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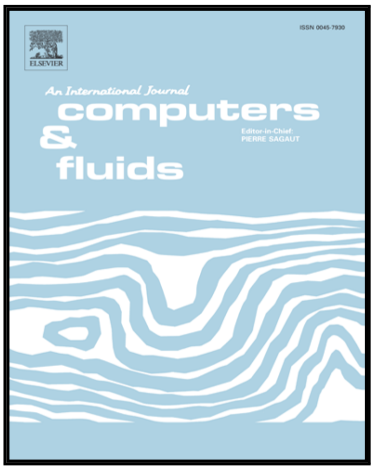

Re-print of Residual equilibrium schemes for time dependent partial differential equations

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Re-print of Residual equilibrium schemes for time dependent partial differential equations

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Abstract

Many applications involve partial differential equations which admits nontrivial steady state solutions. The design of schemes which are able to describe correctly these equilibrium states may be challenging for numerical methods, in particular for high order ones. In this paper, inspired by micro-macro decomposition methods for kinetic equations, we present a class of schemes which are capable to preserve the steady state solution and achieve high order accuracy for a class of time dependent partial differential equations including nonlinear diffusion equations and kinetic equations. Extension to systems of conservation laws with source terms are also discussed.

Keywords: Fokker-Planck equations, micro-macro decomposition, steady-states preserving, well-balanced schemes, shallow-water

1. Introduction

Several applications involve time dependent partial differential equations (PDEs) which admit nontrivial stationary solutions. The design of numerical methods which are capable to describe correctly such steady state solutions may be challenging since they involve the balance between heterogeneous terms like convection, diffusion and other space dependent sources. We refer to [1, 2] (and the references therein) for recent surveys on numerical schemes for such problems in the case of balance laws.

Typical examples, include nonlinear convection-diffusion equations

$$\begin{cases} \dfrac{\partial u}{\partial t}(t,x) = \operatorname{div}\left(A(x,u(t,x)) + \nabla_x N(u(t,x))\right), & x \in \Omega,\ t>0, \\ u(0,x) = u_0(x), & x \in \Omega, \end{cases} \tag{1}$$

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