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FOREWORD

Special issue containing papers presented at the 12th IAEA Technical Meeting on Energetic Particles in Magnetic Confinement Systems (7–11 September 2011)

Guest Editor

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The topic of the behaviour of energetic alpha particles in magnetic fusion confined plasmas is perhaps the ultimate frontier plasma physics issue that needs to be understood in the quest to achieve controlled power from the fusion reaction in magnetically confined plasmas. The partial pressure of alpha particles in a burning plasma will be ∼5–10% of the total pressure and under these conditions the alpha particles may be prone to develop instability through Alfvénic interaction. This may lead, even with moderate alpha particle loss, to a burn quench or severe wall damage. Alternatively, benign Alfvénic signals may allow the vital information to control a fusion burn.

The significance of this issue has led to extensive international investigations and a biannual meeting that began in Kyiv in 1989, followed by subsequent meetings in Aspenäs (1991), Trieste (1993), Princeton (1995), JET/Abingdon (1997), Naka (1999), Gothenburg (2001), San Diego (2003), Takayama (2005), Kloster Seeon (2007) and Kyiv (2009). The meeting was initially entitled 'Alpha Particles in Fusion Research' and then was changed during the 1997 meeting to 'Energetic Particles in Magnetic Confinement Systems' in appreciation of the need to study the significance of the electron runaway, which can lead to the production of energetic electrons with energies that can even exceed the energy produced by fusion products.

This special issue presents some of the mature interesting work that was reported at the 12th IAEA Technical Meeting on Energetic Particles in Magnetic Confinement Systems, which was held in Austin, Texas, USA (7–11 September 2011). This meeting immediately followed a related meeting, the 5th IAEA Technical Meeting on Theory of Plasma Wave Instabilities (5–7 September 2011). The meetings shared one day (7 September 2011) with presentations relevant to both groups.

The presentations from most of the participants, as well as some preliminary versions of papers, are available at the websites [1, 2]. To view a presentation or paper, go to the link 'program', view the list or speakers and poster presenters and press 'talk' or 'paper' under the appropriate name. Summaries of the Energetic Particle Conference presentations were given by Kazuo Toi and Boris Breizman. They respectively discussed the experimental and theoretical progress presented at the meeting. Their presentations can be viewed on the 'iaeaep' website [1], by pressing 'Summary–I (or II)' by each of their names.

Highlights of this meeting include the tremendous progress that has been achieved in the development of diagnostics that enables the 'viewing' of internal fluctuations and allows comparison with theoretical predictions, as demonstrated, for example, in the talks of P. Lauber and M. Osakabe. The need and development

of hardened diagnostics in the severe radiation environment, such as those that will exist in ITER, was discussed in the talks of V. Kiptiley and V.A. Kazakhov. In theoretical studies, much of the effort is focused on nonlinear phenomena. For example, detailed comparison of theory and experiment on D-III-D on the n = 0 geodesic mode was reported in separate papers by R. Nazikian and G. Fu. A large number of theoretical papers were presented on wave chirping including a paper by B.N. Breizman, which notes that continual wave chirping from a single frequency may emanate continuously once marginal stability conditions have been established. Another area of wide interest was the detailed study of alpha orbits in a burning plasma, where losses can come from perturbations from perfect toroidal symmetry arising from finite coil number, magnetic field imperfections introduced by diagnostic or test modules and from instability. An important area of development, covered by M.A. Hole and D.A. Spong, is concerned with the self-consistent treatment of the induced fields that accounts for responses beyond vacuum field perturbations or a pure toroidally symmetric MHD response. In addition, a significant number of studies focused on understanding nonlinear behaviour by means of computer simulation of energetic particle driven instability.

An under-represented area of investigation was the study of electron runaway formation during major tokamak disruptions. It was noted in an overview by S. Putvinski that electron energies in the 10–20 MeV range is to be expected during projected major disruptions in ITER and that reliable methods for mitigation of the runaway process needs to be developed. Significant recent work in the field of the disruption induced electron runaway, which was reported by J. Riemann, does not appear in this special issue of *Nuclear Fusion* as the work had been previously submitted to *Physics of Plasmas* [3]. Overall it is clear that reliable mitigation of electron runaway is an extremely important topic that is in need of better understanding and solutions.

It has been my pleasure to serve as the organizer of the 12th meeting and to serve as a Guest Editor of this issue of *Nuclear Fusion*. I am sure that the contents of this issue will serve as a valuable research guide to the field of energetic particle behaviour in a burning plasma for many years to come. The site of the next meeting will by Beijing, China in the fall of 2013, which will be organized by Zinghong Lin.

References

[1] Program 2011 *12th IAEA Technical Meeting on Energetic Particles in Magnetic Confinement Systems (Austin, Texas, USA, 7–11 September 2011)* http://w3fusion.ph.utexas.edu/ifs/iaeaep/program.html

[2] Program 2011 *5th IAEA Technical Meeting on Theory of Plasma Wave Instabilities (Austin, Texas, USA, 5–7 September 2011)* http://w3fusion.ph.utexas.edu/ifs/iaeapi/program.html

[3] Riemann J., Smith H.M. and Helander P. 2012 *Phys. Plasmas* **19** 012507