Summary of the BOOST kick-off meeting: Building the future Of numerical methOdS for iTer. date 08/04/2011

Presents:
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Luc Giraud (LG)
Emmanuel Agullo (EA)
Mikko Byckling. (MB)
Damiano Lombardi (DL)

Morning: 10.00

Presentation Session:

GD presented the project: the context, the positioning, the state of the art and the objectives. In particular he focused on the five points enlightened in the project proposal: fluid models, kinetic models, localized kinetic upscaling techniques, numerical analysis of the methods and algorithm definition and implementation. More in details, GD spoke of the development of Asymptotic Preserving schemes for the Euler equations for charged particles subject to the Lorentz force, and of the extension of the results already obtained through the use of simplified Euler equations (isothermal) to a more general energy equation. He introduced the problematic of arbitrary coordinate systems or mesh geometries and the problematic related to the coupling of the schemes in the case of different species (electrons, ions, neutrals). For kinetic equations GD recalled the project objective to construct a numerical scheme which in the limit will solve an asymptotic model obtained under both assumptions of large magnetic fields and low-Mach numbers. He spoke also of coupling different species and of taking into account self produced electric and magnetic fields and collisions in particular for particles approaches. When a clear distinction can be done between different regimes (fluid and kinetic) GD recall that one goal will be to provide a scheme which will be able to locally benefit of kinetic effects. Other points will regards the study of the consistency and stability for kinetic and fluid asymptotic preserving methods and error estimates in terms of the mesh size and time step. Finally GD recalled that one goal will be to develop multi dimensional codes for the simulation of plasmas that can be described by kinetic or fluid equations.

Before the presentation of GD all participants shortly introduced themselves and their work.

MO presented the IRFM (Institut de Recherche sur la Fusion Magnetique) and their activities. He briefly explained the involvement of the IRFM into the ITER project. MO gave an overview of the state of the art of the codes used at IRFM for simulating the plasma dynamics: he cited among others Gysela, Jorek and various fluid codes. In parallel to these activities related to plasma fusion, MO spoke about some other activities of IRFM as asymptotic theory and integrated modelling. He briefly presented other research fields in which the IRFM is involved as solar physics or magneto spheric plasma physics. He spoke about some of the main goals related to the magnetic plasma

simulations:
1 Characterize the plasma dynamics.
2 Handle the different spatial and temporal scales problem. In particular, he gave some details regarding the different spatial scales related to the Debye length and the ion gyrofrequency in comparison to the typical dimension of the experiment (difference of the order of 10^6). Moreover, he recalled that the time scales related to several plasma phenomena are of the order of 10^6 times smaller in comparison to the typical simulation time of the experiments. Finally, MO made a short review of the gyrokinetic models in comparison to particles or semilagrangian schemes for Vlasov equation.

PD presented the IMT and their activities for plasmas. He described the asymptotic preserving strategy and he spoke about problems related to the loss of the physical significance of the balance equation for the limit model. PD presented a new AP approach in comparison to an old approach. This new approach consists in starting with the initial balance equation in which a perturbation is introduced and then use AP schemes to solve it without breakdown of the time and space steps when the perturbation parameter tends to zero. PD presented the work done so far on the AP methods for plasmas: he focused on the fluid AP schemes and he remarked that the problem can be reduced to strongly anisotropic elliptic equation which have to be solved. PD showed what he intends to do in the next future on this subject: develop an AP method for a fluid two species model coupled with quasineutrality which will lead to two strongly anisotropic elliptic equations coupled to each others. PD enlightened the needs of test problems to understand the behaviours of the schemes in challenging applications which are closer to real problems. MO proposed to furnish these test cases. Finally, PD focused on the importance of improving efficiency through the algorithm development in collaboration with the CERFACS team and the importance of working on the scheme design in collaboration with LATP.

CN presented an application of the AP methodology for a non linear anisotropic temperature diffusion equation in a Tokamak. She remarked that the scheme works for arbitrary geometry and on coarse cartesian grids. CN presented some future development as the introduction of a convection term and the numerical analysis of the schemes in the elliptic and in the parabolic case. She presented also an AP schemes for kinetic problems. MO remarked that the temperature diffusion equation is relevant for the modelling of the heat transfer in the presence of magnetic field. MO suggested also that the kinetic models CN presented can be simplified, at least at the beginning, considering only one equation for the electrons and considering the ions fixed.

LG presented his team with relevance to its work on the development of numerical schemes for multiscale applications. He presented some of the work of CERFACS concerning present and past projects which can be utilized and extended to the case of the present project. LG spoke about algorithms for linear algebra and MPG heterogeneous architectures. He recalled the work done in collaboration with JN and PD on the implementation of the AP scheme for anisotropic diffusion equation. He finally recalled that the codes can eventually constitute a base for the construction of the plasmas codes. LG described some very challenging applications of parallel linear algebra and dense linear algebra on multicore architectures and sparse domain decomposition techniques.

Afternoon: 14.45

Administration Session. Moderator CN
During the administration session the participants discussed the realisation of a web page to give visibility to the project. The web site will contain the description of the project and of the component teams, the papers and reports. All documents will be available to the different teams, they will be also available to the public. CN accepted to realise a logo of the project. The

participants discussed of the next meeting, to eventually substitute physical meeting with phone conferences. The consortium agrees that physical meeting are important and that they must be preferred when possible. A meeting is proposed every six month. PD introduced the discussion about the publication strategy. He proposed to inform the consortium about planned publications on journals or proceedings and to inform the participants of the project about conferences participations. PD proposed that the decisions regarding publications will be collective and discussed at least between the team coordinators and the participants which will be more involved in the activities concerning the publications. EA proposed to set up a mailing list using INRIAgforge and he is in charge of its realization. For the visibility of the project and to promote interaction between the members of the project and other researchers in the field, it has been proposed to organize a workshop within 2 years on numerical methods for plasmas. The question of searching funding is still open and will be discussed in future meetings.

15.45 Discussion on the Working Packages planning. Moderators PD, MO and LG.
PD presented the details of the work planned for the application of the AP method to the two fluid model (ions and electrons) and how to optimize the resulting scheme in collaboration with the CERFACS team. CN presented different possibilities in order to extend the work on the anisotropic temperature diffusion equation by including a convection term. CN will work on the AP schemes for kinetic equations where epsilon (the scaling parameter) goes to zero in connection with GD. The members agreed that this second axis of research is maybe too premature for a post doc and they decided to eventually propose this subject to a post doc not before next year. GD proposed to work on the kinetic upscaling techniques to pass from gyrokinetic to the gyrofluid model.

17.00 Wrap up
The participants summarized part of the administrative work for the next semester in a "to do list":
1) Web site: GD proposed a strategy (realize a tentative of a web site to submit to the approval of the participants and decide if it is sufficient or if the consortium prefers a professional web site).
2) Logo: CN is in charge of realizing it.
3) Communication: MO will work on the conference calls.
4) Mail list: EA is in charge of realizing a mailing list.
5) Signatures: GD tells PD when withdraw the new project submitted to the ANR.
6) Contract for Damiano Lombardi: GD and PD are in charge of the contract for the post-doc.
7) PD proposed a document with the work to be done
8) CN and MO will meet to discuss the work to be done
9) MO will write a document with test cases and open problems
10) Next meeting is scheduled the 14th or 17th of October 2011 in Marseille.
11) GD will send an email to organize the next meeting beginning of September.