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Understanding Space Plasmas Through Laboratory Experiments

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Space-time ambiguity associated with in-situ measurements made from moving platforms is often an irreducible problem, which makes detection and characterization of a specific space plasma phenomenon difficult. Often when the orbiting sensor returns to the location of the original measurement the plasma has evolved and thus it is difficult to obtain a meaningful statistical ensemble of measurements of a particular phenomenon. In general there are many variables and multiple forces operating simultaneously in the space environment. In such an environment it is hard to pinpoint the causality of events and isolate a specific phenomenon for precise and repeated measurements necessary for definitive conclusion. To circumvent these difficulties we complement in-situ measurements with laboratory experiments in a controlled environment scaled to the appropriate space plasma conditions in the Space Physics Simulation Chamber (SPSC) at the Naval Research Laboratory (NRL). Coordinated analyses using both laboratory and space data have clarified a number of subtleties of plasma behavior in the ionosphere and magnetosphere. This includes plasma response to highly localized electric fields [1], structure and dynamics of boundary layers [2] such as dipolarization fronts, coherent and incoherent processes associated with triggered/chorus emissions frequently observed in the radiation belts, limits on the validity of the quasi-linear description often used to describe space plasma evolution [3], and the cause and effect of weak turbulence [4]. Specific examples will be discussed to highlight the synergy derived from laboratory experiments in understanding the natural plasma phenomena.

References

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