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Report on PLASMA-2003

The 18th National Symposium on Plasma Science and Technology (PLASMA-2003) was organized by Birla Institute Technology, Mesra, Ranchi in collaboration with Plasma Science Society of India during December 08-11, 2003. The Convener of the Symposium was Dr. P. K. Barhai, and Dr. J. T. Andrews was the Coordinator. The focal theme of the Symposium was Industrial Applications of Plasma. The Symposium was inaugurated by Shri Samaresh Singh, Honourable Minister for Science & Technology & IT, Government of Jharkhand. The inaugural session was presided by Dr. S. K. Mukherjee, Vice Chancellor, B. I. T., Mesra, Ranchi. The Key Note address on "*The Economic Impact of Plasma Technologies*" was delivered by Prof. P. I. John. President, PSSI, Dr. D. Bora and Secretary, PSSI, Dr. V. N. Rai also addressed the gathering on the activities of PSSI. The symposium had an International flavour due to the participants from Germany, USA and Nepal. Some of the Plenary and invited speakers were Dr. N. Venkatramani, Dr. R. K. Varma, Dr. H. C. Pant, Dr. Vinod Krishnan , Dr. H. Ehrich, from University of Disberg, Essen, Germany, Dr. B. B. Nayak, Dr. A. C. Das and Dr. N. K. Joshi.

The Symposium consisted of key note address, plenary talks, invited talks, short oral presentation and poster sessions in the areas of 1. Basic Plasma Studies 2. Wave and Exotic Plasma 3. Plasma Processing and Industrial application 4. Dusty Plasma 5. Fusion Plasma 6. Laser Plasma 7. Computational and Simulation Plasma 8. Plasma Diagnostics 9. Space and Astrophysical Plasma 10. Interdisciplinary plasma and exhibitions by equipment manufacturers like National Instruments, Leica, Metal Power, B. B. Dey & Co. and ADITYA High Vacuum Pvt. Ltd.. The symposium consisted of inaugural session, 9 technical sessions and 3 poster sessions. There were 6 plenary talks, 18 invited talks, 20 oral presentations and 236 contributed papers.

Financial support was provided by the Institute for Plasma Research, Council of Scientific and Industrial Research, Board of Research on Nuclear Sciences, Department of Science & Technology, All India Council for Technical Education, Indian Space Research Organisation and Birla Institute of Technology, Mesra, Ranchi.

The Panel Discussion was Chaired by Dr. S. S. Kushwaha, Vice Chancellor, Ranchi University. Eight participants were awarded certificate of Merit for best poster presentations.

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Electron inertia: A newly discovered cause of destabilizing the flowing plasma against acoustic wave fluctuations

P. K. Karmakar, U. Deka & C. B. Dwivedi

Inertial quality of an object is normally treated as an intrinsic resistive property of the matter. By virtue of definition and physical reality it is indeed so. To induce and drive motions in such objects, some minimum force is required to at least over come the inertial resistance in response to externally applied forces. The mass of the objects measures the inertial strength of the objects. For example, the mass of electrons in plasma is quite less than that of the ions by three orders of magnitude and hence in any low frequency wave phenomena of ion inertial space and time scales the electron inertia is ignored. In this asymptotic limit of inertia less electrons, the ion acoustic waves are free to move without any dissipation and/or amplification in any unbounded quasi-neutral homogenous plasma in either static or moving state. Of course in moving state of plasma the ion acoustic waves suffer Doppler frequency shift in the direction of plasma motion. On the time scale of the electron inertia, high frequency electrostatic oscillations are produced and the ions are assumed to form static background.

There are many cases where the collisional dissipations can allow certain instabilities to proceed, which would not other wise occur [1]. The example of Rayleigh-Taylor (R-T) instability is well known, which is driven by the combined effects of external gravity and density gradients but requires ion-neutral collisions to proceed. This is to note that the dissipative effects normally introduce damping of the wave energy. However, in certain situations as mentioned above it helps to allow the growth of the wave energy. Like wise, it is recently reported [2] that the consideration of weak but finite electron inertia drives a new kind of resonance instability of ion acoustic wave fluctuations in a plasma with drifting ions. Here the electron inertia in collaboration with ion drift motion causes the linear growth as well as the Doppler frequency shift in the usual ion acoustic wave motion. Destabilizing threshold requires that the plasma flow velocity must exceed the phase velocity of the ion acoustic wave.

The electron inertia induced instability is governed by electron fluid compression due to finite but weak electron inertial delay in screening the acoustic wave potential fluctuations generated by the compression and rarefaction of the ionic fluid. In fact, this novel effect is masked by Boltzmann approximation of the electron density distribution under asymptotic limit of inertia less electrons. But as shown and discussed in [2], the practical significance of asymptotic limit of inertia less electrons is judged in plasmas with drifting motion of these plasmas on ion inertial space and time scales. It is reported that the ions with drift velocity exceeding the phase velocity of the ion acoustic wave fluctuations in association with electron inertia produce the resonantly growing solution of the acoustic wave fluctuations at Doppler shifted (down) eigen mode frequency. Its role in understanding the sheath driven low frequency instability producible in double plasma device is discussed. Physical situations for practical realization of this instability occur in transonic zone of the sheath edge plasma and also in solar wind plasmas. It is shown [3] by graphical analysis that the resonance growth of short scale acoustic wave fluctuations is more likely to occur in transonic plasmas of finite width around the sonic point in real space as well as in Mach number space. Considering this specific situation in mind it is theoretically shown [4] that the usual nonlinear normal mode (ion acoustic soliton) of the ion acoustic wave fluctuations can undergo qualitative and quantitative changes in presence of background plasma conditions of linear wave turbulence.

A driven Korteweg-de Vries (d-KdV) equation is obtained under transient limit of ion acoustic soliton propagation through the unstable condition of transonic plasma so that the total growth experienced by the spectral wave components is well within the linear limit of amplitude. The derived d-KdV equation is solved by numerical methods. Amplified (suppressed) solutions of the usual acoustic KdV soliton are found to exist depending on the resonance (non-resonance) conditions of the ion flow velocity for given source acoustic wave number. This happens in case of extremely weak dispersion strength (i.e. long wavelength) of the source perturbations in comparison to that of the usual soliton. In case of significant dispersion strength of the source perturbations, new kind of oscillatory shock-like structures are obtained. This is attributed to the asymmetric nature of the derived d-KdV equation that arises due to driving source of the spectral wave components of the usual acoustic soliton. By this simple example of the non-linear ion acoustic wave description in an unstable plasma medium the traditional notion of unstable condition of linear normal mode as a non-existential condition of its non-linear counter part is rebutted.

In a simple fluid model approach of theoretical description of the *scrape-off layer* (SOL), it is emphasized that the electrons can satisfy the Boltzmann distribution quite closely yet the electrons can have finite flow motion comparable to acoustic speed [5]. It is thus reasonable to judge the practical significance of the asymptotic limit of inertia less electrons for the derivation of Bohm condition. Very recently simple calculations are performed by including finite but weak effect of electron inertial dynamics for static Debye sheath scale analysis [6]. This is to report and apprise the readers that the reduction in Bohm threshold for sheath formation is noted. This is emphasized that the universal character of the Bohm condition needs further review. This is hypothesized that the Debye sheath edge should behave as a turbulent zone with finite extension. Here the sheath and Debye sheath both have the same physical meaning.

References

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[3] P. K. Karmakar, U. Deka and C. B. Dwivedi, Graphical analysis of electron inertia induced acoustic instability, presented in 18th National Symposium on Plasma Science & Technology, organized by BIT, Mesra, Ranchi, Jharkhand during Dec. 8-11, 2003 and also communicated to Pramana-J. Phys.

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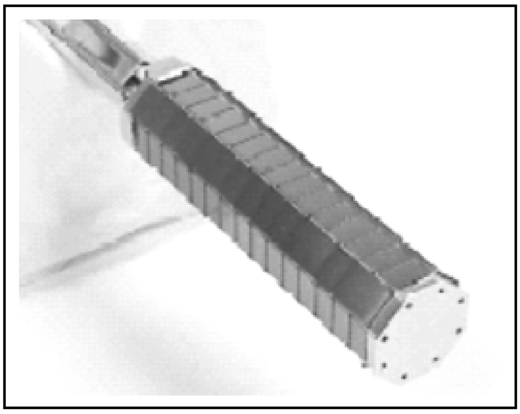
[6] J. J. Nakarmi, D. S. Air, U. Deka and C. B. Dwivedi, Effect of finite but weak electron inertia delay on plasma sheath formation, presented in 18th National Symposium on Plasma Science & Technology, organized by BIT, Mesra, Ranchi, Jharkhand during Dec. 8-11, 2003 and also communicated to Pramana-J. Phys.

News from Internet

Visit http://www.eere.energy.gov/inventions/pdfs/jxcrystals.pdf for more details!

THERMOPHOTOVOLTAIC ELECTRIC POWER GENERATION USING EXHAUST HEAT INNOVATIVE TECHNOLOGY PRODUCES ELECTRICITY FROM INDUSTRIAL WASTE HEAT

The thermophotovoltaic electric power generation technology is primarily applicable to the glass, metal casting, and steel industries. These industries produce large amounts of waste heat at high temperatures, which can be used to generate electricity. Other applications for this technology are off-grid residential cogeneration, grid connected residential cogeneration, and grid-connected residential selfpowered furnaces.



Furnaces in the glass, metal casting, and steel industries operate at very high temperatures and lose tremendous amounts of energy in their exhaust streams. With the emissions-reducing shift to gas-oxy furnaces in these industries, exhaust temperatures are climbing even higher. Waste heat from furnaces in the glass, metal casting, and steel industries is usually vented to the atmosphere. In some facilities, it must be diluted with cool air to reduce its temperature prior to venting. Until now, the venting of this waste heat has represented the loss of a valuable resource. A new technology adds value to this waste stream by using exhaust heat to generate hundreds of kilowatts of electricity. This unique innovation uses new infrared-sensitive photovoltaic cells mounted inside ceramic tubes. These tubes are heated in the exhaust stream of an industrial process and radiate energy inward to the photovoltaic cells to generate electricity directly from the waste heat. The energy density in these systems is over 100 times that of solar energy, producing over 100 times the energy of conventional photovoltaic or solar cells.

This new technology, developed by JX Crystals, Inc., produces electricity directly from furnace exhaust waste heat by using infrared-sensitive photovoltaic cells.

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PSSI MEMBERSHIP

Persons related to Plasma Physics are encouraged to take PSSI membership. Please visit our web site or write to Dr Vinay Kumar [vinay@ipr.res.in] for Membership application form. Please note that in the recent GBM, it was decided to revise the membership fees as given below with effect from February 01, 2004.

Category	Admission Fee	Subscription
Life Member	Rs. 50	Rs. 750 (Single payment)
Regular Member	Rs. 50	Rs. 100 (Per Year)
Student Member	Rs. 25	Rs. 50 (Per Year)
Associate Member	Rs. 50	Rs. 150 (Per Year)
Institutional Member	Rs. 50	Rs. 5000 (Per Year)
Donar Member		Rs. 5000 or more

ANNOUNCEMENTS

Buti Foundation

"Buti Young Scientist Award" has been instituted by Buti Foundation to encourage young research scholars / fresh Ph. Ds. Applications from desired candidates along with manuscript will be invited two months before the Annual National Conference on Plasma Science and Technology by the Executive committee PSSI. Papers will be presented in a special session. Best presentation will be selected by a special panel of judges for the award. PSSI expresses gratitude towards 'Buti Foundation' for encouraging young scientists.

PLASMA-2004

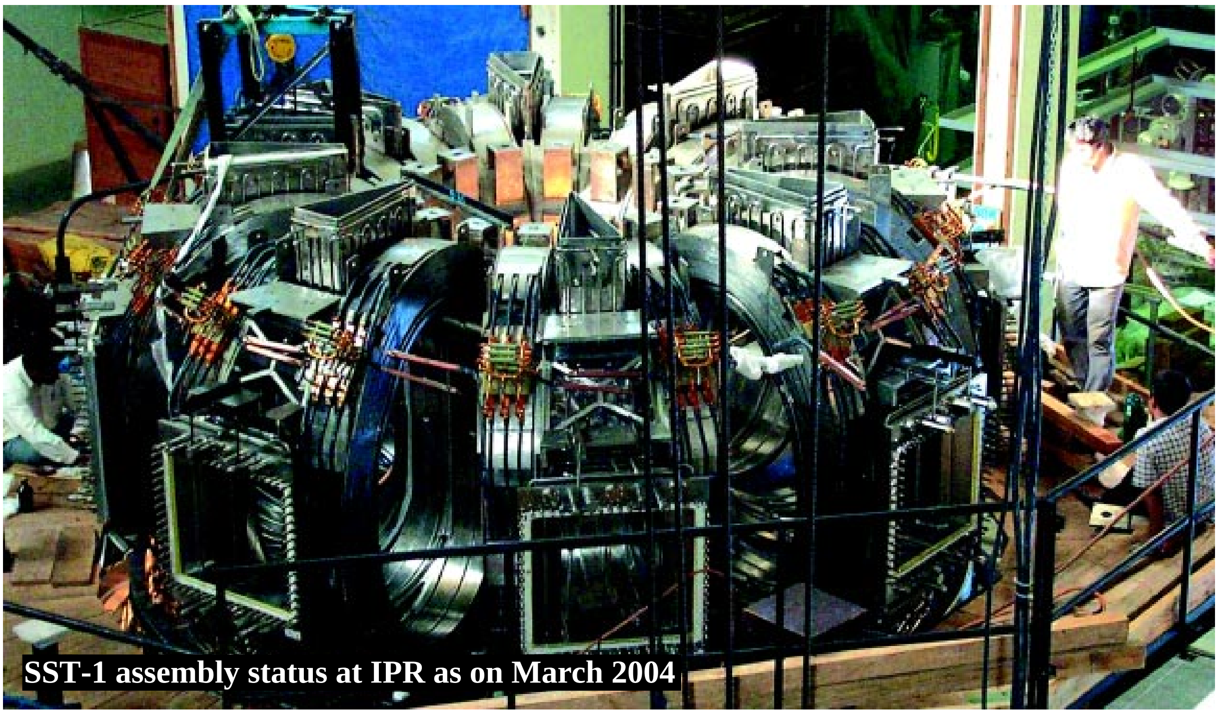
19th National Symposium on Plasma Science and Technology will be hosted by Bundelkhand University, Jhansi and Plasma Science Society of India at Jhansi. Dates for the Symposium will be announced in the next issue of the News Letter and put in the Web site.

EdSpeak....

Please contribute at least one page news items/ articles related to Plasma Science and Technology.

Please send your articles to Editor : raju@ipr.res.in

More photographs during PLASMA-2003



SST-1 assembly status at IPR as on March 2004