new generation.

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