جامعة خليفة
Khalifa University

Abstract

Space plasmas are generally characterized by the presence of highly energetic particles, which are accelerated via various mechanisms. These suprathermal particles populate the upper zone in the velocity space, leading to a long-tailed (non-thermal) distribution and a power law dependence for high velocities, that is effectively modeled by a kappa-type (non-Maxwell-Boltzmann) distribution [1, 2, 3]. Electrostatic solitary waves (ESWs), i.e. localized density and electric field propagating at supersonic speeds are ubiquitous e.g. in the Earth's magnetosphere and in the ionosphere; these are essentially stationary-profile pulse-shaped electrostatic potential disturbances associated with particle density enhancement (or depletion) regions observed in abundance by satellite and spacecraft missions.

The talk will review the basic principles of the modeling of ESWs in Space plasmas in the presence of suprathermal particles in the background. The effect of superthermality on the dispersion characteristics of linear waves will be discussed, mainly focusing on the role of suprathermals on the phase speed. The main aspects of the nonlinear modeling of ESWs based on plasma-fluid theory will be revisited from first principles, taking into account a kappa-distributed background. Focusing on nonlinear modes, the role of the spectral index (kappa) on dynamical localized wave features (amplitude, existence region and propagation characteristics) will be elucidated [4]. Applications of this modeling in relation with Space observations will be discussed, in particular focusing on satellite observations and on data provided by the Cassini (Saturn) and the MAVEN (Mars) mission.

This talk is aimed at an audience with moderate prior knowledge of modeling in geophysics and in Space science. It consists of an overview of earlier research work carried out in collaboration with Michael McKerr (UAE & Belfast, UK), Ibrahem Elkamash (Egypt), Manfred A. Hellberg (Durban, South Africa), Frank Verheest (Gent, Belgium), Nareshpal Singh Saini (GNDU, India) and S. Maharaj (SANSA, Hermanus, S. Africa) among others [5].

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[3] M. A. Hellberg et al, Physics of Plasmas, 16, 094701 (2009).
[4] I. Kourakis, S. Sultana and M.A. Hellberg, Plasma Phys. Cont. Fusion, 54, 124001 (2012).
[5] See e.g. N.S. Saini & I. Kourakis, Physics of Plasmas, 15, 123701 (2008); N.S. Saini, I. Kourakis & M.A. Hellberg, Physics of Plasmas, 16, 062903 (2009); T.K. Baluku, M.A. Hellberg, I. Kourakis & N.S. Saini, Physics of Plasmas, 17, 053702 (2010).

Speaker's Bio

Dr. Ioannis (Yannis) Kourakis is a plasma physicist, currently based at Khalifa University (Abu Dhabi, UAE). He holds an Associate Professorship at the Mathematics Department and also served as acting coordinator for the KU-Mars program. Prior to his appointment at KU, he has held a number of research posts at Ruhr University Bochum (Germany) and at Ghent University (Belgium), followed by academic posts at Queen's University Belfast (UK) and at Sorbonne University Abu Dhabi (UAE).

He has held a Special Visiting Researcher status at the Federal University of Rio Grande do Sul (Porto Alegre, Brazil) and a joint Newton (UK)-FAPESP (Brazil) Fellowship hosted at UNESP (State University of Sao Paulo, Brazil). He sustains active research links with the Kapodistrian University of Athens (Greece), with the South-African Space Agency (SANSA, Hermanus), with Ruhr University Bochum (Germany), with University of Kwazulu Natal (Durban) and with the Indian Institute of Geomagnetism (IIGM, Mumbai), among others.

Dr. Yannis's research focuses on nonlinear dynamics (theory), with emphasis on plasma physics and materials science. His most recent work has focused on nonlinear waves and shocks in plasma physics and in space science, mainly based on fluid and kinetic models for electrostatic/electromagnetic wave propagation in multicomponent and dusty (complex) space plasmas. His earlier work has spanned a number of areas, including optical (modulational) instabilities, dissipative solitons, left-handed (negative refractive index) materials, Bose-Einstein condensates and hydrodynamics (freak waves). He has published ~160 articles in refereed journals and >75 papers in conference proceedings. His work has attracted >6K citations (h-index=45, from G-Scholar).