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STUDY OF SOME NUMERICAL ARTIFACTS INTERVENING IN THE FINITE DIFFERENCES SIMULATIONS OF KdV SOLITONS PROPAGATION

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Abstract. *As it is well known, the complex simulations are frequently affected by numerical artifacts, which reduce drastically their accuracy. Taking into account that the numerical artifacts due to the non-linearity of the considered physical problem are less studied that those due to the symmetry breaking or to the high logical depth of the used schemes, the finite differences (FD) simulations of some (Korteweg-de Vries) solitonic pulses were studied. In this aim, both the possible FD discretizations and the artifacts corresponding to different values of the simulation uniqueness parameters were studied. The possibilities to explain quantitatively the observed numerical artifacts, transforming them in numerical phenomena, were also studied.*

Keywords: Complex numerical simulations, numerical artifacts, Korteweg-de Vries solitary waves, FD discretizations, numerical phenomena

1. Introduction

As it is well-known, we live in a computerized world, our civilization being a "civilization of computers". Since all complex installations and devices are now controlled by computers, their corresponding complex simulations can lead to some numerical artifacts and – if they are used to control such systems – to major failures. Particularly, the Patriot missile failure to stop a Scud missile during the Gulf War in 1991 (with disastrous results) [1] and the self-destruction of the European Space Agency's Ariane 5 rocket, at 37 seconds after its launch [2], were both assigned to some computer errors [3] and their associated numerical artifacts. If the mechanisms of the computer artifacts installation can be quantitatively described, these artifacts are called « numerical phenomena » [4].

A typical source of numerical artifacts corresponds to the Finite Difference (FD) simulations of the solitary waves propagation, due to the nonlinear character of their equations. Taking into account the major applications of the more than 100 types of different solitary waves [5] in all Physics fields: Cosmology and Astrophysics, Mechanics and Fluid Mechanics, Molecular chains, Condensed

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