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Robert Helliwell, pioneer of whistler-mode research

D. L. Carpenter and U. S. Inan

Space, Telecommunications and Radioscience Laboratory, Stanford University, Stanford, California, USA

Correspondence to: D. L. Carpenter (don_carpenter@hotmail.com)

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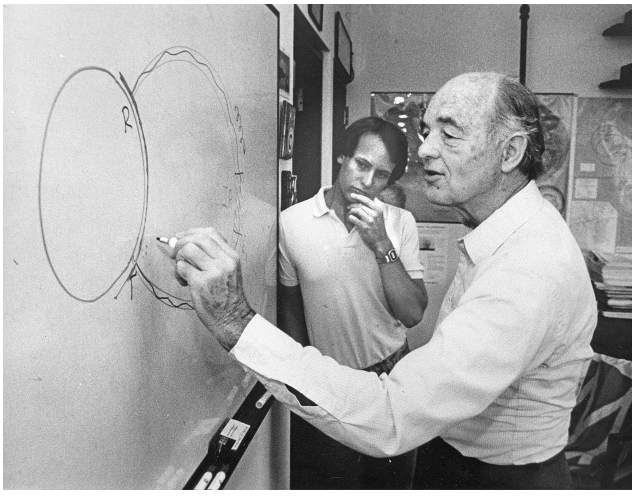

Robert Helliwell, a true pioneer of radio probing of the Earth's space environment, has passed away at the age of 90. He worked in the Electrical Engineering Department at Stanford as a graduate student, as a research scholar, and then as a faculty member for a period of 69 yr. As an expert on what he called the "hot" and "cold" magnetospheres, he was one of the first to recognize and then exploit the great potential of whistler mode waves not only as remote probes of the structure and dynamics of the dense thermal component of the magnetospheric plasma, but also as probes of interactions between slow-mode waves and the tenuous hot plasmas of the earth's radiation belts. He made pioneering contributions in both these areas, beginning in the mid to late 1950s with ground based observations of whistler mode signals propagating from lightning sources or Very Low Frequency (VLF) transmitters along geomagnetic field aligned paths whose endpoints ranged from Alaska to Antarctica. Highlights of this early work were discovery of the so-called nose whistler, whose dispersion properties allowed identification of the field line trajectory of a received whistler, and the observation of wave emissions triggered through nonlinear interactions with transmitter signals. Data from the whistler network acquired during and following the 1957–1958 International Geophysical Year (IGY) became the basis for global maps of the earth's inner plasma envelope, or plasmasphere, with its unexpected sharp outer boundary, the plasmapause (first reported by one of Helliwell's associates, a former student).

Symbolic of the great scope of this early work is Helliwell's classic monograph, published in 1965 (and republished recently by Dover Press) on "Whistlers and Related Ionospheric Phenomena". That work remains unrivalled as a reference on the spectral properties of both whistlers and a variety of VLF emissions.

Realizing that above the ionosphere there exist a rich variety of "non ducted" whistler mode waves that do not penetrate to ground receivers, Helliwell worked with colleagues on the pioneering OGO satellite series of the 1960s. Previously unobserved classes of lightning induced whistlers, of transmissions from powerful VLF transmitters, and of naturally occurring discrete and diffuse VLF emissions were observed and their propagation paths inferred through ray tracing.

Helliwell's crowning achievement was the establishment of a program of active wave experiments at Siple Station near L = 4 in West Antarctica. Conducted between 1973 and 1988, those experiments produced a rich body of data on the properties of the Coherent Wave Instability, by which weak injected narrow band (<10 Hz bandwidth) waves propagating along field aligned paths regularly underwent fast temporal growth by of order 30 dB to saturation levels and also triggered free running emissions. While it was Helliwell's dream, largely unfulfilled, to find a simple explanation for

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this remarkable phenomenon, the complexities of the CWI were none the less revealed, such that in this area experiment moved (and remains today) well ahead of theory.

Robert Helliwell's contributions as a researcher, teacher, and member of the science community were many. At Stanford he fostered a strong sense of group loyalty and a collegial atmosphere in which members could each work with a large measure of independence. He authored or co-authored over 130 papers and supervised the work of 44 doctoral students. In 1972 he received the Appleton Prize from the International Radio Science Union (URSI) for outstanding contributions to ionospheric research. He was a Fellow of IEEE as well as AGU, served as President of the AGU section on Solar Terrestrial Relations, and chaired several committees of the National Academy of Sciences. His legacy and contributions continue through the work of his many former students and the ongoing work of the Stanford VLF Group.

The attached photo shows Helliwell in 1985 discussing Siple transmitter experiments with graduate student Dave Shafer, who wintered over at Siple as a field engineer in 1983.

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