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Introduction

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The present Special Issue includes a selection of papers on natural computing presented at the (Renaissance) International Workshop “Physics and Computation” held in Vienna, Austria, August 25–28, 2008.

Physics and computation theory have interacted from the early days of computing. After a joint start we witnessed the famous late 1950s divorce (fuelled by the hope of doing machine-independent computation) only to realise in the 1980s that, ultimately, physics laws permit computation.

There is a long tradition of workshops on “Physics and Computation” inaugurated by the famous 1982 meeting whose proceedings have been published in a Special Issue of the *Int. J. Theor. Phys*. Volume 21, Numbers 3–4, April (1982) which starts with Toffoli’s programatic article “Physics and computation” (pp. 165–175).

In what follows we will briefly present the contributions in the issue, including the papers on the reaction–diffusion model of computation, on the relativistic computers and on quantum computation, a total of eight papers out of the nineteen papers invited:

- Andrew Adamatzky, *From reaction–diffusion to physarum computing*
  The author introduces a model of a reaction–diffusion medium encapsulated in an elastic membrane (vegetative state, or plasmodium, of Physarum polycephalum) and demonstrates that computation of spanning trees and other types of proximity graphs, and implementation of storage-modification devices (e.g. Kolmogorov-Uspensky machine) can be executed by plasmodium.
- Časlav Bruckner, *How quantum mechanical experiments can test the (un)decidability of mathematical statements?*
  The author shows how to use quantum measurements to test the (un)decidability of certain mathematical propositions, namely that elementary quantum systems are

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capable of encoding finite axioms, and quantum measurements are capable of verifying truth values of propositions.

- Jérôme Durand-Lose, *Black hole computation: implementations with signal machines*
  The author presents a setting in a continuous Euclidean space-time that mimics the behaviour of a relativistic computer. The computations generate line-segments in a continuous space-time. Not only is Zeno effect possible but it is used to unleash the black hole power. Both discrete computation and analog computation are considered.
- Jerzy Górecki, J. N. Gorecka, and Y. Igarashi, *Information processing with structured excitable medium*
  The authors present chemical realisations of simple information processing devices like logical gates, signal comparers or memory cells and we show that by combining these devices as building blocks the medium can perform complex signal processing operations.
- Mark Hogarth, *A new problem for rule following*
  The autor argues that different space-time geometries yield radically different concepts of computer, and the range of computers extends far beyond Turing's machine.
- Hajnal Andréka, István Németi, and Péter Németi, *General relativistic hypercomputing and foundation of mathematics*
  The authors describe a physical device in relativistic spacetime which can compute a non-Turing computable task, e.g. which can decide the halting problem of Turing machines or decide whether ZF set theory is consistent.
- Mike Stannett, *Computable, uncomputable, neither or both?—a finitary computational formulation of quantum theory*
  The author describes a finitary reformulation of the path-integral model which is equivalent to the standard version, but in which particles never follow continuous trajectories; instead, motion comprises a finite sequence of distinct "hops". It is then argued that the quantum world has an inherently computational structure that could nonetheless allow uncomputable values to be observed.
- Karl Svozil and Josef Tkadlec, *On the solution of trivalent decision problems by quantum state identication*
  The trivalent functions of a trit can be grouped into equipartitions of three elements. The authors discuss the separation of the corresponding functional classes by quantum state identifications.

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