

Chapter 6

Summary and conclusions

There has been considerable interest in new wave modes and instabilities in dusty plasmas recently and this is currently a rapidly growing area in dusty plasma physics. Numerous unique types of electrostatic and electromagnetic waves and instabilities exist in dusty plasmas because of the dust charging process. We have described a new numerical simulation model that can be used for studying unique physical properties of waves and instabilities in dusty plasmas due to dust charging effects. The dust charge fluctuation mode and the damping of lower hybrid oscillations due to dust charging have been investigated using our numerical simulation model. We have studied plasma instabilities associated with dust streaming relative to a background plasma as well as instabilities produced by dust expanding into a background plasma across a magnetic field. We also have studied an ion streaming instability due to the dust charge fluctuations in unmagnetized dusty plasmas. This instability may have important applications in dusty plasmas in which the plasma ions drift with respect to the dust and electrons. Ion wave instabilities may be important for structures observed in numerous space and laboratory plasmas. It is important to note that this configuration typically may not be driven unstable without the dissipative effects of dust charging. The saturation mechanism for the streaming instability here is most likely ion heating.

An important contribution of this study is that we have verified theoretical predictions of dust charge fluctuation dynamics as well as provided further physical insight into

these processes using our numerical model. The results also indicate that the nonlinear evolution of dust charge fluctuations has important effects on instabilities in dusty plasmas that requires further investigation. Future efforts should be directed to utilize better charging models, investigate the effects of ion wave instabilities and a distribution in dust charge as well as low frequency dust related modes. Also, ion kinetic effects will be incorporated in future work to investigate the saturation mechanism for streaming instability and more closer comparison to experiment [Harvnes, 2000] will be performed.

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Vita

Gyoo-Soo Chae was born in Kyungsan, S. Korea in 1967. He received the B.S. and M.S. degrees in electronics from Kyungpook National University, Korea. In August 1996 he was accepted as a Ph.D. student in electrical engineering at Virginia Tech where he was privileged to work under the supervision of Dr. Wayne Scales in the area of numerical simulation of waves in dusty plasmas. Since 1998, he has been a Graduate Research Assistant. His research interests are waves in dusty plasmas and RF and Microwave antenna design. His personal interests are primarily outdoor activities, including tennis and golf.