

This Week's Citation Classic

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Evans J V. Theory and practice of ionosphere study by Thomson Scatter radar.
Proc. IEEE 57:496-530, 1969. [Lincoln Laboratory, MIT, Lexington, MA]

The paper reviews the 'Thomson Scatter' or 'Incoherent Scatter' technique for studying the earth's ionosphere and upper atmosphere by means of high-power ground-based radar systems. Most of the theoretical and experimental papers dealing with the technique prior to 1968 are cited. [The SC[®] indicates that this paper has been cited over 130 times since 1961.]

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"The study, by means of radiowave reflections, of the region of the earth's atmosphere that is ionised by the sun (the ionosphere) was begun in 1924-25 by Sir Edmund Appleton, G. Breit, and M. Tuve.¹⁻³ In 1958, it was recognized that radiowaves that are of too high frequency to be reflected by the ionosphere also can be used for this work if a sufficiently powerful radar is constructed so that the scattering from the randomly moving thermal electrons can be detected. Experimental verification followed quickly, and experiments during the early 1960s with a number of high-power radars showed that this 'Thomson Scatter' allowed the determination of the electron density, electron and ion temperatures, and some information on the ionic species as func-

tions of altitude. Moreover, from the temperatures of the charged particles, it was possible to infer the temperature of the neutral atmosphere over much of the region above 100 km. Finally, by observing the bulk motion of the plasma, one could infer the neutral winds and electric fields that drive the ions, as well as the fluxes of ions that leave the ionosphere along magnetic field lines and enter the outermost part of the earth's atmosphere—the magnetosphere.

"Recognizing the limitations of most existing radars to pursue these studies, I was persuaded in 1966 to spend a year as a visiting professor at the University of Illinois in Urbana to help promote the idea of constructing a new system specially designed for upper atmosphere studies. While I was there, I wrote a report that attempted to review Thomson Scatter technique as applied to these ionospheric investigations.⁴ The project to build the radar did not succeed, and in 1968, following my return to Lincoln Laboratory, I reorganized much of the material in the report into a review paper I had been asked to write for the *Proceedings of the IEEE*.

"The Incoherent Scatter technique enjoys increasing use and a growing number of papers are being published based on it. The review is widely cited because it obviates the need in these papers to enter into a detailed description of the technique. While it is pleasing to have written a much-cited paper, one would prefer it be for some scientific discovery of fundamental importance!"

1. Appleton E V & Barnett M A F. On some direct evidence for downward atmospheric reflection of electric rays. *Proc. Roy. Soc. London* 109:621-41, 1926.
2. Breit G & Tuve M. A test of the existence of the conducting layer. *Phys. Rev.* 28:554-73, 1926.
3. A radio method for estimating the height of the ionosphere conducting layer. *Nature* 116:357, 1925.
4. Evans J V. *Design considerations for a Thomson Scatter radar*. Urbana, IL: University of Illinois, Aeronomy Lab., Report 17, 1967.