



MATHEMATICS

SEMINAR

Assoc.Prof. Oğul Esen
Gebze Technical University

Title : On Decomposition of the Hamiltonian Realization of Vlasov's Plasma

Abstract: This talk is on non-relativistic collisionless plasma particles occupying in a finite region $Q \subset R^3$. Vlasov's plasma dynamics is determined by the evolution of the plasma density function f , defined on the cotangent bundle T^*Q with the Darboux' coordinates (\mathbf{q}, \mathbf{p}) , according to the Vlasov equation

$$\frac{\partial f}{\partial t} + \frac{1}{m} \mathbf{p} \cdot \nabla_{\mathbf{q}} f - e \nabla_{\mathbf{q}} \phi \cdot \nabla_{\mathbf{p}} f = 0. \quad (1)$$

Here, ϕ is the potential function, m is the mass, and e is the electrical charge. One may couple the Vlasov equation with the Poisson equation

$$\nabla^2 \phi(\mathbf{q}) = -e \int f(\mathbf{q}, \mathbf{p}) d\mathbf{p}, \quad (2)$$

and arrive at the Vlasov-Poisson equations. Hamiltonian analysis of the Vlasov plasma was achieved in [1]. Kinetic moments of the plasma density functions are determined to be Poisson mappings [2]. The first aim is to provide Hamiltonian (Lie-Poisson) analysis of the Vlasov plasma, and the dynamics of its kinetic moments, from the matched pair decomposition point of view [3]. Both of these physical systems will be recasted as Lie-Poisson systems as couplings of *mutually interacting* (Lie-Poisson) subdynamics [5]. In each case, we observe that one of the constitutive subdynamics is the compressible isentropic fluid flow, and the other is the higher-order (≥ 2) kinetic moments. In this regard, the algebraic/geometric (matched pair) decomposition is in a harmony with the physical intuition. As a second goal, we address another phenomenon in plasma dynamics, namely all possible decompositions of Hamiltonian formulation of BBGKY (Bogoliubov-Born-Green-Kirkwood-Yvon) hierarchy [4] of the order 3. This talk contains some results from [5] and [6].

References

- [1] J. E. Marsden and A. Weinstein. The Hamiltonian structure of the Maxwell-Vlasov equations. *Phys. D*, 4(3):394–406, 1981/82.
- [2] J. Gibbons, D. D. Holm, and C. Tronci. Geometry of Vlasov kinetic moments: a bosonic Fock space for the symmetric Schouten bracket. *Phys. Lett. A*, 372(23):4184–4196, 2008.
- [3] O. Esen and S. Sütü. Hamiltonian dynamics on matched pairs. *Int. J. Geom. Methods Mod. Phys.*, 13(10):1650128, 24, 2016.
- [4] J. E. Marsden, P. J. Morrison, and A. Weinstein. The Hamiltonian structure of the BBGKY hierarchy equations. In *Fluids and plasmas: geometry and dynamics* (Boulder, Colo., 1983), volume 28 of *Contemp. Math.*, pages 115–124. Amer. Math. Soc., Providence, RI, 1984.
- [5] O. Esen and S. Sütü. Matched pair analysis of the Vlasov plasma. arXiv preprint arXiv:2004.12595, 2020.
- [6] O. Esen, G. Özcan, and S. Sütü. On extensions, lie-poisson systems, and dissipations. arXiv preprint arXiv:2101.03951, 2021.

Date : 21 April 2021 Wednesday

Seminar: 14:30-15:30

Place : Zoom

<https://itu-edu-tr.zoom.us/j/99776109725?pwd=bzhyYjBDdmgyMVNCRDZUK0R3VTBwdz09>

Meeting ID: 997 7610 9725

Passcode: 583835

Contact : kayah17@itu.edu.tr