Numerical Models of Plasmas – Homework

§ **One dimensional plasma model** The one dimensional plasma model was first proposed by Dawson [1], and it is one of the first multi-body *ab initio* time dependent models studied with computer simulations.

§ **Goals** The goals of this homework are: i) to implement the one-dimensional one-species plasma model, ii) to illustrate the numerical model with a plasma process, iii) to discuss and to compare the results of the numerical simulation with the theoretical predictions for the relevant plasma process.

§ **Implementation** To guide the implementation, follow [2]. The implementation of the one-dimensional plasma model can be performed in any computer language. The implementation must include diagnostics.

§ **Physical Processes** To illustrate the numerical process, any textbook plasma process with a one-dimensional counterpart can be selected. Make sure there are analytical results to compare with. Some examples of these processes are Landau damping, the spectrum of electrostatic plasma fluctuations, linear plasma waves, plasma waves driven by moving charges (see relevant plasma physics textbooks and the original seminal papers by Dawson [1, 2] or the review [3]). Proper diagnostics must be included in the implementation and their use illustrated. It is mandatory to include a energy conservation diagnostic and to demonstrate how energy is conserved.

§ **Report** A brief report must be prepared including the key theoretical results underlying the process being studied with the one-dimensional plasma model, illustrations of the numerical code on the selected plasma process, discussion of initial conditions, comparison between the theory and the simulations.

§ **Grading** The homework will be graded on the 0 – 20 scale with the following components: Implementation (0 – 10); Illustration of physical process (0 – 6); Discussion and comparison between theory and simulations (0 – 4)

§ **Deadline** The deadline for submission is Sunday, October 8, 23:59. Post deadline submissions will incur on a penalty of 1 point (in the 0/20 scale)

per day *i.e.* submissions on Oct 9 (10) will be graded on the 0/19 (0/18) scale.

§ **Documents to submit** The submission of the homework must include: i) the numerical code with the required instructions to run the code, that will be strictly followed ii) a report covering the illustration of the numerical model, benchmarking with theory, discussion of energy conservation, and discussion/comparison between theory and simulations.

§ **Submission** By email to `luis.silva@tecnico.ulisboa.pt` with the subject `[TAFC] Homework 1` including the link to a zip file hosted on DropBox/Google Drive/OwnCloud/OneDrive/ . The link must be active until Monday, October 9 23:59. Your email will be your identifier.

References

[1] John M Dawson, *One-dimensional plasma model*, The Physics of Fluids **5** (1962), no. 4, 445–459.

[2] ———, *The electrostatic sheet model for a plasma and its modification to finite-size particles*, Methods in Computational Physics, edited by B. Alder et al., vol. 9, Academic Press, New York, 1970, p. 1.

[3] ———, *Particle simulation of plasmas*, Reviews of Modern Physics **55** (1983), no. 2, 403.