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PhD PROPOSAL 2009

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Title : Modelling of angular momentum transport in a tokamak plasma

Summary :

A strong shear in the plasma rotation is believed to be a key factor for turbulence suppression and hence improve the energy confinement, with is a key challenge for ITER. In order to predict the rotation shear in ITER, it is necessary to study the source and transport of angular momentum in existing tokamaks. In most of them, strong plasma rotation is mainly driven by Neutral Beams Injection (NBI) heating, which provides a significant external momentum source. However, in ITER and a reactor, NBI is nor expected to provide much external momentum (partly due to the high injection energy required). On the other hand, “intrinsic” plasma rotation (that is to say, with no or little external torque) has been reported by several tokamak experiments, e.g. in JET, Alcator C-Mod and Tore Supra. From the theory side, turbulent mechanisms are believed to be responsible of part of the angular momentum transport. Recently quasi-linear transport models have been developed and are starting to be tested against experiments. Theoretical work on angular momentum source generated by turbulence is also underway in order to explain the measured intrinsic rotation. In view of the fact that it could play an important role in ITER, angular momentum transport and source has become a well identified important subject, supported by the International Tokamak Physics Activities (ITPA) organization and the European Fusion Development Agreement (EFDA) Topical Group on Transport.

The thesis will be devoted to modelling the turbulent angular momentum transport and to integrating a complete plasma model solving simultaneously the transport equations and the sources terms.

Concerning the angular momentum transport:

- As a first step, the student will include the angular momentum transport in the quasi-linear turbulent transport model we have recently developed for energy and particle (QuaLiKiz).
- Then CRONOS (a codes platform integrating transport equation and source models) should be modified in order to include the angular momentum transport.

Concerning the angular momentum source:

- CRONOS already models sources due to neutral beam injection, radio frequency heating, etc. Nevertheless, these existing modules need to be tested and benchmarked versus other existing codes. This work will be done with the CRONOS team project.
- On the source generated by turbulence, the student will work closely with the physicists working on fully non-linear turbulence model such as GYSELA and ETAI3D.

Finally, the student will use QuaLiKiz in CRONOS to analyze, for the first time, the simultaneous evolution of heat, particle and angular momentum on a plasma discharge time scale. The student will compare the scenario obtained in CRONOS with the experimental ones obtained in Tore Supra and JET.

This wide PhD thesis topic is at the interface between theory, modelling and experiments. It requires scientific curiosity and taste for work in team.

Skills : plasma physics; scientific programming
Level: Master in Physics