IMéRA Aix-Marseille Université

Aix-Marseille université

International workshop on Fusion energy: challenges and perspectives

May 29, 2017

Invited speakers:
Wendell Horton and Phil Morrison, Univ. Texas, Austin, USA

Speakers:

Wouter Bos, LMFA, Lyon
Robert Chahine, LMFA, Lyon
Dominique Escande, PIIM, Marseille
Maxime Hauray, I2M, Marseille
Benjamin Kadoch, IUSTI, Marseille
Eric Serre, M2P2, Marseille
Michel Vittot, CPT, Marseille

Spyder Web of the plasma structures following the magnetic field
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Institute for Advanced Studies (IMERA), Marseille

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Organizers: Kai Schneider, Benjamin Kadoch, Sadruddin Benkadda, Jean-Marc Layet, Lounes Tadrist
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International workshop on
'Fusion energy: challenges and perspectives'
@ IMéRA, Marseille

Program, May 29, 2017

9:00	Welcome
9:05 – 10:00	Wendell Horton, U Texas, Austin, USA *'Turbulent Transport in Magnetized Plasmas.'*
10:00 – 10:30	Wouter Bos, LMFA, EC Lyon *'Statistical mechanics of axisymmetrical turbulence.'*
10:30	Coffee break
11:00 – 11:30	Eric Serre, M2P2 *'Towards predictive numerical models for transport and turbulence simulations in tokamak edge plasmas.'*
11:30 – 12:10	Dominique Escande, PIIM *'A transversal approach of fusion research.'*
12:30	Lunch
14:00 – 14 :55	Phil Morrison, U Texas, Austin, USA *'GEMPIC: An exact Poisson integrator for the full Vlasov-Maxwell System.'*
15:00 – 15:30	Maxime Hauray, I2M *'Recent mathematical results on the quasi-neutral limit.'*
15:30 – 16:00	Michel Vittot, CPT *'TBA'*
16:00	Coffee break
16:30 – 17:00	Robert Chahine, LMFA, EC Lyon *'Is there a dynamo-effect in RFPs?'*
17:00 – 17:30	Benjamin Kadoch, IUSTI *'Multiscale statistics in dissipative drift-wave turbulence.'*
18:00	Farewell

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Turbulent Transport in Magnetized Plasmas

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Laboratory and space plasmas show a rich variety of nonlinear structures evolving out of plasma turbulence. First we consider the structures evolving from the well diagnosed simpler laboratory experiments beginning with the MISTRAL experiments at AMU and their simulations showing the emission of tongues or blobs of plasma -in this case in singly ionized Argon plasma and then to the complementary tokamak-like Helimak machine at the University of Texas where there data again for Ar+1 plasma shows both drift-wave coupled to Alfven wave plasma structures driven by the interchange or Rayleigh-Taylor instability from circular curvature of the magnetic field lines. Then we move on to analysis and simulations of the ToreSupra plasma and discuss the new configuration WEST with a magnetic separatrix modeling that in JET and further ITER toroidal machines. The WEST means Tungsten W walls for steady state plasmas driven by RF waves where record steady state plasma have been produced in both WEST and EAST -Hefei China machines. The steady state in tokamaks are essential to compete with the intrinsically steady state machines of Wendestein W-7X in Grieswald, Germany and Large Helical Device in Toki, Japan which are designed with external coils that eliminates the mega-ampere plasma toroidal currents in tokamaks. Exploratory linear plasma machines called the field reversed configuration FRC and ultra high field mirror machines are gaining support in view of their simpler, less expensive configurations and their natural occurrence in magnetospheres and solar plasmas.

References:

W. Horton and S. Benkadda. ITER Physics. World Scientific, 2015

W. Horton. Turbulent Transport in Magnetized Plasmas. World Scientific, 2012, 2nd Edition, forthcoming.

GEMPIC: An exact Poisson integrator for the full Vlasov-Maxwell System

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(Dated: May 17, 2017)

Abstract

The Vlasov-Maxwell (VM) system, which couples the evolution of the phase space probability density with the full system of Maxwell's equations, was shown in the 1980s to be an infinite-dimensional noncanonical Hamiltonian system.[1] Noncanonical means the Poisson operator does not have the standard canonical form in terms of conjugate coordinates and momenta and is degenerate, giving rise to Casimir invariants. This talk will summarize recent work[2] on a novel framework for Finite Element Particle-in-Cell computation developed by discretizing the VM Hamiltonian structure. A semi-discrete (finite-dimensional) Poisson bracket that retains the properties of anti-symmetry and the Jacobi-identity, as well as conservation of discrete versions of its Casimir invariants, implying that the semi-discrete system retains the parent Hamiltonian structure, was obtained. In order to obtain a fully discrete Poisson integrator, the semi-discrete bracket is used in conjunction with Hamiltonian splitting methods for integration in time. Techniques from Finite Element Exterior Calculus ensure conservation of the divergence of the magnetic field and Poisson's equation as well as stability of the field solver. The resulting methods are gauge-invariant, feature exact charge conservation and show excellent long-time energy and momentum behavior. Due to the generality of the framework, these conservation properties are guaranteed independently of any particular choice of the Finite Element basis, as long as the corresponding Finite Element spaces satisfy compatibility. Plasma physical examples using the GEMPIC code[3] will be described.

[1] P. J. Morrison, Phys. Lett. A **80**, 383 (1980); AIP Conf. Proc. **88**, 13 (1982); J. Marsden and A. Weinstein, Physica D **4**, 394 (1982).
[2] M. Kraus, K. Kormann, P. J. Morrison, and E. Sonnendrücker, J. Plasma Phys. to appear (2017).
[3] SeLaLib: http://selalib.gforge.inria.fr/.

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