PDS-2-1-4 Photonic reservoir computing as a new paradigm for optical information processing

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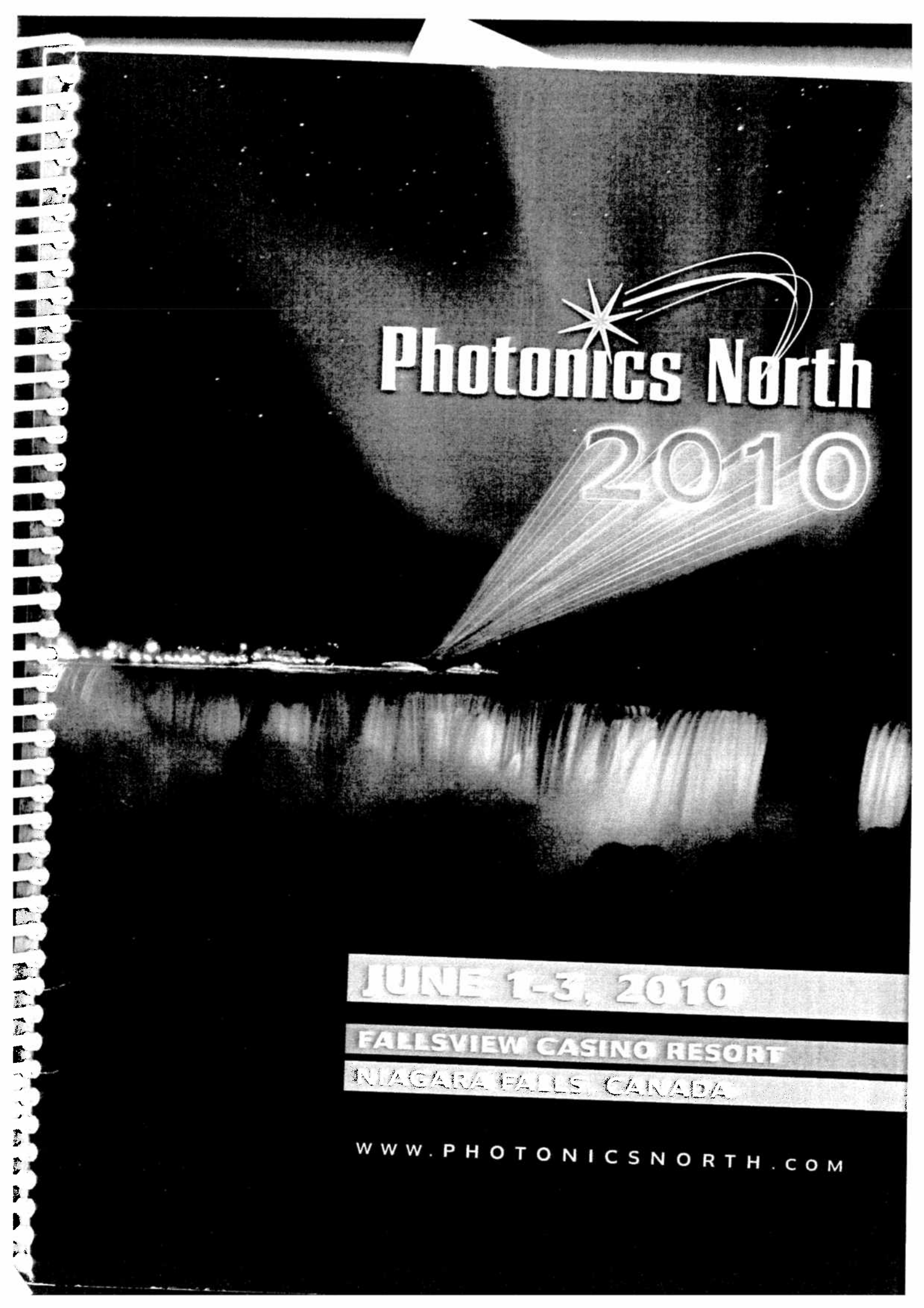
Nanophotonic reservoir computing is a novel paradigm for massively parallel information processing. It is an implementation in photonics of the so-called reservoir computing concept [1], a recently proposed methodology from the field of machine learning and neural networks, which has been used successfully in several pattern classification problems, like speech and image recognition. However, it has so far been used mainly in a software implementation, which limits its speed and power efficiency. Photonics could provide an excellent platform for such a hardware implementation, because of the presence of unique non-linear dynamics in photonics components due to the interplay of photons and electrons, and because light also has a phase in addition to an amplitude, which provides for an important additional degree of freedom as opposed to a purely electronic hardware implementation.

In one of our proposed photonic implementation, we employ a network of coupled Semiconductor Optical Amplifiers (SOA) as the basic building blocks for the reservoir [2]. Although they differ in many key respects from traditional software-based hyperbolic tangent reservoirs, we show using simulations that such a photonic reservoir can outperform traditional reservoirs on a benchmark classification task. Moreover, a photonic implementation offers the promise of massively parallel information processing with low power and high speed.

We discuss the performance of nanophotonic reservoir computing on memory benchmarks and for prediction of chaotic time-series. We also discuss novel reservoir architectures based on resonators.

[1] Maass et al., Neural Computation, 14 (11) 2531-2560, 2002.
[2] Vandoorne et al., Optics Express, vol. 16, no. 15, pp. 11182-11192, 2008.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