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MULTI-WAVE SOLITON AUTOMATA

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ABSTRACT

A soliton or solitary wave, when travelling through a molecule, for instance a polyacetylene chain, may cause changes in the bond structure. These changes can be interpreted as state changes of an automaton. In the late 1970s F. L. Carter suggested that computers could be built based on the switching of bonds by solitons. Several successful experiments were conducted at that time.

An abstract mathematical model of soliton switching, soliton automaton, was defined by Dassow and Jürgensen about 1986. A graph with weighted edges takes the rôle of the molecule, and the soliton is a kind of pebble which moves from node to node along the edges of the graph and, in doing so, changes the weights of the edges. Using this model, the logical potential of soliton-based switching has been explored. So far, the essential simplifying assumption was that only one soliton can be in the molecule at any given time.

We extend this model to include the simultaneous presence of more than one soliton. When multiple soliton waves or particles are present, their interactions have to be modelled in a physically meaningful way. Some situations are specific to the multi-soliton case and are not observed otherwise. This leads one to re-consider even the most basic concepts regarding soliton automata. In this paper we lay the foundations for this theory of multi-soliton automata, explain the modelling decisions, and discuss issues which are new when multiple solitons are considered. The new model includes the single-soliton case in a consistent manner.

Keywords: molecular computer, unconventional modes of computation, bond switching, soliton automaton, soliton wave, multiple soliton waves, finite automaton

1. Solitons

"When considering unorthodox means of computation one needs to discard any preconceived ideas, but first investigate what the new means have to offer and, after that, how to use the new features to achieve the intended goals." This was stated by one of the present authors (HJ) in the 1980s in several talks. A similar opinion is found

A preliminary version of this paper, without proofs and details, appeared as *Soliton Automata with Multiple Waves* in the Festschrift *Computing with New Resources: Essays Dedicated to Jozef Gruska on the Occasion of His 80th Birthday* [10].

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