

## DISTINGUISHED LECTURE SERIES

Winter Term 2021/2022

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Virginia Commonwealth University

### **Voltage control of nanomagnets and skyrmions: Towards energy efficient memory and neuromorphic computing**

While Magnetic Random-Access Memory (MRAM) devices are non-volatile (store information even when power is switched off), 1000 times more energy is required to write information into state-of-the-art MRAM compared to CMOS devices! This motivates research on electrical field control of magnetization in nanoscale magnets: (1) Strain mediated control: strain generated in a piezoelectric layer and transferred to a magnetostrictive layer; (2) Direct voltage control of magnetic anisotropy (VCMA).

Towards this end, this talk will discuss experimental demonstrations of voltage-induced strain and acoustic wave switching of the magnetization of nanomagnets and microscale magnetic tunnel junctions (MTJs) as well as potential to scale such non-volatile memory devices to lateral dimensions below 50 nm. Further, our recent work shows that direct voltage control of magnetic anisotropy (VCMA) in conjunction with magnetic skyrmion states offer a robust and energy efficient mechanism for switching nanomagnets scalable to lateral dimensions below 20 nm.

Finally, we will discuss voltage control of domain wall motion in magnetic nanowires towards implementation of energy efficient deep neural networks whose synaptic weights can be reprogrammed online. We will also discuss coupled nanomagnetic device fabrics such as nanomagnets driven by SAW or voltage driven oscillations of fixed skyrmions. Stray fields and spin waves enable coupling between the nonlinear magnetization dynamics of elements of this fabric to implement reservoir computers, which are amenable to online training to classify temporal patterns. Both these ideas could be a key enabling technology for edge computing in IOT devices, where power is at a premium.

Date: **Monday, January 17, 2022**

Time: **04:00 pm**

Venue: **On site 46/HS 270 or Online via Zoom; the speaker is joined by Zoom**

Meeting ID: **641 9279 3075**, Passcode: **4Ko!!2122**, Link:

**<https://uni-kl-de.zoom.us/j/64192793075?pwd=WnIJYWZhZENCmV2tWZk12U0lHRUthUTog>**