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ジャイロ運動論コード GKV とトカマク輸送コード TRESS による連成輸送解析

Transport simulations by the coupling of the gyrokinetic code GKV and the tokamak transport code TRESS

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In recent years gyrokinetic codes, especially δf flux-tube gyrokinetic codes, have been extensively applied to the experimental analyses and they have achieved success to explain the transport level and identify the dominant instability that drives transport. In contrast to the success of the experimental analyses, they have rarely been applied to time-dependent predictive simulations. There seem to be several reasons: In general, gyrokinetic simulations entail heavy computational costs as compared to those by transport codes. The δf flux-tube gyrokinetic codes calculate the turbulent transport fluxes with the background kinetic profiles fixed, meaning that the evolution of the profiles cannot be dealt with. The full-f global gyrokinetic codes can do that, but they entail more computational costs than the δf flux-tube ones. For those reasons, reduced transport models have been usually used for predictive transport simulations as a realistic manner. While reduced transport models require less computational costs and are suitable for transport codes, some sort of physics is neglected or eliminated in the process of reducing the comprehensive model to the one that is manageable within realistic computational resources.

As an eclectic way, we now propose the coupling of a transport code and a gyrokinetic code. The gyrokinetic code calculates the effective diffusivity χ at each location at each time, and the resultant diffusivity is passed to the transport code so as to evolve the global kinetic profiles. For this purpose, the new transport code TRESS has been developed working together with the δf flux-tube gyrokinetic code GKV [1]. TRESS is a handy 1D diffusive transport code and is spatially discretized by the finite element method with the cubic Hermite basis functions, which has third order accuracy. This way of dicretization enables us to obtain the robust solution even when the jagged χ profile is given and also to have the consistency between a dependent variable and its derivative. This feature is of significant importance because the gradients of the kinetic profiles are essential for the gyrokinetic simulations.

The coupling and execution are realized in a manner shown in Fig. 1. Typically GKV runs in parallel using 256 CPUs for each process (radial location). TRESS and GKV will ultimately be linked together in an MPMD (Multiple Program, Multiple Data) style, but we believe we should first demonstrate the TRESS+GKV system does work properly. Thus we take the simplest way of coupling, where TRESS is embedded in GKV and any processes calculate the profile evolution after every single process shares all χ's in common. As a first trial, χ is calculated by the mixing length estimate using the linear growth rate.

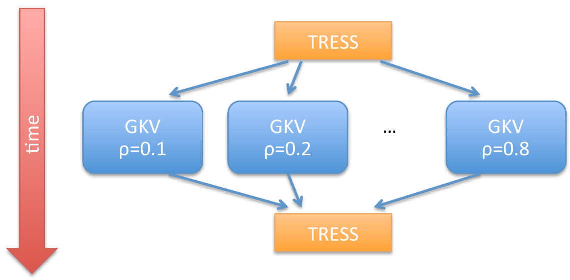

Figure 1: Schematic diagram of the coupling of TRESS and GKV.

[1] T.-H. Watanabe and H. Sugama, *Nucl. Fusion* **46** (2006) 24.