



*Michigan Institute
for Plasma Sci-
ence and Engi-
neering Seminar*

Ion Acceleration by Beating Electrostatic Waves: Theory, Experiments and Relevance to Spacecraft Propulsion

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Room 1200 EECS Building



Abstract

A recently discovered ion acceleration mechanism, which appears to occur naturally in Earth's ionosphere, holds promise as an effective means to energize ions for applications in thermonuclear fusion and space plasma propulsion. Unlike previously known mechanisms for energizing plasmas with electrostatic (ES) waves, and which accelerate only ions whose initial velocities are above a certain threshold (close to the wave's phase velocity), the new acceleration mechanism involving pairs of beating ES waves is non-resonant and can accelerate ions with arbitrarily small initial velocities. This offers a more effective way to couple energy to plasmas. I will discuss the fundamentals of the nonlinear dynamics of a single magnetized ion interacting with a pair of beating ES waves and show that there exists necessary and sufficient conditions for the phenomenon to occur. I will then present recent results from a dedicated experiment in my lab in which laser-induced fluorescence (LIF) measurements of ion energies have provided the first laboratory observation of this acceleration mechanism. The talk will conclude with a few ideas on how the fundamental insight can be applied to develop novel plasma propulsion concepts.

About the Speaker: Professor Edgar Choueiri is Professor of Mechanical and Aerospace Engineering and Director of the Program in Engineering Physics and of the Electric Propulsion and Plasma Dynamics Laboratory at Princeton University where he also received his PhD in Aerospace Engineering/Plasma Science. Prof. Choueiri is the author of more than 145 publication on plasma thrusters, plasma physics, instabilities and turbulence in collisional plasmas, plasma accelerator modeling, space physics, applied mathematics and acoustics. He has served as the Principal Investigator on tens of research projects funded by NASA, AFOSR, NSF, DOE and industry, including two space experiments. He is a Fellow of the AIAA and served as Chair of its Electric Propulsion Technical Committee. He is President of the Electric Rocket Society and was recently elected president of the Lebanese Academy of Sciences. He is a recipient of many honors and awards including a knighthood from the President of Lebanon and the Howard B. Wentz Award for Excellence in Teaching and Scholarship.