NASA CR 132785

(NASA-CR-132785) PLASMA KINETIC THEORY
Final Report (California Univ.) 5 p HC
$3.00 CSCL 20I

N73-27623

Unclas
G3/25 09293

University of California, Berkeley June 7, 1973

FINAL REPORT

NASA Grant NGR-05-003-220 and NGL 05-003-220

(November 1966 to January 1973)

PLASMA KINETIC THEORY

This NASA grant provided full support for the post-doctoral appointments of Ronald C. Davidson and Toshio Nakayama, and partial support for Allan N. Kaufman (principal investigator), David C. Montgomery (visiting professor), Claire E. Max (postdoctoral), and Blake Patterson (graduate student). In this report, we shall review the research performed by these persons, and supported in whole or in part by the NASA grant. We shall not discuss other research performed by Kaufman, supported by other agencies (AEC, AFOSR, Goddard Space Flight Center) during this period.

Allan N. Kaufman
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Principal Investigator

I. Plasma Turbulence

A. Uniform Medium

A new approach to the problem of weak turbulence was pioneered and developed by Davidson (2a, 2b, 2c, 2g). The basic idea is that perturbation expansions are applied to statistical correlation functions, rather than to the field of individual realizations, as had previously been done. Theorems were obtained by Kaufman and Davidson (1b), indicating an approach to generalized Rayleigh-Jeans distribution.

The role of damped waves in plasma turbulence has been analyzed by Montgomery (3d) and resolved by Kaufman (1f).

B. Nonuniform Medium

New techniques were developed by Kaufman (with Nakayama and J. King) to treat magnetically confined plasma in a turbulent state, such as the magnetosphere (1a, 1c, 1d). The basic idea is to study diffusion in the space of adiabatic invariants, and to account for resonance broadening in wave-wave interactions.

II. Nonlinear Oscillations

A. General Theory

Exact solutions were obtained for large amplitude waves in a Vlasov plasma (2d, 2e).

B. Alfvén-Mode Instability

Guiding-center theory was used to study the nonlinear growth (5a) and convective evolution (5b) of Alfvén waves in the solar wind. For a many-wave system, quasilinear relaxation was studied (2f).

C. Relativistically Strong Electromagnetic Waves

With application to pulsars in mind, the propagation (6a) and instability (6b) of intense low-frequency radiation has been determined.

III. Miscellaneous

A. Darwin Model

To study low-frequency non-radiative electromagnetic effects, the local conservation laws of the Darwin model were determined (1e).

B. Electrostatic Approximation

Validity conditions were determined for the neglect of electromagnetic effects (3b).

C. Thermal relaxation

Simulation methods were used to test the relaxation theories for plasma models (3c).

D. Textbook

A graduate text on recent developments in the theory of a Coulomb plasma was written (3a).

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