

TRANSISTOR MUSEUM™

THE FIRST TRANSISTORS IN SPACE

PROFESSOR DON GURNETT ORAL HISTORY

The 60th Anniversary of the First Satellite Signals
from Earth's Dawn Chorus



DETECTING EARTH'S DAWN CHORUS FROM SPACE

Launched December 13, 1962, from Vandenberg AFB, the Iowa-3 satellite carried aloft a remarkable instrumentation package that had been developed at the [University of Iowa](#) by the satellite research team led by Dr. James Van Allen. A major contribution to the historic importance for Iowa-3 was the successful operation of the Very Low Frequency (VLF) wide-band receiver, which was one of [11 experiments conducted by the satellite](#). The VLF receiver and associated spectrum analyzer and digital telemetry performed flawlessly and represent the first space-borne instrumentation to detect and analyze the naturally occurring very low frequency radio waves known as the "Earth's dawn chorus" ([Audio link here](#)). This pioneering work established a new and important field of space science known as Plasma Wave Physics. Of singular note to the historic importance of this foundational contribution in the field of Plasma Wave Physics is the well-[documented work of Don Gurnett](#), who, as a young undergraduate student working in Van Allen's lab, designed and built the electronics package for the Iowa-3 VLF receiver instrumentation. Don's work with satellites had begun even earlier [in 1959 when he approached Van Allen](#) for a job in the UI satellite lab. Since that time, Professor Don Gurnett has achieved international recognition for his pioneering work with space-borne plasma wave physics, including the historic interstellar radio wave reception from [Voyagers 1 and 2](#). In 2019 Don retired from the [University of Iowa after a 60+ year academic](#) career. Shown in the photos above are: At center from 1962, a young Don Gurnett with the Iowa-3 satellite - his right hand highlighting the unique dipole antenna he designed for the VLF receiver. At left: Don with other Iowa-3 team members and at right, James Van Allen and Don Gurnett from 1980s with photo of Voyager. (Courtesy of the University of Iowa Center for Advancement).

The Sounds of Earth's Dawn Chorus

On a winter's eve in late December 1962 at the UI satellite lab in Iowa City, a signal was sent to turn on the transmitter of the orbiting Iowa-3 satellite. Don Gurnett's VLF onboard instrumentation was activated and, according to Don, "We immediately heard an [astonishing combination of whistlers, dawn chorus](#) and other strange VLF radio sounds". This milestone marked the beginning of space-borne plasma wave physics and established Don Gurnett as a leading contributor for subsequent historic missions including Galileo and Voyager. [Professor Gurnett's memoir](#) recounting his many contributions to Plasma Wave Research has been recently published by the American Geophysical Union.

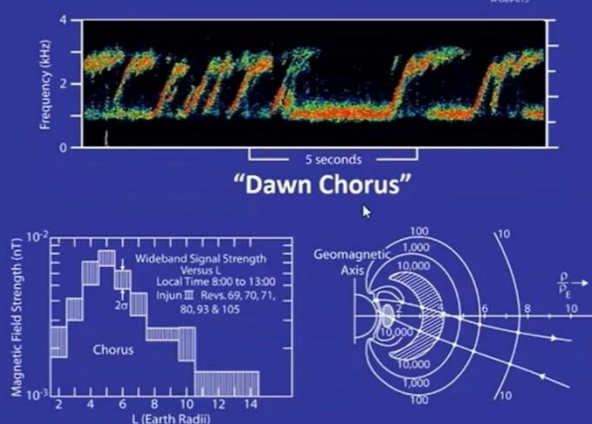
TRANSISTOR MUSEUM™

THE FIRST TRANSISTORS IN SPACE

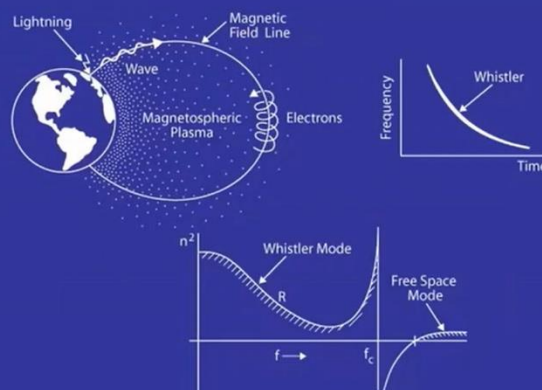
PROFESSOR DON GURNETT ORAL HISTORY

The Iowa-3 Satellite Detects and Transmits VLF Signals from Earth Orbit in 1962

Musical Radio Emissions From The Van Allen Belts



Whistlers: Radio sounds produced by lightning



Earth's Dawn Chorus

Chorus waves in Earth's magnetosphere are generated in the Van Allen radiation belts by electrons spiraling along Earth's magnetic field lines in this region. Once generated, the chorus waves interact with the moving electrons, disturbing the spiral orbit of the electrons and causing them to fall into Earth's upper atmosphere along the magnetic field lines.

Chorus waves consist of a rapid succession of intense ascending tones, rising in frequency over very short time intervals, each tone lasting typically less than one second. The frequencies of these rising tones occur in the audio frequency range and sound like a dawn chorus of chirping birds, a sound that gives these waves their name.

[Use this link for VLF Space Audio for Earth's Dawn Chorus transmitted by Don's VLF instruments on Iowa-3](#)

Planetary Lightning and VLF Whistlers

Whistlers are produced by lightning and travel along Earth's magnetic field line from one hemisphere to the other, as shown in this illustration. In the ionized gas that exists in this region of space, the high frequencies travel faster than the low frequencies, thereby dispersing the wave from the lightning strike into a whistling tone that decreases in frequency with increasing time, hence the term "whistler."

[Use this link for VLF Space Audio for Earth Whistlers transmitted by Don's VLF Instruments on Iowa-3](#)

[Use this link for VLF Space Audio for Earth Multi-Hop Whistlers transmitted by Don's VLF Instruments on Iowa-3](#)

[Use this link for VLF Space Audio for Earth Proton Whistlers transmitted by Don's VLF Instruments on Iowa-3](#)

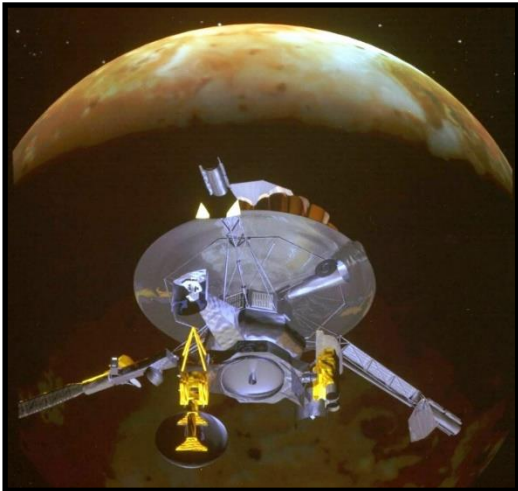
The above information documents some of the important findings of Don Gurnett's early work with the VLF instrumentation on the Iowa-3 satellite. A much-expanded repository of this work, including Don's later contributions to the success of the Voyager 1 and 2 spacecraft, can be found at the [University of Iowa Space Audio website](#). The information shown above has been provided by Don Gurnett and is used with permission. Original audio from space-audio.org.

TRANSISTOR MUSEUM™

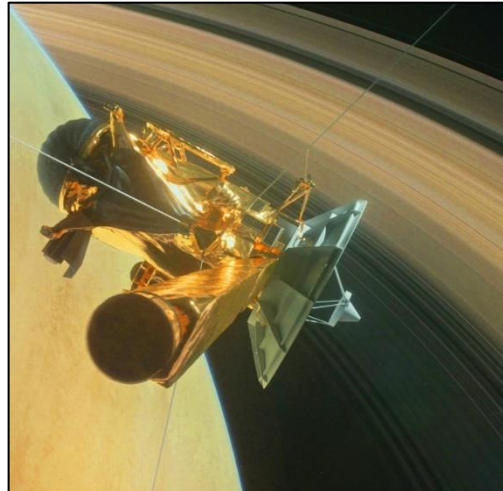
THE FIRST TRANSISTORS IN SPACE

PROFESSOR DON GURNETT ORAL HISTORY

Don Gurnett's Plasma Wave Science Instrumentation Explores the Outer Planets and Interstellar Space



Galileo: Launched in 1989, Galileo was the first spacecraft to orbit an outer planet, with 34 orbits around Jupiter. Don Gurnett was NASA's [Principal Investigator for the Galileo Plasma Wave Physics System](#). The PWS instruments performed successfully and returned large amounts of Jovian scientific data, including this [audio](#) generated by Galileo PWS instrumentation during a fly-by of Ganymede, one of Jupiter's moons.



Cassini: Launched in 1997, the Cassini spacecraft and its attached Huygens probe began a seven-year journey to Saturn and completed 294 orbits of the ringed planet. As the [initial principal investigator](#) on the Radio and Plasma Wave Science Instrument, Gurnett obtained the first radio and plasma observations of the Saturn auroras and magnetosphere. Audio signals [here](#) and [here](#) document some of the spectacular results of the RPWS.



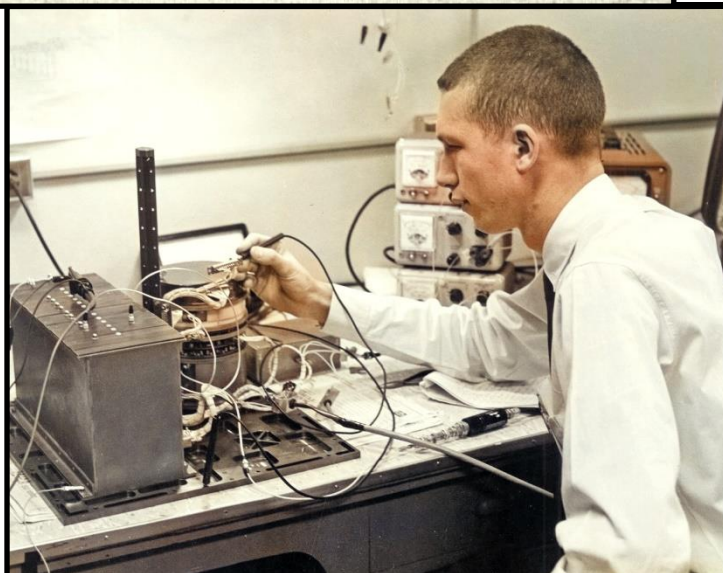
Voyagers 1 and 2: Perhaps the most compelling and significant accomplishment for Dr. Gurnett's Plasma Wave Science instrumentation is associated with the Voyager 1 and 2 spacecraft, both launched in 1977 and both providing unparalleled scientific data for 45 years and counting. See [Don's YouTube presentation](#) on this topic and [listen to the historic confirmation](#) provided by Don's PWS system that Voyager 1 had entered interstellar space.

TRANSISTOR MUSEUM™

THE FIRST TRANSISTORS IN SPACE

PROFESSOR DON GURNETT ORAL HISTORY

Designing Model Airplanes, Using Vacuum Tube Radio Controls and Working with Early Transistors



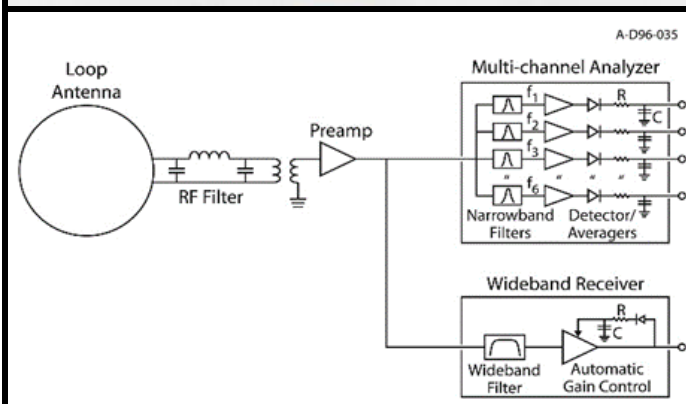
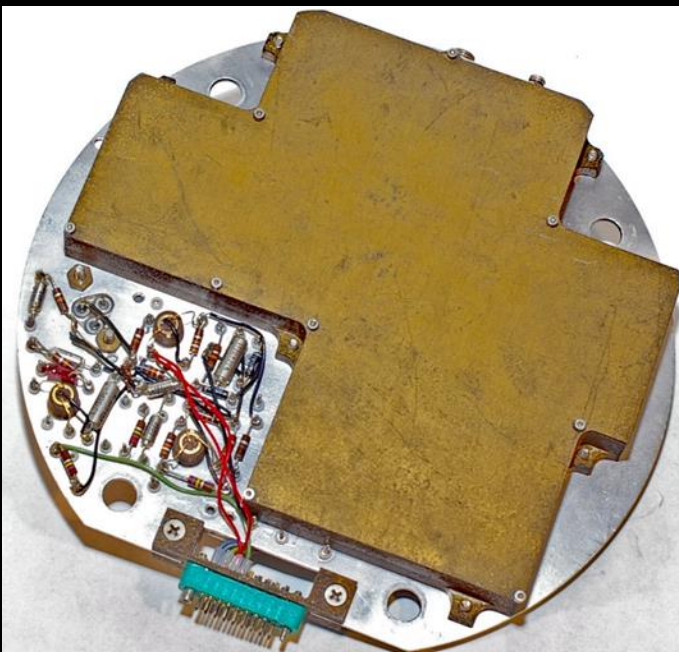
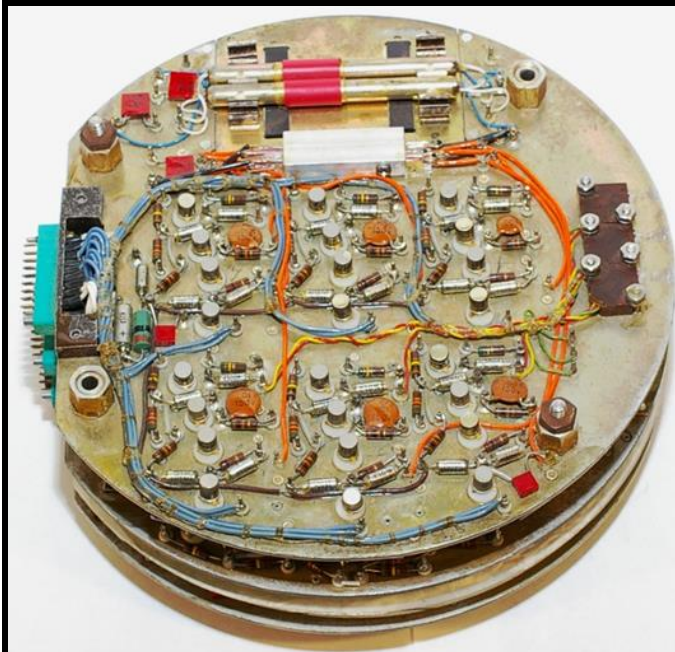
Don Gurnett was very actively involved in [model airplane design and national competitions](#) from an early age, beginning in the late 1940s. At left is a 1956 photo of Don building a powered model airplane of his own design. The photo at top shows a kneeling [Don Gurnett behind his wide wingspan model plane](#), which won the 1957 Clipper Cargo competition sponsored by Pan American. Most [radio controlled models](#) of the time used vacuum tube technology since transistors were just beginning to appear in these types of applications. The 1961 photo at right shows Don as an undergraduate tech working on early transistorized satellite gear in Van Allen's lab.

TRANSISTOR MUSEUM™

THE FIRST TRANSISTORS IN SPACE

PROFESSOR DON GURNETT ORAL HISTORY

Early Fairchild Planar Transistors Function Successfully On The Iowa-3 Satellite



NPN SILICON PLANAR TRANSISTORS
2N910 2N911 2N912
Tentative Specifications April 1961



FAIRCHILD
SEMICONDUCTOR
CORPORATION

EARLY SILICON TRANSISTORS FUNCTION SUCCESSFULLY ON IOWA-3

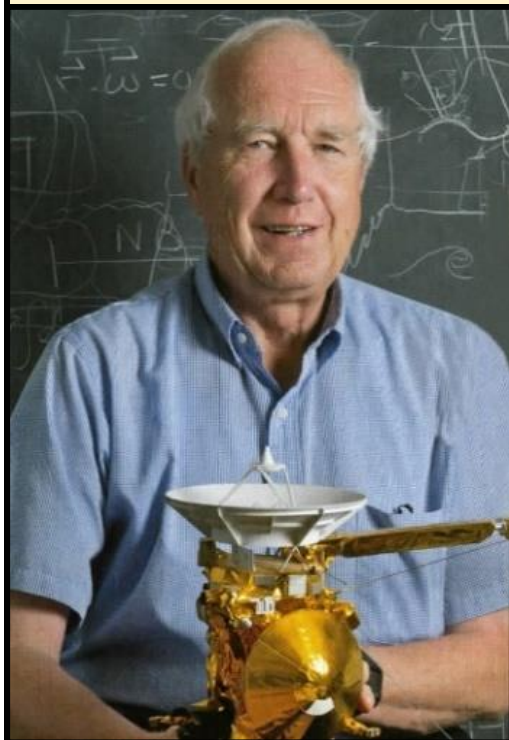
Shown above at top are circuit boards used to implement the radio and plasma wave instrumentation for the Iowa-3 satellite. At this time in 1962 Don Gurnett was working as an undergraduate engineering student in James Van Allen's lab and had been assigned the systems engineering role for developing this hardware package. According to [Don's memoir](#), the six-channel spectrum analyzer (shown top left and diagram below) was contracted to Raytheon, and the VLF receiver and preamplifier circuit (top right) was designed and built by the UI team. The transistors that Don used in these circuits are all Fairchild 2N9XX types dated 1962 and represent one the first space-borne applications for the just-released Fairchild silicon planar technology. Earlier satellite electronics, for example the [Explorer 12](#) launched in mid-1961, used first-generation [Fairchild silicon types such as mesa](#). Don's VLF instrumentation package performed flawlessly on Iowa-3.

TRANSISTOR MUSEUM™

THE FIRST TRANSISTORS IN SPACE

PROFESSOR DON GURNETT ORAL HISTORY

From Hand-Built Championship Model Airplanes in the 1950s to Interstellar Space 60 Years Later



IN MEMORIAM — DON GURNETT

I first contacted Professor Don Gurnett in February 2021 to inquire about his interest in working with the Transistor Museum to document his Oral History with a special focus on his pioneering achievements in spacecraft electronics instrumentation. Don responded with enthusiasm about this project, and I had the real pleasure of working with him over the next 11 months, with many enjoyable hours of phone interviews and email exchanges. Sadly, [Don passed away](#) on January 13, 2022, before this Oral History was finalized. He did review earlier drafts and was particularly enthusiastic about including photographs he provided from his early days of designing and flying model airplanes. Don was very moved by the photo above right, which was taken in the mid-1950s and shows him with a prized hand-built glider. The original photo was black and white, and it has been colorized for this Oral History with Don's direction to best match his recollection of that summer's day long ago in the Iowa countryside near his family home. Don felt strongly that his later accomplishments in spacecraft missions were made possible in large part by his dedicated youthful involvement with mid-century model airplane technology.

The 2010 photo at left shows Professor Gurnett with a model of the Voyager spacecraft. Launched in the late 1970s and currently 14 billion miles away from Earth, the [two Voyagers are still sending back data](#). Voyager 1 entered interstellar space in 2012, and [confirmation of this historic event](#) was made possible by radio signals from the spacecraft relaying data from Don's onboard PWS instrumentation. A remarkable legacy indeed for the young man who gazed up at the clear blue Iowa sky all those years ago.

TRANSISTOR MUSEUM™

THE FIRST TRANSISTORS IN SPACE

PROFESSOR DON GURNETT ORAL HISTORY

Additional Resources Documenting Don Gurnett's Extensive Lifetime Career Achievements

ITEM	DESCRIPTION
1	Professor Gurnett's memoir — published in 2020 by the American Geophysical Union. This paper discusses Don's recollections concerning the origins of space radio and plasma wave research at the University of Iowa. Begins with details of Don's work as a freshman engineering student in 1958 at James Van Allen's lab at the University and provides technical and personal perspective on important spacecraft achievements through the subsequent early years of space exploration.
2	University of Iowa Website, (Iowa Now) — Posted January 2022, "Legendary Iowa space physicist Donald Gurnett dies." Don's career at the University of Iowa spanned more than 60 years, and this UI website provides comprehensive coverage of his work at the university.
3	Don Gurnett CV — This University of Iowa curriculum vitae provides a comprehensive list of the many spacecraft that Don has been associated with since the 1960s. Also listed are Don's many teaching and academic accomplishments.
4	Voyager 1 Mission on YouTube - 2013 video on YouTube presented by Don Gurnett and Bill Kurth. Celebration and technical overview on the occasion of Voyager 1 entering interstellar space.
5	Dawn of the Space Age to Interstellar Space — A very recent 2021 Zoom presentation by Don Gurnett on YouTube to the Cleveland Astronomical Society. In this presentation Don discusses astronomy, 60 years of space-age history and his own personal recollections .
<p style="text-align: center;">Notes on the photographs and images used in this Oral History</p> <p>Photos used on pages 1, 2, 4 and 5 are Credit: Don Gurnett and colorized with permission. Van Allen Photo on page 1 courtesy of the University of Iowa Center for Advancement. Spacecraft photos used on page 3 are Credit: NASA. Don Gurnett photograph with Voyager model on page 6 is Credit: IOWAN/Mark Tade. Don Gurnett photograph with glider on page 6 is Credit: Don Gurnett and colorized with permission.</p>	

The Transistor Museum wishes to thank the Gurnett family for their support during the writing of this Oral History. We also wish to thank the University of Iowa for support and permission to use selected material.