Fakultät für Naturwissenschaften

# das Institut für Chemie und das Institut für Physik

**laden ein**

**gemeinsam mit der Gesellschaft Deutscher Chemiker zum**

## Vortrag

**von Herrn**


## Prof. Dr. Wolfram Pernice

*Kirchhoff-Institut für Physik*

***Universität Heidelberg***


# “Embracing Uncertainty: A Photonic Approach to AI Computing”

am: 27. November 2025

um: 16:00 Uhr

wo: im Raum 1/232

Gäste sind herzlich willkommen!

TECHNISCHE UNIVERSITÄT
IN DER KULTURHAUPTSTADT EUROPAS
CHEMNITZ


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Fakultät für Naturwissenschaften

# Institut für Chemie


## Prof. Dr. Wolfram Pernice

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GDCh Gesellschaft Deutscher Chemiker

## Embracing Uncertainty: A Photonic Approach to AI Computing


Biological systems excel at navigating uncertainty—a capability that is central to their adaptability and efficiency. In contrast, artificial neural networks (ANNs), implemented on conventional deterministic hardware, are optimized primarily for accuracy and struggle to reflect the probabilistic nature of real-world inference. Bayesian neural networks (BNNs) address this gap by replacing fixed parameters with probability distributions, enabling them to capture both epistemic uncertainty (stemming from limited data) and aleatoric uncertainty (arising from noise). This makes BNNs especially powerful in situations where information is incomplete.

Yet, implementing probabilistic models efficiently remains a major challenge on digital hardware, which relies on deterministic von Neumann architectures that rigidly separate memory and computation. Photonic hardware offers a compelling alternative. Chaotic light serves as a natural entropy source, enabling massively parallel probabilistic operations and true random number generation. Building on this principle, we introduce a photonic neuromorphic architecture that uses chaotic light fields for single-shot probabilistic computing. Probabilistic information is stored and processed via non-volatile phase-change materials, allowing efficient Bayesian inference. This work establishes a pathway toward fast, energy-efficient, and scalable probabilistic machine learning architectures that move beyond the limits of conventional electronics.


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