Integrated Modelling and Simulation of Toroidal Plasmas

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Integrated modelling is indispensable for understanding nonlinear interactions between various physical processes in toroidal plasmas, predicting the performance of burning plasmas and developing control schemes for ITER and future fusion reactors. Integrated simulation should describe whole plasma, (core, edge, SOL and divertor plasmas) and whole discharge (start up, sustainment, unexpected disturbance, and shut down). In order to describe various phenomena in toroidal plasmas, integrated modelling codes include a variety of components describing equilibrium, global stability, transport, energetic particles, actuators, and control systems. The time evolution of plasma is mainly described by transport components, and several levels of transport modelling are available, conventional diffusive modelling, dynamic multi-fluid modelling, and kinetic velocity distribution function modelling, even if turbulence modelling is separated based on the difference of time scale. Since many components are included in integrated modelling, systematic schemes for data exchange and execution control are necessary. Standard plasma data models and data access interfaces have been developed and implemented in integrated modelling codes. As an example, the integrated modelling code, TASK, is introduced and applied to the simulation of plasmas in tokamaks and helical devices.