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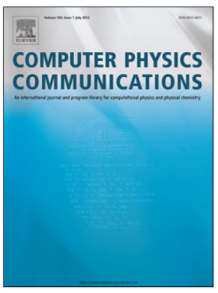

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ASYMPTOTIC-PRESERVING SCHEME FOR A STRONGLY ANISOTROPIC VORTICITY EQUATION ARISING IN FUSION PLASMA MODELLING

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Abstract. The electric potential is an essential quantity for the confinement process of tokamak plasmas, with important impact on the performances of fusion reactors. Understanding its evolution in the peripheral region – the part of the plasma interacting with the wall of the device – is of crucial importance, since it governs the boundary conditions for the burning core plasma. The aim of the present paper is to study numerically the evolution of the electric potential in this peripheral plasma region. In particular, we are interested in introducing an efficient Asymptotic-Preserving (AP) numerical scheme capable to cope with the strong anisotropy of the problem as well as the non-linear boundary conditions, and this with acceptable computational costs. This work constitutes the numerical follow-up of the more mathematical paper by C. Negulescu, A. Nouri, Ph. Ghendrih, Y. Sarazin, *Existence and uniqueness of the electric potential profile in the edge of tokamak plasmas when constrained by the plasma-wall boundary physics.*

1. Introduction

The subject matter of the present paper is related to the magnetically confined fusion plasmas with the objective to contribute to the improvement of the numerical schemes used for the simulation of the plasma evolution in tokamaks.

Producing energy via thermonuclear fusion processes in a tokamak is strongly dependent on the aptitude to confine the plasma in the core of the tokamak, and at the same time on the ability to control the plasma heat-flux on the wall of the device. The fulfillment of these two requirements (sine qua non) is complicated by the turbulent plasma transport occurring in such high temperature environments. So, an important outstanding problem in fusion research is the comprehension, the prediction as well as the control of the turbulent plasma flow in a tokamak, in particular in the edge region of such a device. What is meant by "edge" or "peripheral" region of the tokamak is the region constituted firstly of the open magnetic field lines of the SOL (Scrape-off Layer), intercepting the wall (at the limiter), and bounded by the closed magnetic field region inside the separatrix.

The study of peripheral tokamak plasmas is crucial for several reasons. First of all, this region imposes boundary conditions for the core plasma, and has thus to be treated with care. In particular, it is very important for the confinement properties of the reactor, to understand the turbulences occurring there. Secondly, it is the SOL plasma which contacts the wall of

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Key words and phrases. **Keywords:** Magnetically confined fusion plasma, Plasma-wall interaction, Singularly perturbed problem, Highly anisotropic evolution problem, Asymptotic-Preserving numerical scheme.