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OPTIMAL CONTROL & PARAMETER ESTIMATION FOR PLASMAS

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ABSTRACT

Fusion based on magnetic confinement aims at producing power by using the energy liberated by deuterium and tritium nuclei reacting at extremely high temperatures (10^7 - 10^8 K), thus resulting in a plasma that is confined by magnetic fields in machines of toroidal shape known as tokamaks. Numerous technological and scientific challenges remain, that require a sustained research effort. Foremost among these challenges is the issue of power exhaust. The control of heat fluxes onto the tokamak walls in high energy confinement configurations and for both steady-state and transient regimes must be addressed to successfully run future ITER experiments. Sustaining burning plasmas in the core of the machine while achieving sufficient power spreading on the dedicated wall components to keep the heat flux below the handling capability of the materials, imposes stringent and conflicting constraints on the tokamak operation. A major challenge nowadays for low-fidelity models making for power exhaust simulations is the improvement of the turbulence modelling related to the heat transport in the perpendicular direction to magnetic flux surfaces, from the core, where the heat is produced by fusion, to the tokamak chamber, where the heat is extracted. The assimilation of experimental or numerical data from tokamak measurements and high-fidelity models, respectively, have the potential to reduce uncertainties on the free parameters inherently occurring in the models, used to close the averaged fluxes and stresses due to fluctuations. The goal of this MS is to share recent theoretical and numerical results around optimal control approaches applied on reduced models, for heat transport in plasmas, to reconstruct the most significant parameters that can then be used to predict model solutions.

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