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TITLE CAVITON DYNAMICS IN STRONG LANGMUIR TURBULENCE

AUTHOR(S) Don DuBois, T-DOT
Harvey A. Rose, T-DOT
David Russell, T-DOT

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Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Caviton Dynamics in Strong Langmuir Turbulence*

Don DuBois, Harvey A. Rose and David Russell
Theoretical Division and Center for Nonlinear Studies**
Los Alamos National Laboratory, Los Alamos, NM, 87545

ent studies based on long time computer simulations of Langmuir turbu- s described by Zakharov's model will be reviewed. These show that for to moderate ion sound damping the turbulent energy is dominantly in non- "caviton" excitations which are localized in space and time. A local caviton will be presented which accounts for the nucleation-collapse-burnout cycles vidual cavitons as well as their space-time correlations. This model is in l agreement with many features of the electron density fluctuation spectra onosphere modified by powerful HF waves as measured by incoherent scat- ar. Recently such observations have verified a prediction of the theory that Langmuir waves are emitted in the caviton collapse process. These observa- nd theoretical considerations also strongly imply that cavitons in the heated ere, under certain conditions, evolve to states in which they are ordered e and time. The sensitivity of the high frequency Langmuir field dynamics low frequency ion density fluctuations and the related caviton nucleation will be discussed.

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I. INTRODUCTION

In this lecture I want to summarize the results of a research program which has used on the "long time" development of strong Langmuir turbulence (SLT) which lriven by intense coherent radiation in long scale length plasmas near critical isity. This problem was chosen for its theoretical simplicity and because of its vance to ionospheric modification experiments using powerful HF radiation. ese experiments probably provide the best physical realization of the theoretical al, long scale length, quasi stationary plasma.

The strong Langmuir turbulent system which I will try to describe is a fasci-ing system in which locally coherent, nonlinear "wave" structures or excitations lergo chaotic or turbulent motion. These elementary excitations which we call vitons" consist of high frequency Langmuir waves trapped in self-consistently lving density cavities. The low frequency density response which describes the ities evolves under the influence of the pondermotive force of the localized Lang-r waves. These excitations have a finite lifetime: they are born by gaining energy n the external fields in a process of "nucleation;" they "collapse" to small di-isions where they die or "burnout" by giving up their electrostatic energy to lerated electrons. These excitations also interact by the radiation of ion acous-waves and "free" Langmuir waves. The study of this interaction is in its infancy we have examples in which the caviton gas apparently undergoes a phase tran-on to states which are highly ordered in space <u>and</u> time. These phenomena are a ificant departure from our concepts of linear wave excitations and weak turbu-e or renormalized turbulence theories with their often uncontrolled assumptions 1 as random phase approximations.

Data from the ionospheric modification experiments has accumulated for about ears. In the early days these data seemed consistent with the conventional the-involving linear parametric instabilities and weak turbulence cascades. How-, with the passage of time it was realized that these data were manifestly nsistent with the conventional theory. A more detailed discussion of this is n in reference 1 from which much of the material here is derived.

During the same time period new theoretical insights into SLT were developed ering around the seminal work of V. E. Zakharov.[2] He developed a very useful