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IONOSPHERE(U) CALIFORNIA UNIV LOS ANGELES DEPT OF
PHYSICS G J MORALES ET AL. 31 DEC 86 N00014-85-K-0538

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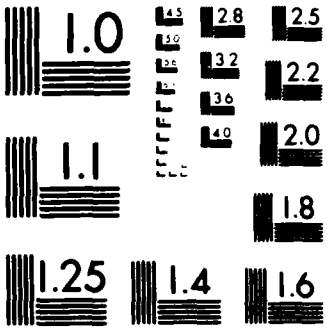

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Final Technical Report on

ONR Contract N00014-85-K-0538

August 15, 1985 through December 31, 1986

"ELECTRON ACCELERATION BY WAVE PROCESSES IN THE EARTH'S IONOSPHERE"

G. J. Morales - Principal Investigator

J. E. Maggs - Co-Principal Investigator

Physics Department

University of California at Los Angeles

Los Angeles, CA 90024

The support provided by ONR contract N00014-85-K-0538 over the period August 15, 1985 through December 31, 1986 has yielded several important results pertaining to the acceleration of electrons in the earth's ionosphere. Two complementary problems have been investigated: 1) acceleration of electrons by whistler waves excited in the topside ionsphere, and 2) modification of the ambient ionosphere electron distribution function by ground based high-power HF transmitters. In addition to having arrived at a detailed description of the underlying physical processes in these two acceleration scenarios, several theoretical results having broad applicability have been generated. Outstanding among these are: solution of a general 4th order differential equation describing mode conversion, and description of resonant field excitation in a density gradient including the self-consistent of Landau damping caused by fast electrons. It is expected that the techniques developed in this project can facility the description of more involved processes encountered in applications in which particle acceleration in a density gradient plays an important role.

Technical results obtained with partial support from this contract have been reported in 5 conference presentations and 3 long papers are expected to appear in refereed journals. As of this writing one paper has already been published in The Journal of Geophysical Research, another is being refereed by The Physics of Fluids, and the third is in the final stages of preparation.

The content of the paper published in The Journal of Geophysical Research is summarized as follows:

The nonlinear modification of the electron distribution function caused by the interaction with a resonant electrostatic field is studied analytically using a perturbation analysis. This interaction produces tail heating and for a limited range of parameter values can form a bump in the distribution, which may lead to emission of secondary waves. These results are applied to the ionosphere's F and upper E regions in the context of ionospheric modification experiments using ground-based powerful HF transmitters.

The results of the paper being refereed by The Physics of Fluids is described in following abstract:

An analytic study is made of the second order modifications produced on the fast tail electron distribution function of a nonuniform plasma subjected to resonant excitation by wave sources. The source models considered can represent excitation by external electromagnetic waves propagating obliquely to the plasma density gradient, mode-conversion of electrostatic whistlers, beat of two transparent electromagnetic waves, and direct conversion from ripples in the density profile. The calculation treats the Landau damping provided by fast tail electrons self-consistently and is applicable to plasmas having a long density scale length L, i.e., $(k_D L)^{1/3} >> 1$, where k_D is the Debye wave number of the warm background electrons. A threshold condition is found for the

formation of a positive slope in the tail distribution by the various excitation mechanisms.

PACS - 52.25 Fi, 52.35 Nx, 52.40 Nk

Technical Manuscripts

1. Merit M. Shoucri, G. J. Morales and J. E. Maggs, "Modification of the Ionospheric Electron Velocity Distribution Function", J. Geophys. Res. 92, 246 (1987).

2. G. J. Morales, M. M. Shoucri, and J. E. Maggs, "Self-Consistent Modification of a Fast Tail Distribution by Resonant Fields in Nonuniform Plasmas", (submitted to The Physics of Fluids).

3. J. E. Maggs, A. Baños, and G. J. Morales, "Electrostatic Whistler Mode Conversion of Plasma Resonance" (in preparation).

Conference Presentations

1. J. E. Maggs, G. J. Morales, and A. Baños, "Electron Acceleration by Mode Conversion of Whistler Waves at Plasma Resonance", Annual meeting of the plasma physics division of the American Physical Society, held in San Diego, CA, November 4-8, 1985, APS Bull. 30, 1562 (1985).

2. M. Shoucri, G. J. Morales, and J. E. Maggs, "Generation of Electrostatic Sidebands by Bump-on-Tail Instability During Ionospheric Modification Experiments," National Radio Science Meeting, held in Boulder, CO, January 13-16, 1986, URSI pgm p-86.

3. A. Wang, J. E. Maggs, G. J. Morales, and M. M. Shoucri, "Effect of Resonantly Excited Electric Fields upon Fast Electron Tail Distribution," annual meeting of Plasma Physics Division of the American Physical Society held in Baltimore, November 3-7, 1986, APS Bull. 31, 1438 (1986).

4. M. M. Shoucri, J. E. Maggs, and G. J. Morales, "Fast Electron Landau Damping of Resonantly Excited Fields in Nonuniform Plasmas," annual meeting of Plasma Physics Division of the American Physical Society held in Baltimore, November 3-7, 1986, APS Bull. 31, 1438 (1986).

5. G. J. Morales, J. E. Maggs, M. Shoucri, B. D. Fried, and A. Wang, "Electron Acceleration by Nonuniform Wave Electric Fields," National Radio Science Meeting, held in Boulder, CO, January 12-15, 1967, URSI pgm p-107.

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