Advancing magnonic neuromorphic computing

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In this contribution I will describe various approaches to magnonic neuromorphic computing. The field of magnonics has shown a significant potential in advancing information processing [1]. By exploiting spin waves, or magnons, magnonic devices are capable of controlling and mixing signals that encode solutions to various machine learning problems. This approach leverages the unique properties of magnons, such as their low energy consumption and inherent nonlinearity, offering an alternative for developing energy-efficient computing systems based on neuromorphic architectures.

Reservoir computing has gained significant attention as a promising paradigm for neuromorphic computing. It is based on the effective use of nonlinear time dynamics, and can be seen as a physical realization of recurrent neural networks. Here, the key requirement is that reservoir exhibits complex temporal behavior. In this context, we explore the time dynamics of magnonic systems as a coupled system of a magnonic reservoir (magnetic stripe) and nonlinear chiral magnonic resonators [2], and use it as a powerful reservoir for magnonic computing.

Our approach is based on the time-multiplexed encoding of neurons [3], where time bins of magnonic signal encode the effective hidden units. We show that by introducing multiple time delays for magnonic signals, we can extend the system's performance beyond currently considered analysis. The goal is to enhance the system's memory capacity. Our preliminary results showcase the use of the developed approach in time-series prediction and illustrate its potential for extending to other applications for analyzing temporal correlations and classification of signals.

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References:

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