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Physical models of brain circuits - A non-Turing approach to computation — •Karlheinz Meier — Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany

The brain is a complex network of 100 Billion nodes and an average of 10000 synaptic connections per node. It evolves in continuous interaction with the environment on timescales from milliseconds to years. Numerical simulations of this system provide some insights but are severely constrained by prohibitive energy consumption and simulation times.

In 1982 Feynman postulated a method, in which the number of computer elements required to simulate a large physical system is proportional to the space-time volume of the physical system. Similar to today*s quantum emulators neuromorphic systems follow this path by building physical models of brain circuits under user control rather than solving differential equations numerically.

Like the biological archetype physical model neuromorphic systems exhibit attractive features like energy efficiency, fault tolerance and the ability to learn. Their time evolution is governed by the choice of physical parameters rather than external control signals.

The talk will introduce this approach and show some results. Special emphasis is given to the representation of information by probability distributions stored in networks of spiking neurons from which stochastic samples are drawn during an inference process.