RADIOPHYSICS

An Ion Gyrofrequency Phenomenon observed in Satellites

Barrington and Belrose[1], Gurnett and O'Brien[2] and Brice *et al.*[3] have reported that very-low-frequency emissions at frequencies of a few kc/s may be observed in satellites immediately following an atmospheric which has propagated upwards to the satellite. Brice and Smith[4] suggested that these triggered emissions were related to the lower hybrid resonance for propagation transverse to the Earth's magnetic field.

A related phenomenon has now been observed in the *Alouette I* and *Injun III* very-low-frequency data, examples being given in Figs. 1 and 2 respectively. These noises were first detected, aurally, by one of us (J. K.) on recordings of *Alouette I* made at Stanford. It was realized that the noises were genuine (and not interference from other equipment in the satellite) when similar noises were found at Stanford from tapes of very-low-frequency recordings of the *Injun III* satellite which were on loan from the State University of Iowa.

These noises are observed only after the reception of an atmospheric and are at frequencies much less than 1 kc/s. They show initially a rapid rise in frequency, following which the frequency is very nearly constant. This maximum frequency is 520 c/s in Fig. 1 and 400 c/s in Fig. 2. The satellites were at heights of about 1,000 km (for *Alouette I*) and 1,800 km (for *Injun III*) when the noises of Figs. 1 and 2 respectively were recorded.

It is suggested that these noises may be related to an ion gyrofrequency resonance, since the maximum frequency is approximately the gyrofrequency for protons in the plasma surrounding the satellite.

While the relationship of these noises to the preceding atmospherics suggests a 'triggering' process, it appears possible that the noises are simply dispersed forms of the original atmospheric impulse (with the dispersion arising from propagation from the ground to the satellite).

The work at Stanford was sponsored by the National Aeronautics and Space Administration under grant *NsG*–174–61.

The work at Iowa was supported in part by the Office of Naval Research under contract *N9onr*–93803 and by the

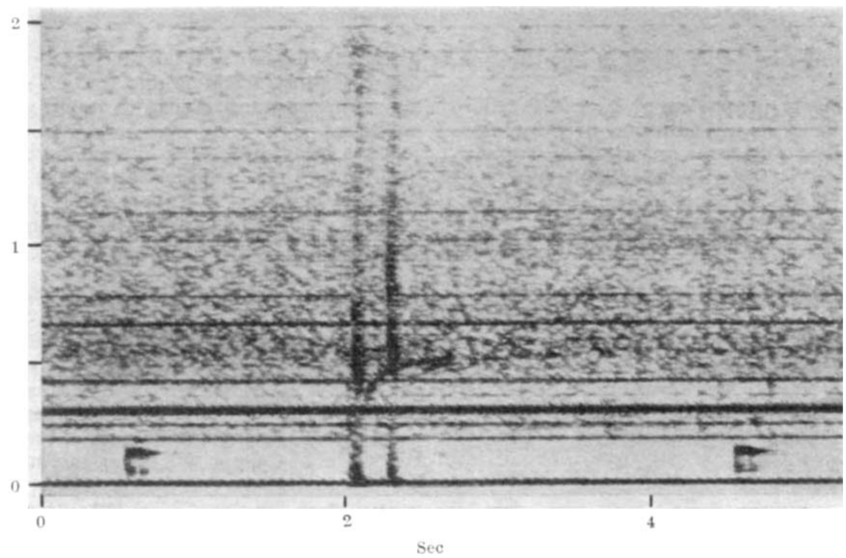

Fig. 1. Discrete noises which appear to be triggered by atmospherics at frequencies below 1 kc/s, recorded by *Alouette I* (March 18, 1963; 0807 : 05 U.T.)

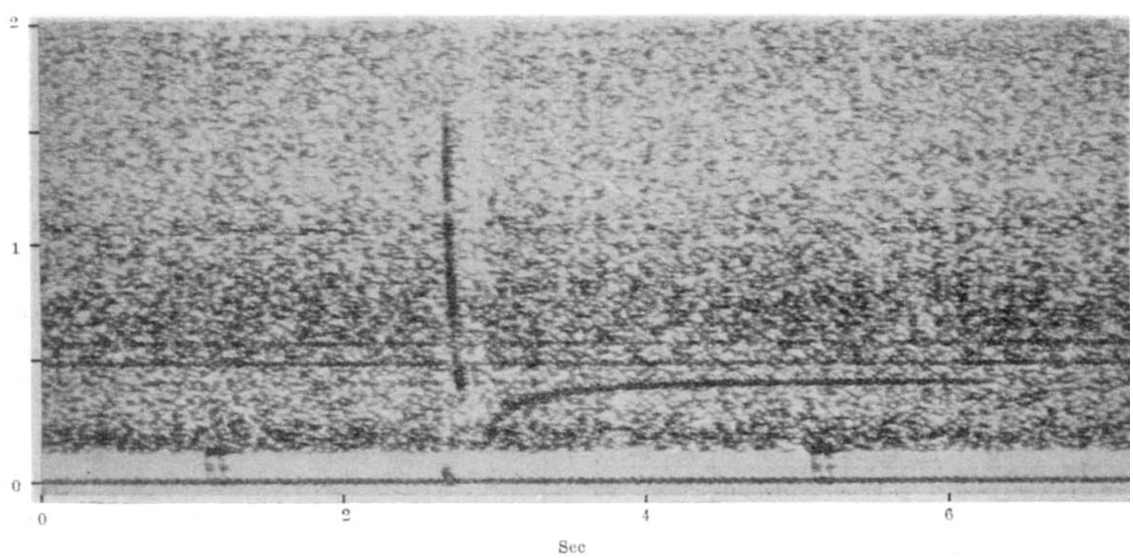

Fig. 2. A strong quasi-constant frequency discrete noise below 1 kc/s recorded by *Injun III* (February 17, 1963; 1231 : 12 U.T.)

National Aeronautics and Space Administration under grant *NsG*–233–62.

R. L. SMITH
N. M. BRICE*
J. KATSUFRAKIS

Radioscience Laboratory,
Stanford University,
California.

D. A. GURNETT
S. D. SHAWHAN

Department of Physics and Astronomy,
State University of Iowa,
Iowa City.

J. S. BELROSE
R. E. BARRINGTON

Defence Research Telecommunications Establishment,
Defence Research Board,
Ottawa, Ontario.

* Now at Faculty of Engineering, Carleton University, Ottawa, Ontario.

[1] Barrington, R. E., and Belrose, J. S., Paper presented at Spring URSI Meeting, April 29–May 2, 1963, Washington, D.C. (1963).

[2] Gurnett, D. A., and O'Brien, B. J., "High-Latitude Geophysical Studie with Satellite Injun 3. 5. Very-Low-Frequency Electromagnetic Radiation," *J. Geophys. Res.*, **69** (1) 65 (1964).

[3] Brice, N. M., Smith, R. L., Belrose, J. S., and Barrington, R. E., *Nature*, **203**, 926 (1964).

[4] Brice, N. M., and Smith, R. L., *Nature*, **203**, 926 (1964).

PHYSICS

Extrathermal Electrical Conductivity Measurements in a Magnetoplasmadynamic Generator

A DETAILED description of the International Research and Development Co., Ltd., magnetoplasmadynamic (MPD) generator has been given previously[1,2]. On July 14, 1964, a series of power generation experiments with cæsium seeding of the helium were undertaken. This series differed from the previously reported runs[3] mainly in the generator and nozzle configuration and materials. To reduce end current leakage, the tantalum nozzle used previously was replaced by a boron nitride nozzle, the exit region of the generator lengthened by 2 in. and the interior of the diffuser inlet spray-coated with alumina. The generator channel was constructed from boron nitride in attempts to reduce the internal current leakage encountered previously with alumina[3]. Sixteen pairs of narrow (1/16 in. × 1/2 in.) tantalum electrodes replaced the five pairs of square (1/2 in. × 1/2 in.) electrodes used previously; the gap between the electrodes was large (3/16 in.), to reduce insulator and boundary layer electrical breakdown. Five pairs of tantalum pins (1/16 in. diam.) were used to monitor open circuit voltages, two pairs in the nozzle and three pairs in the generator exit region. Four static pressure tappings and three thermocouples were also located in the channel wall. During operation of the loop nozzle inlet gas temperatures in excess of 1,700° C were measured. The maximum channel temperature measured was 1,110° C with a corresponding flow velocity of 1,730 m/sec and a Mach number of 0·79.

Fifteen short-duration cæsium injections were carried out at different flow conditions during the loop operation; magnetic fields up to one tesla were used. The cæsium injection circuit gave a nominal seeding rate of 0·2 atomic per cent; this low rate was necessitated by the low capacity of the evaporator. In practice, while cæsium was injected for only a few sec (maximum 15 sec) observed open-circuit voltages lasted much longer and decayed only slowly to zero. In most cases voltages were measured several minutes after seeding had stopped. From these measurements it was concluded that the true seeding fraction was one-half to one-tenth the nominal value.

Open circuit voltages in the channel up to 36 V were generated near the channel inlet, falling to about half this value at exit; Fig. 1 shows values for three runs. The fall in voltage occurs as gas velocity decreases in the channel; faulty electrical insulation may cause the rapid drop between electrodes 12 and 13.

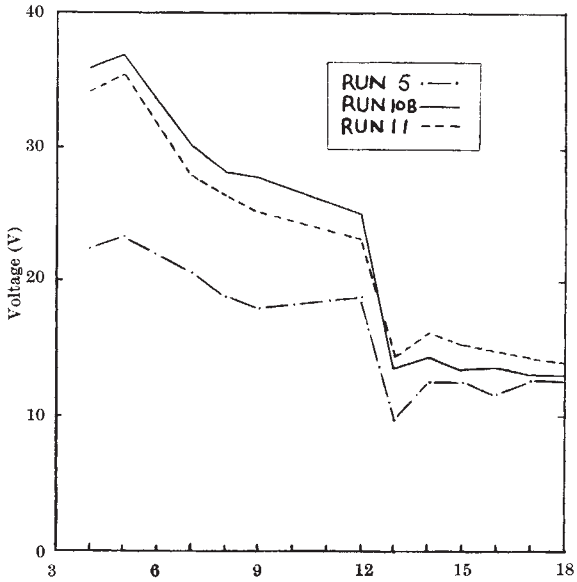

Fig. 1

The electrical conductivity of the plasma was obtained by switching each of the sixteen electrode pairs simultaneously on to five load resistors (18, 68, 280, 1,000 and 4,700 ohms) and open circuit in rapid sequence and displaying the resulting voltage on a 24-channel ultra-violet recorder trace. This sequence takes about a second and can be repeated continuously. From the ultra-violet traces the voltage–current characteristics for the plasma can be constructed. The slope of these characteristics yields the internal resistance (R) of the plasma, which is related to the electrical conductivity (s) by $s = L/RA$, where L is the distance between electrodes (m), A is the electrode area (m^2), S is in mho/m and R in ohms. If the

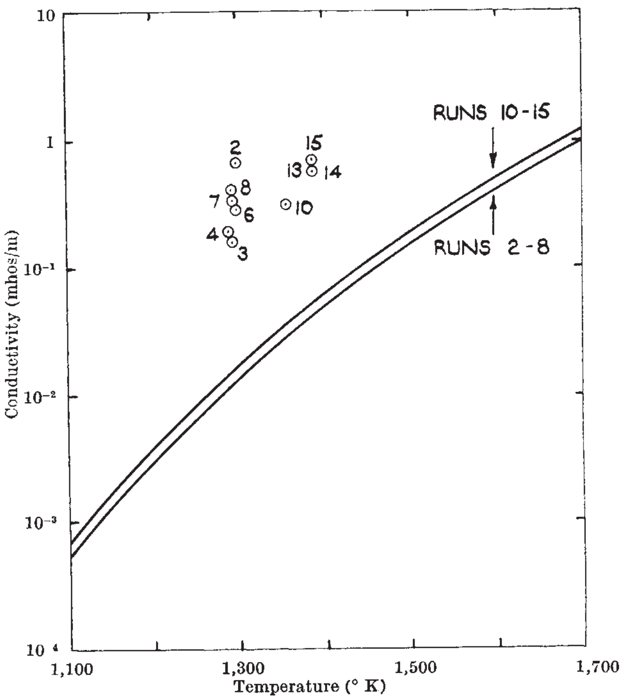

Fig. 2