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PHYSIK

Physikalisches Kolloquium

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https://uni-due.zoom-x.de/j/64228670246?pwd=RjVQeFNIUkRKRkpiNVpKYXhJaFNLdz09 (gilt für alle Vorträge)

Towards Unconventional Computing: making materials matter

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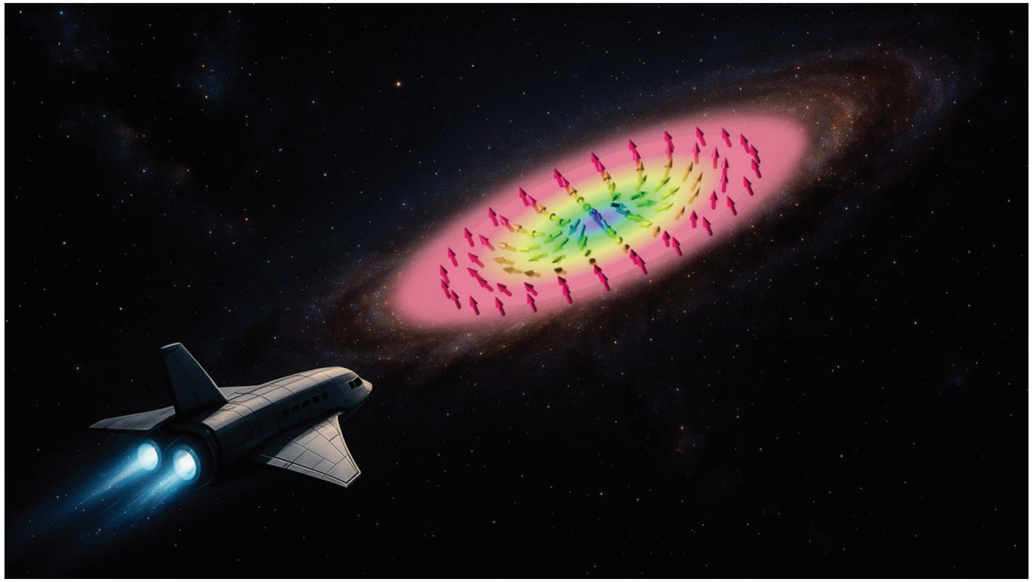

Modern artificial intelligence now spans capabilities from reasoning in large language models to solving complex scientific problems, but these advances come with a growing environmental cost. As neural networks scale rapidly, their computational and energy demands increase accordingly. At the same time, AI is transitioning from data centers to autonomous systems, wearables, and other edge devices, where limited power budgets significantly constrain performance. The combination of ever-larger models and the push toward widespread embedded intelligence makes the current trajectory unsustainable.

In this talk, I explore how materials themselves can serve as the substrate for computation, enabling fundamentally new, fast, scalable, and energy-efficient paradigms that transcend conventional transistor technology. By embedding computation in material physics, we open pathways to adaptive, fast, and low-power information processing. Focusing on oxide-based, magnetic, and ferroelectric material systems and their rich dynamical behaviors, I will discuss how intrinsic physical processes such as resistive switching, magnetization dynamics of spin textures, and photocurrent response can be harnessed to perform computation directly within matter. Building on these principles, such systems naturally implement in-memory computing, neuromorphic neural networks, and physical reservoir computers, where nanoscale material responses become computational primitives for energy-efficient, physics-driven information processing. By summarizing these directions, I will show that unconventional computing is a necessary step toward sustainable, scalable AI, where the physics of materials truly begins to matter.