

## Section 5. Atmospheric Radio Noise and Thunderstorms

An attempt has been made to derive the envelope amplitude probability distribution (APD) for atmospheric radio noise near thunderstorms. Formulas for APD's have been derived based upon the model for atmospheric radio noise near thunderstorms. First, elementary formulas for APD's are derived for the case when impulsive noise sources are continuously distributed over a limited range. Next, by taking into account the characteristics of the return stroke and K change pulses, APD curves at VLF are calculated using these formulas for atmospheric radio noise near a thunderstorm. Good agreement is shown between the calculated and measured APD curves. Further calculations indicate that the changes of the measurement frequency, and of the shortest distance to a thunderstorm influence the characteristics of the APD's. At last, similar procedure in analysis has been applied to derive APD's for automotive radio noise, and the resulting calculated APD curves has been shown for (1) a single vehicle and (2) a large number of vehicles running on a roadway, respectively.

Measurements of impulsive noise radiating from bullet trains running either an upward or downward slope on the New Tokaido Line have been performed with the amplitude probability distribution-crossing rate distribution (APD-CRD) measuring apparatus using vertical dipole antennas. APD and CRD pairs have been simultaneously measured in a narrow bandwidth for some VHF. It is noted that APD's and CRD's change remarkably, depending on whether the bullet train runs an upward or downward slope. Generally, this effect is reduced to the following. These two distributions change remarkably, depending on whether the bullet train runs with or without current feeding the main motors of the vehicles. Models of the two categories of noise have been presented: they lead to reasonable agreements between the measured and calculated CRD and/or APD curves.

Then, the occurrence of the Sinkansen noise and either the instantaneous variation of the feeder ac voltage, or that of the potential difference between two earthing points have been simultaneously measured. The following relationships have been established: (1) the

noise bursts occurs around the peak value of the feeder ac voltage, when the train runs a downward slope with no current feeding the motors, (2) a few large-amplitude pulses occur right close to the turn-off point, when the train runs an upward slope with current feeding the motors.

A novel system is also presented for the purpose of simultaneous measurement of several statistical parameters of radio wave noises. Though this system is basically not so different from a general transient memory, one can afford to measure impulsive noises for quite a long period with this system. In order to show the utility of this novel system a measurement of radio wave noises from the running New Tokaido Bullet Trains has been performed.

Kawasaki came back in April, 1986 from Uppsala University, Sweden where he took part in research on lightning for about one year.

In summer of 1986, we observed some storms with our radar at Fujioka, Gunma as a part of the cooperative research project with some universities organized by Prof. Omoto, University of Osaka Prefecture for gust storm. We planned also the observation of lightning flashes during the period, but we had unfortunately no chance to do.

Lightning flashes to 275kV and 500kV transmission lines were observed from November through December 1986 at Mihama, Fukui as a part of the cooperative research project with Gifu University, Osaka University and Kansai Electric Power Company for lightning to the transmission lines. One day, the lines were struck by six flashes during about fifteen minutes. Three flashes out of the six struck simultaneously on multi-points of the lines and a ground. We observed also during same period at Ine, coast of the Wakasa Bay, electromagnetic waves caused by lightning flashes occurred over the bay and propagated by the bay, i.e. water surface.

Nakano recorded the spectrum of the sun light on the board of the research vessel Hakuhoumaru in the Pacific to find some effects of aerosols to the spectrum.

Iriyama, graduate student, calculated the protection areas by ground wires on the UHV transmission line by computer simulation method.

"The lightning discharge" composed of six chapters written in Japanese shall soon be published by Takeuti from the University of Nagoya Press.

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-Taketoshi Nakai-

-Tosio Takeuti-

#### Publications (1985-1987)

- Kawasaki, Z-I., M. Nakano, T. Takeuti and T. Nakai: Group velocity of lightning return stroke currents, Proc. Int. Conf. on Lightning and Static Electricity, Paris, France (1985).
- Kawasaki, Z-I. and S. Israelsson: Electron fluid model simulations of lightning return strokes, International Conference on Lightning and Static Electricity, Dayton, Ohio U.S.A. (1986)
- Kawasaki, Z-I., T. Nakai, M. Nagatani, and H. Nakada: Measurement of HF radio wave noise caused by running bullet train and estimation of breakdown current, IECE Japan, Tech. Rep. **EMCJ86-88**, 9-15 (1987) (in Japanese)
- Kwasaki, Z-I., N. Nakai, M. Nagatani, and H. Nakada: Measurement of HF radio wave noise caused by running bullet train, Trans. IECE Japan, **J70-B**, 163-165 (1987) (in Japanese)
- Kawasaki, Z-I., T. Takeuti, and M. Nakano: Group velocity of subsequent return strokes in triggered lightnings, Trans. IEE of Japan (1987) (in press)
- Kawasaki, Z-I., M. Nakano, and T. Takeuti: Effect of ground conductivity on 100 kHz to 1MHz Fourier spectrum of lightning electric and magnetic field, submitted to Trans. IECE Japan.
- Nagatani, M. and H. Nakada: Real time color display of the radar return signals by a personal computer, Proc. Res. Inst. Atmospherics, Nagoya Univ., **33**, 37-47 (1986) (in Japanese).
- Nagatani, M., H. Nakada, T. Nakai, and Z-I. Kawasaki: A novel system for the simultaneous measurement of several statistical parameters of impulsive radio noise, IECE Japan, Tech. Rep. **EMCJ86-7**, 1-8 (1986) (in Japanese)
- Nagatani, M., and H. Nakada: A novel system for the simultaneous measurement of several statistical parameters of impulsive radio noises, Proc. Res. Inst. Atmospherics, Nagoya Univ.,

- 34 (1987) (in Japanese)
- Nakai, T.: Automotive noise received with a vertical dipole antenna placed above and on the ground, *IEEE Trans. Electromag. Compt.*, **EMC-27**, 119-125 (1985).
- Nakai, T.: Measurement and analysis of impulsive noise from bullet trains, *IEEE Trans.*, **EMC-28**, 193-203 (1986)
- Nakai, T., M. Nagatani and H. Nakada: On the generation mechanism of Shinkansen noise, *IECE Japan, Tech. Rep.* **EMCJ85-112**, 1-6 (1986) (in Japanese)
- Nakai, T., S. Kawase, and M. Nagatani: On generation of the Shinkansen noise, Submitted to *Trans. IECE Japan* (in Japanese)
- Oishi, Y., M. Nakano, T. Takeuti and T. Nakai: The risetime of the electric and magnetic field changes caused by close lightning return strokes, *Res. Letters of Atmospheric Electr.*, **6-1**, 21-25 (1986)
- Takagi, N., T. Takeuti and T. Nakai: Line constants of return stroke channels of lightning triggered with rockets, *Trans. IEE of Japan*, **105-B**, 378-384 (1985) (in Japanese).
- Takagi, N., T. Takeuti and T. Nakai: On the occurrences of positive ground flashes, *IEE of Japan*, **HV-85-24**, 55-65 (1985).
- Takagi, N., T. Takeuti, and T. Nakai: On the occurrence of positive ground flashes, *J. Geophys. Res.*, **91**, 9905-9909 (1986)
- Takagi, N., S. Watanabe, I. Arima, T. Takeuti, M. Nakano, H. Kinoshita, K. Yamamoto, T. Kitahara, T. Higuchi, and M. Suzuki: Unusual summer thunderstorm, *IEE of Japan*, **HV-86-40**, 1-9 (1986)
- Takagi, N., T. Watanabe, I. Arima, T. Takeuti, M. Nakano, and H. Kinoshita: An unusual summer thunderstorm in Japan, *Res. Letters on Atmospheric Electr.*, **6-2**, 43-48 (1986)
- Takeuti, T.: Lightning, *Kishokenkyu Note*, (1986) (in Japanese).
- Takeuti, T., Z-I. Kawasaki, K. Funaki, N. Kitagawa and J. Fuse: On the thundercloud producing the positive ground flashes, *J. Met. Soc. of Japan*, **63**, 354-358 (1985).
- Takeuti, T., M. Nakano, Z-I. Kawasaki and N. Takagi: Electromagnetic fields on the ground due to lightning strokes triggered with rockets and a tall chimney, *VIIth Symposium on EMC, Zurich* (1985).
- Takeuti, T.: On lightning radar, *IEE of Japan*, **HV-86-43**, 27-33 (1986)
- Takeuti, T.: Lightning discharge, *The University of Nagoya Press* (in press) (1987)