The future of information technology as seen with x-rays

Hermann Dürr

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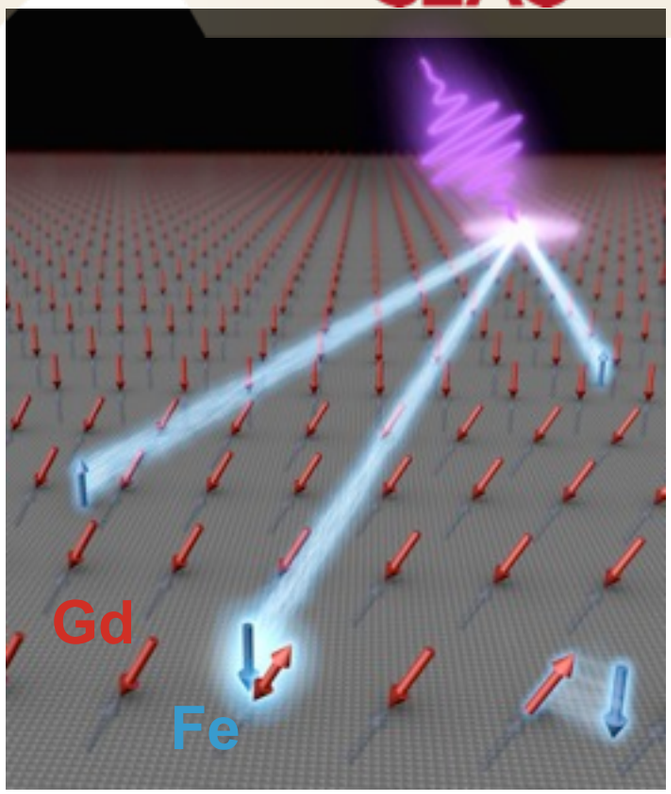
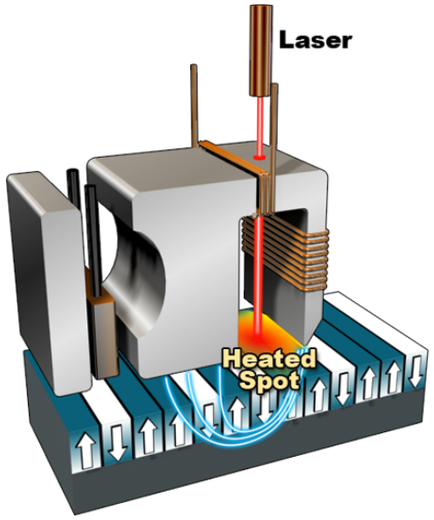
U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

Shaping the future of information technology: Opportunities for basic science

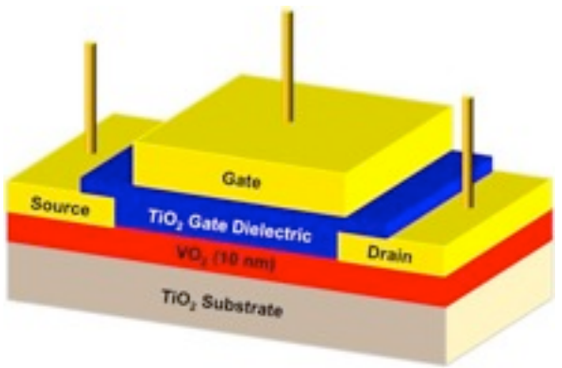


C. Graves, et al. Nature Materials (2013)

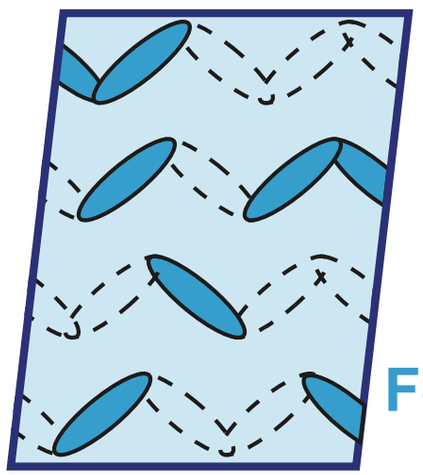


controlling emergence far from equilibrium

present



future



S. de Jong, et al. Nature Materials (2013)

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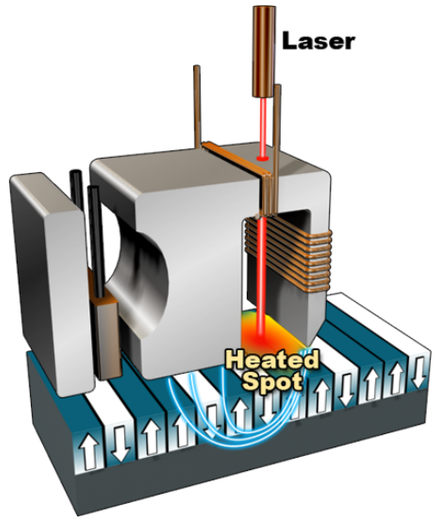

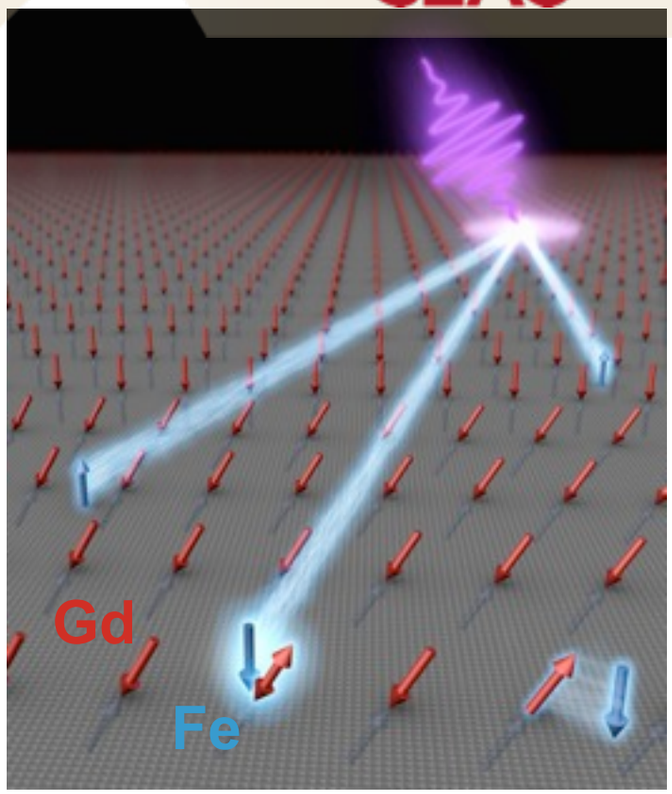

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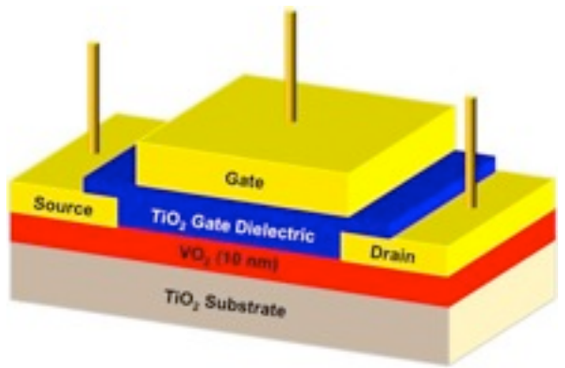
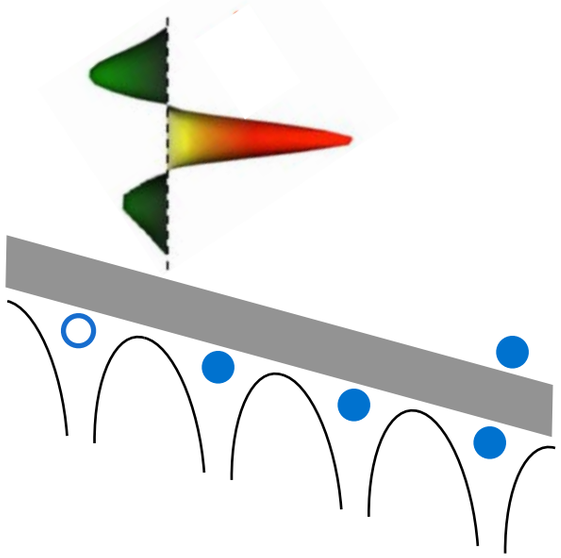


future



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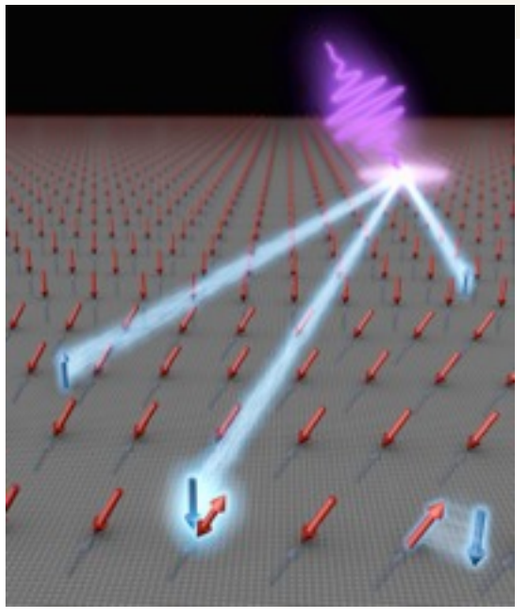
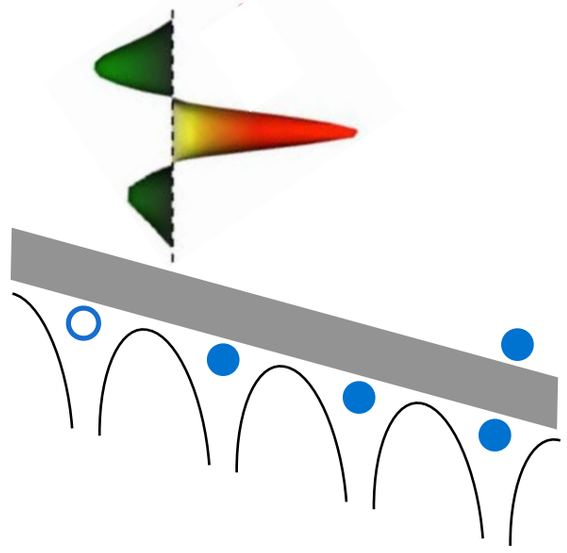
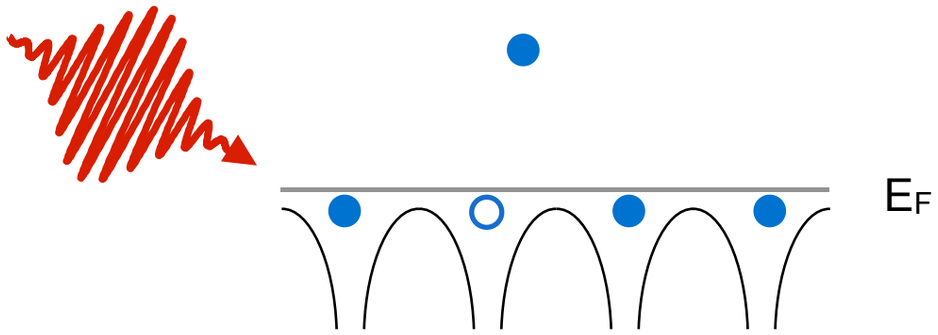


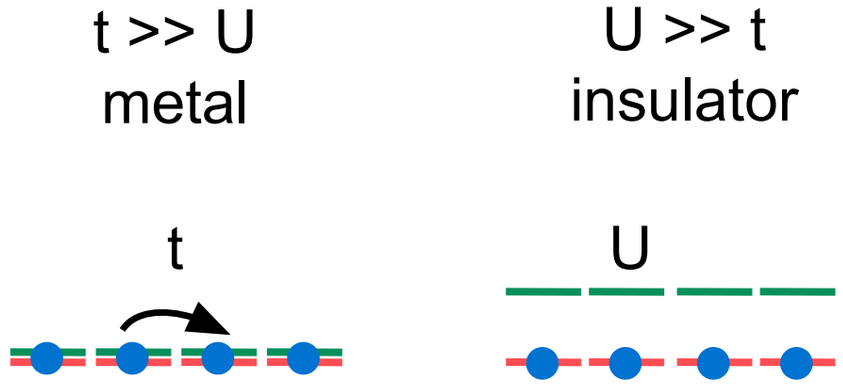
optical excitation



THz excitation



pumps energy



pumps momentum

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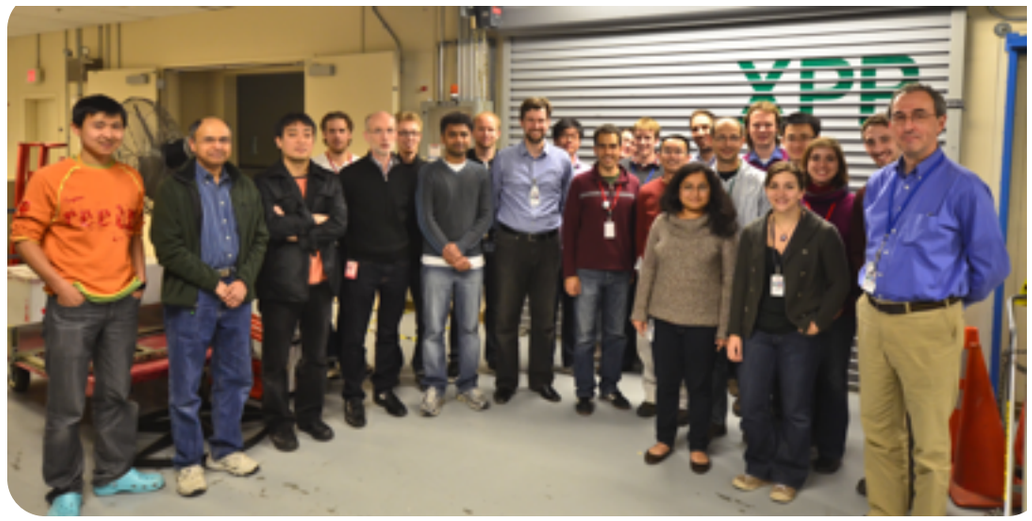
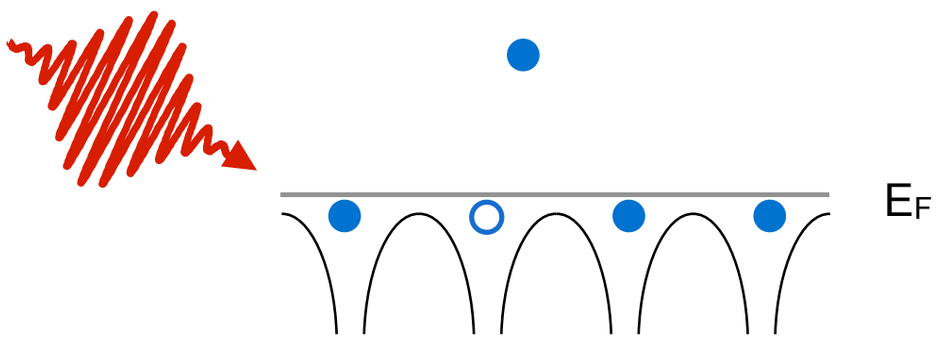
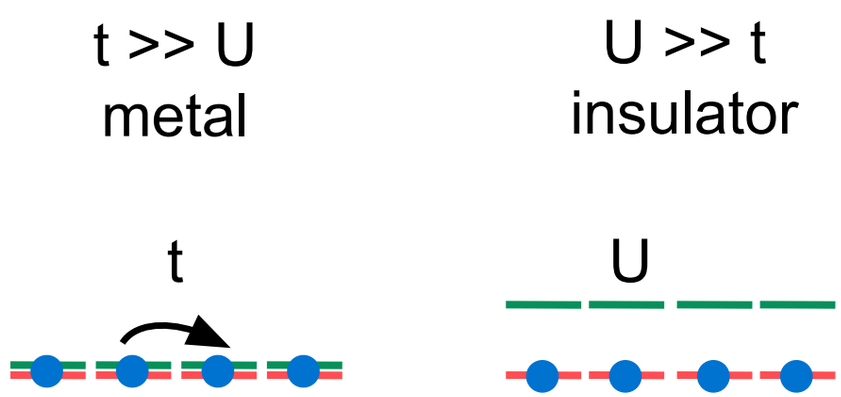




pumps energy



pumps momentum

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The FeCoGd Collaboration

The Stanford – Nijmegen – Zurich – Hamburg – Munich… Team

SLAC/SIMES : C. Graves, A.H. Reid, T. Wang, B. Wu, D.P. Bernstein, S. de Jong, J. Stöhr, A. Scherz, H. A. Dürr
U. Nijmegen : I. Radu, K. Vahaplar, J.H. Mentink, A.V. Kimel, A. Kiryliuk, Th. Rasing
SLAC/LCLS : W. Schlotter, J. J. Turner, M. Messerschmidt, M. Bionta, R. Coffee
MPI/pnSensor: S.W. Epp, R. Hartmann, N. Kimmel, G. Hauser, A. Hartmann, P. Holl, H. Gorke, D. Rolles, H. Soltau, L. Strüder
DESY : L. Müller
ETH Zurich : A. Fognini, Y. Acremann
Nihon U. : A. Tsukamoto

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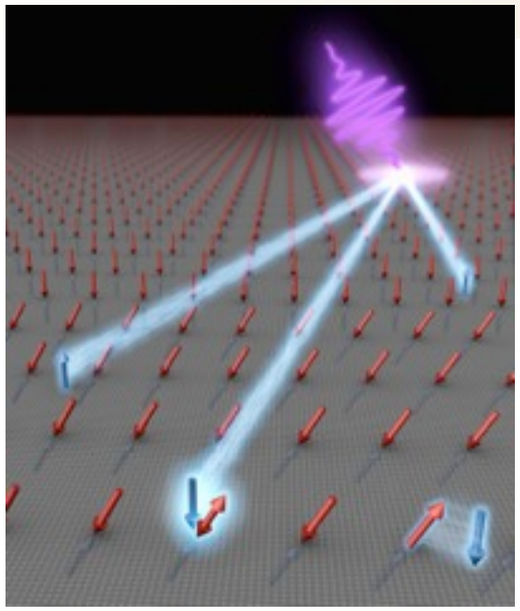
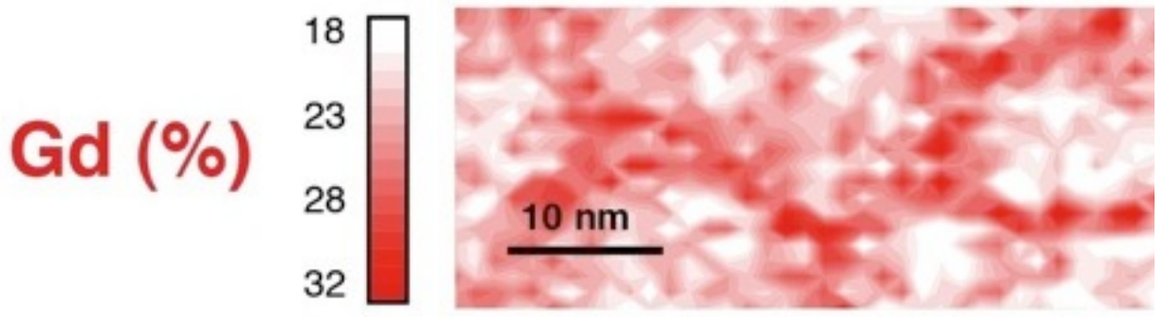
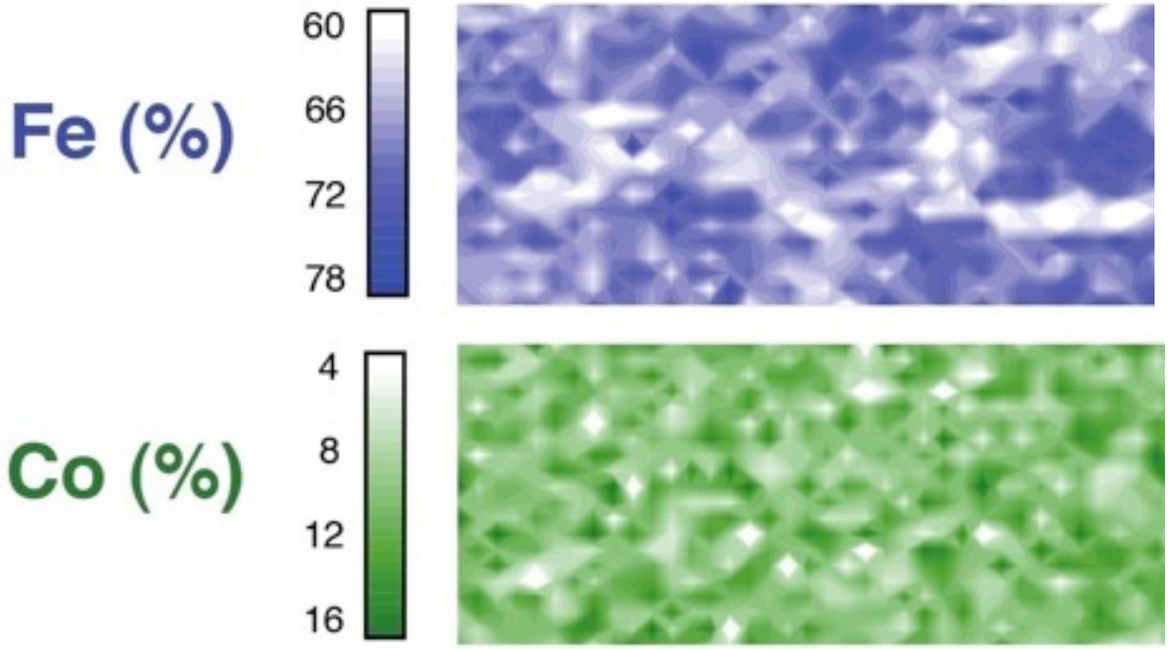
Optical control of nanoscale spin order in $Fe_{66}Co_{10}Gd_{24}$



Real Space





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C. Graves, et al. Nature Materials (2013)

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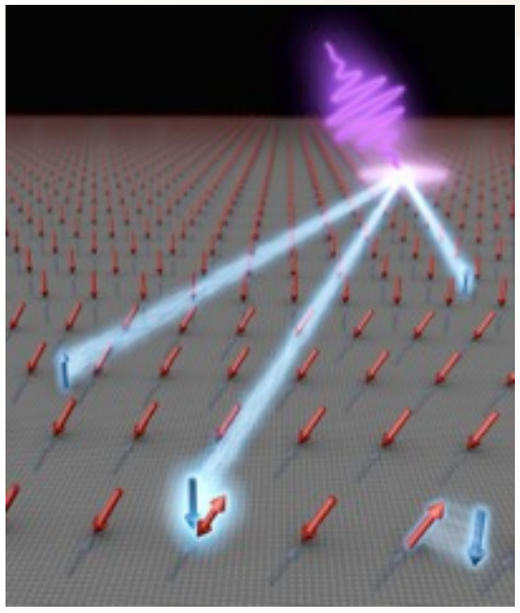
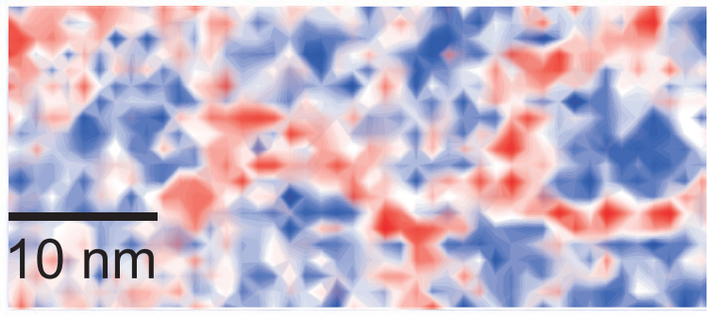
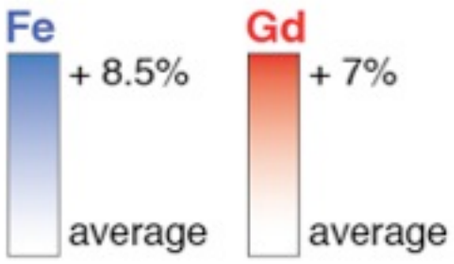


Real Space





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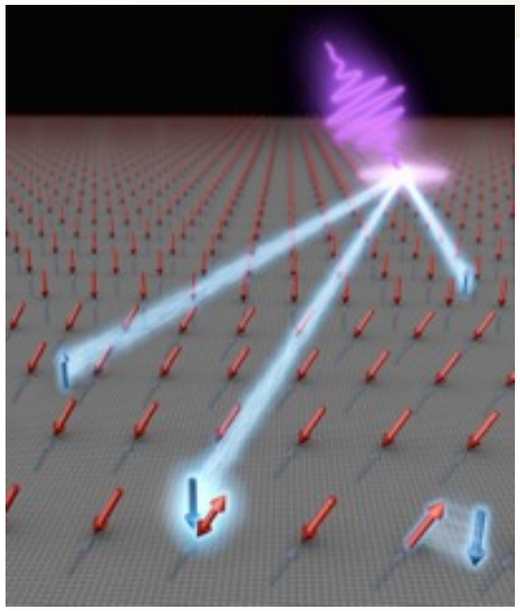
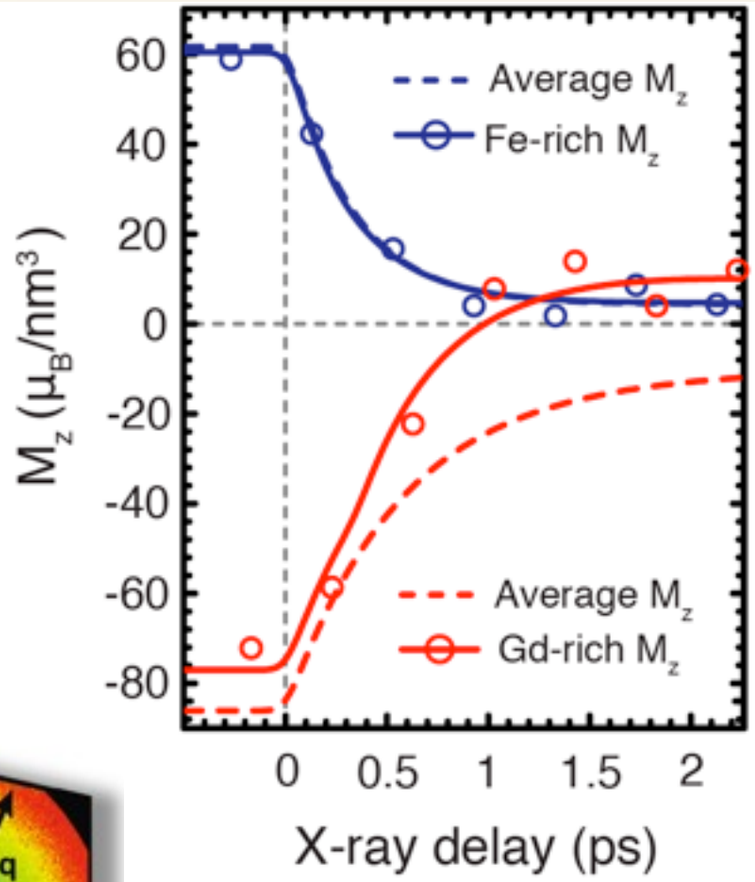
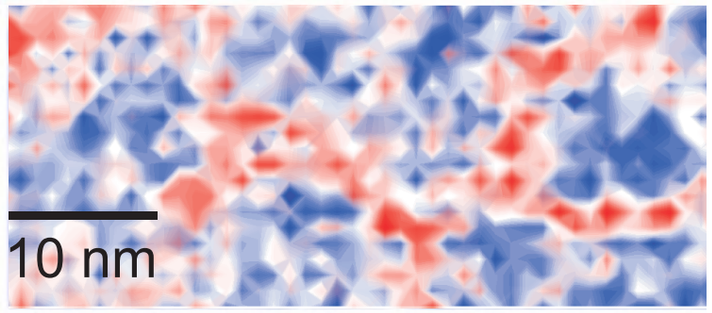
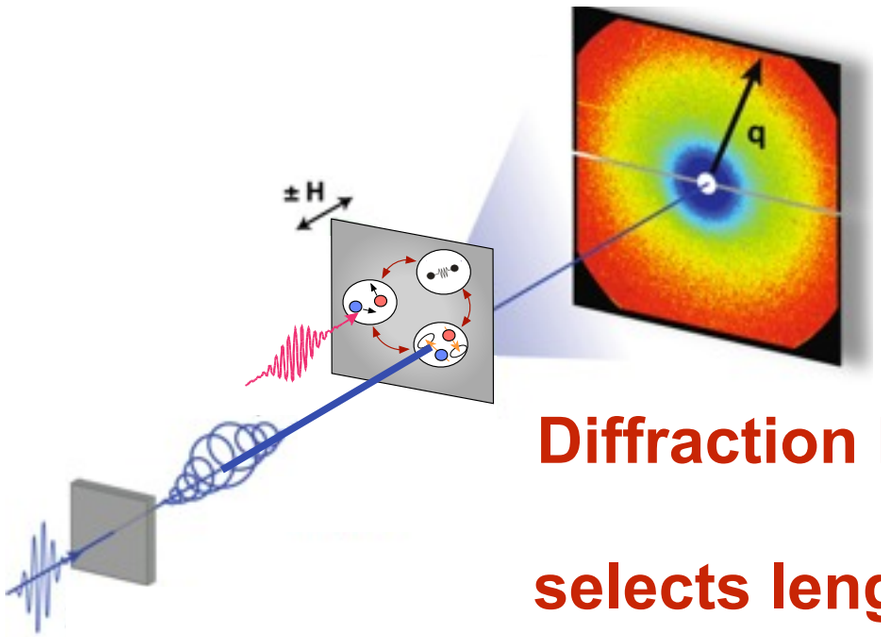




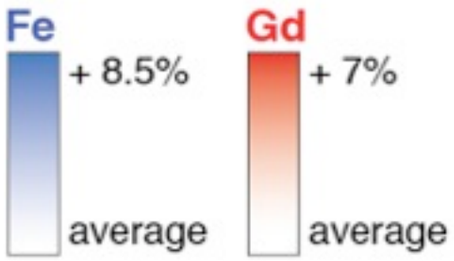
Real Space





Diffraction $I_q \sim | C_q + S_q |^2$

selects length scale ~ 1/q



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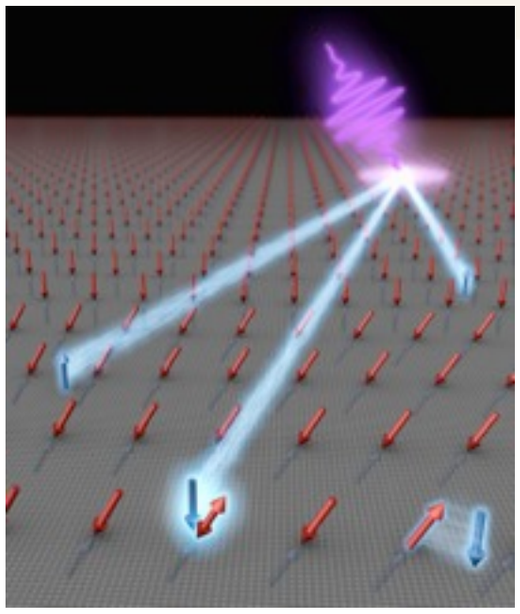
C. Graves, et al. Nature Materials (2013)

Outlook:
Growth of magnetic order in $Fe_{66}Co_{10}Gd_{24}$



... occurs on the ps timescale

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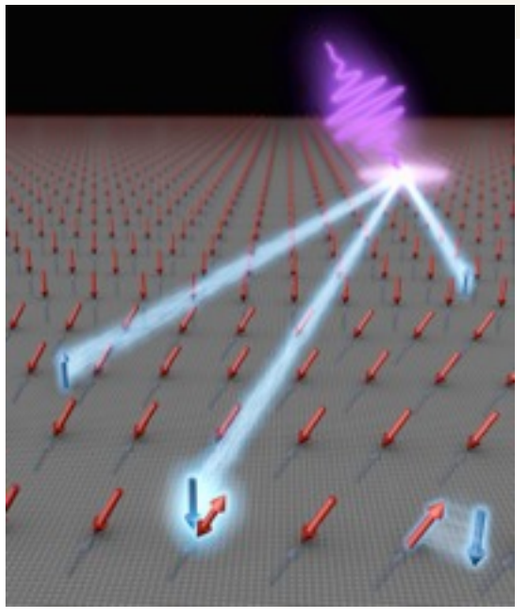
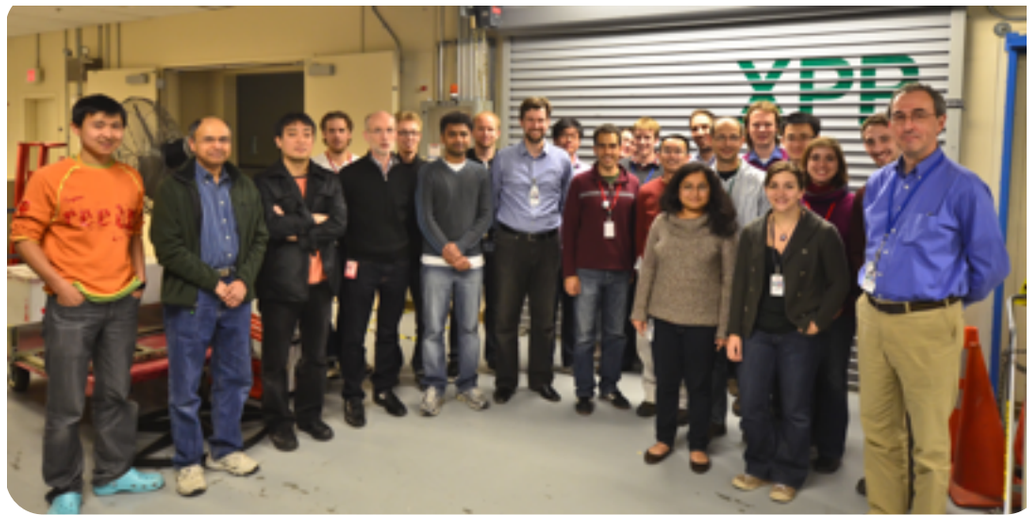
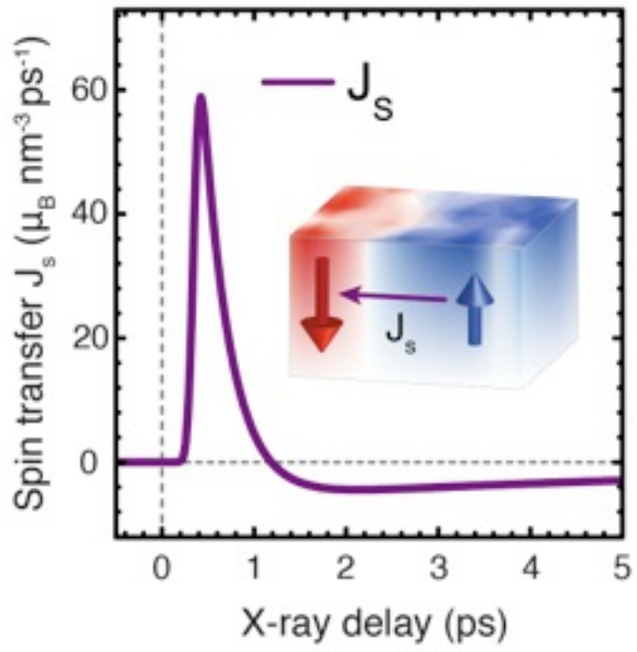
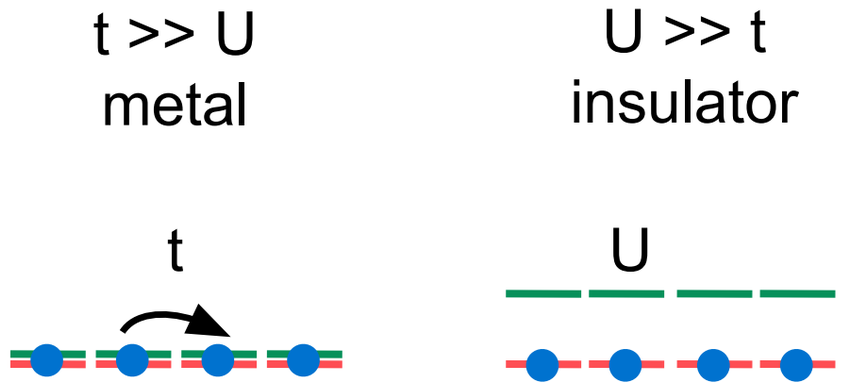






drives magnetic switching via spin currents



pumps momentum
Can we turn an insulator into a metal?

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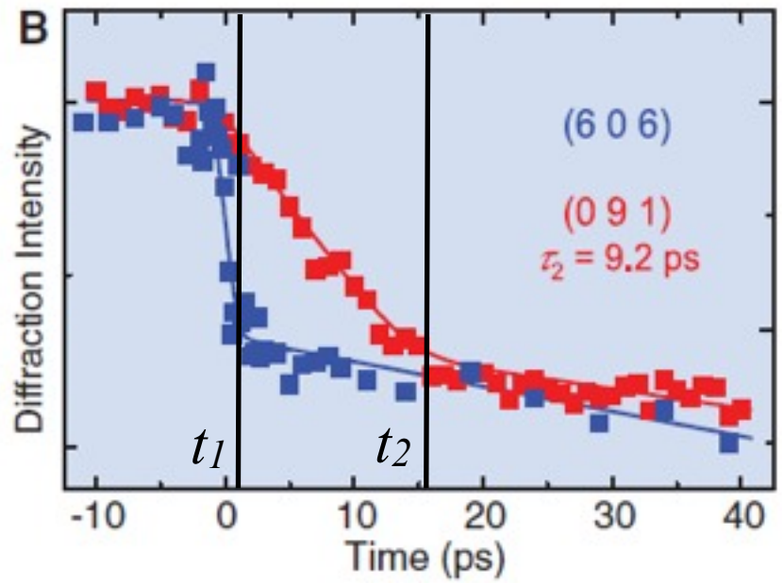
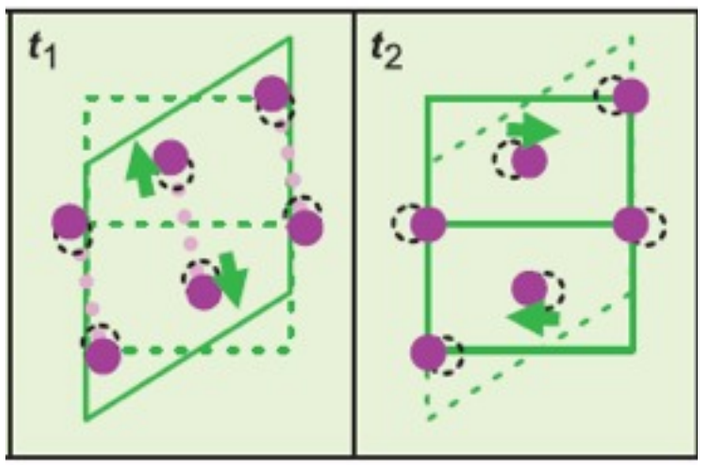
Optically induced ultrafast structural & electronic phase transition in VO_2

Baum, Yang, Zewail, Science **318** , 788 (2007)

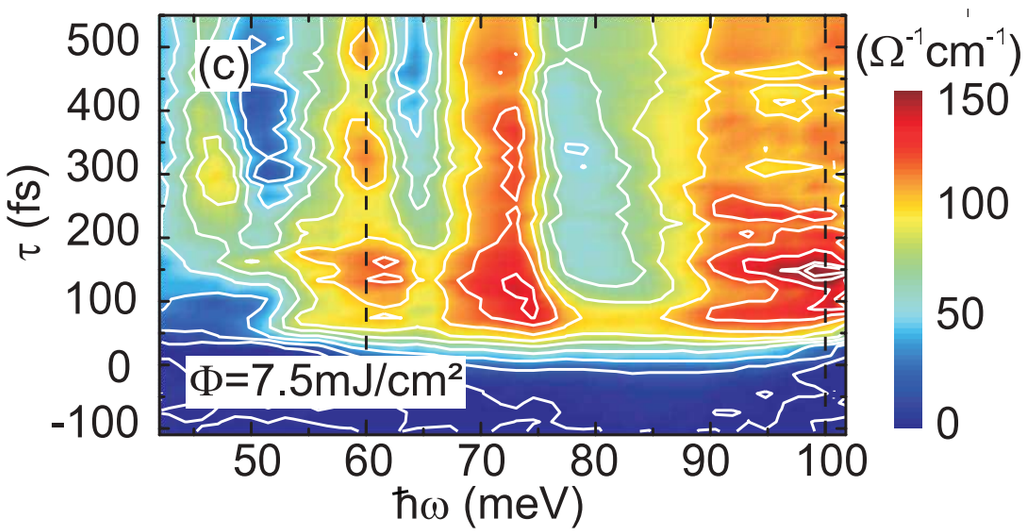




fs electron diffraction

Fast time scale: V-V dilation
Slow time scale: V-V rotation

Kuebler, et al, PRL **99,** 116401 (2007)



fs THz spectroscopy

IMT during V-V dilation

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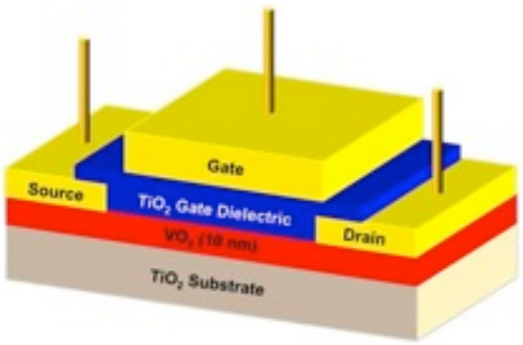
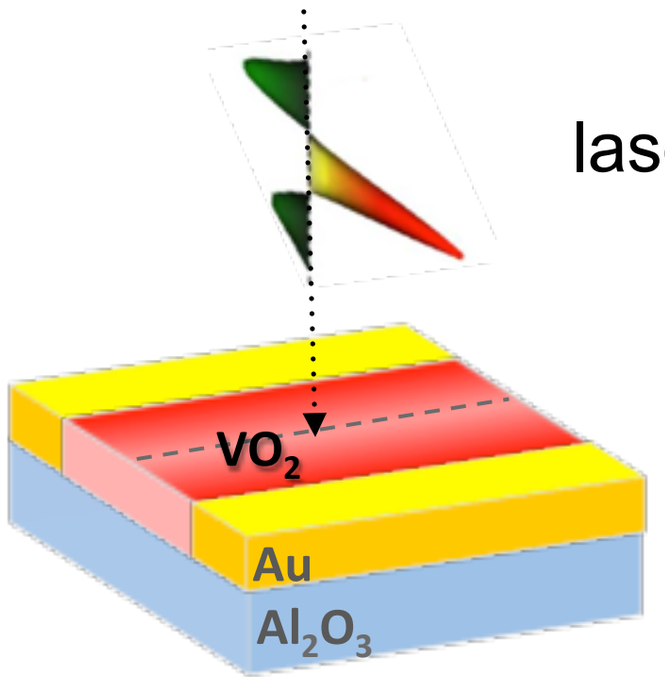
THz control of the insulator-metal transition in VO_2



required electric field ~1GV/m (1V/nm)



laser-induced THz field ~0.04 GV/m

near-field enhanced THz field ~0.2 GV/m

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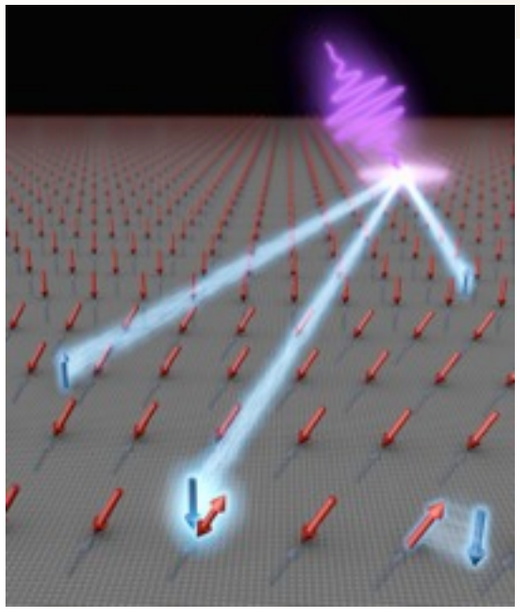
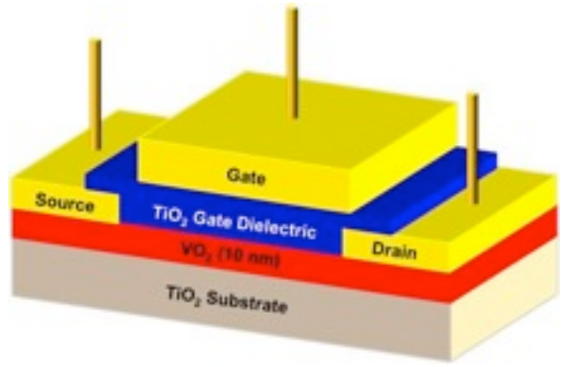
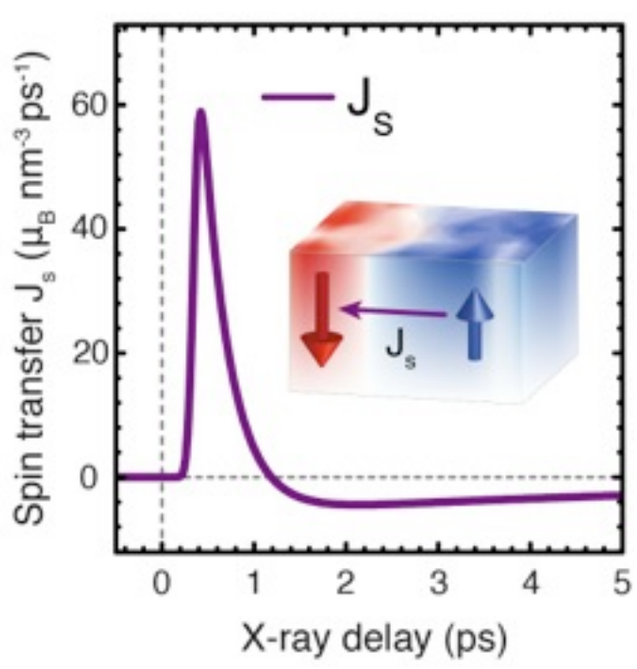


...with few ps short x-ray pulses

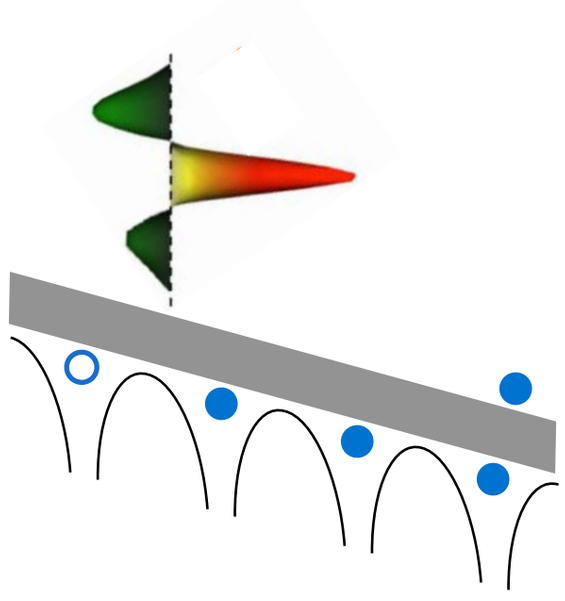
at 1KHz - 1MHz rep. rates

availability of pump lasers crucial





drives ps magnetic switching via spin currents



drives ps cooperative Mott transition

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The Magnetization & Dynamics Group

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