

学术报告

Seeing with the nano-eye:
accessing structure,
题目: function, and dynamics
of matter on its natural
length and time scales

报告人: Prof. Markus B. Raschke
Department of Physics, Department of Chemistry, and JILA
University of Colorado at Boulder, USA

时间: 11月30日(周一) 上午10:00-11:40

地点: 卢嘉锡楼报告厅(202)

欢迎参加!

固体表面物理化学国家重点实验室

化学化工学院

11月24日

Seeing with the nano-eye: accessing structure, function, and dynamics of matter on its natural length and time scales

Prof. Markus B. Raschke
Department of Physics, Department of Chemistry, and JILA
University of Colorado at Boulder, USA

时间: 11月30日(周一) 上午10:00-11:40

地点: 卢嘉锡楼报告厅(202)

Abstract

To understand and ultimately control the properties of most functional materials, from molecular soft-matter to quantum materials, requires access to the structure, coupling, and dynamics on the elementary time and length scales that define the microscopic interactions in these materials. To gain the desired nanometer spatial resolution with simultaneous spectroscopic specificity we combine scanning probe microscopy with different optical, including coherent, nonlinear, and ultrafast spectroscopies. The underlying near-field interaction mediated by the atomic-force or scanning tunneling microscope tip provides the desired deep-sub wavelength nano-focusing enabling few-nm spatial resolution. I will introduce our generalization of the approach in terms of the near-field impedance matching to a quantum system based on special optical antenna-tip designs. The resulting enhanced and qualitatively new forms of light-matter interaction enable measurements of quantum dynamics in an interacting environment or to image the electromagnetic local density of states of thermal radiation. Other applications include the inter-molecular coupling and dynamics in soft-matter hetero-structures, surface plasmon/phonon interferometry as a probe of electronic structure and dynamics in 2D materials, and quantum phase transitions in correlated electron materials. These examples highlight the general applicability of the new near-field microscopy approach, complementing emergent X-ray and electron imaging tools, aiming towards the ultimate goal of probing matter on its most elementary spatio-temporal level.

CV:

Prof. Markus B. Raschke obtained his B.S. degree in Chemistry (1993) and Physics (1994) from University of Bayreuth, Germany, and M.S. degree in Physics from Rutgers University, USA and Ph. D degree in Physics from Max Planck Institute for Quantum Optics and Technical University of Munich in 1999. He then did post doc research in University of California, Berkeley and Max-Born-Institute Berlin. He started as a lecturer in Free University in Berlin (2005-2006), assistant professor and associate professor in University of Washington (2006-2010), and associate professor in University of Colorado from 2010, and became a full professor in 2015.

He obtained Feodor Lynen Fellowship from Alexander von Humboldt Foundation, and received Career Award of National Science Foundation and is fellow of American Physical Society and Optical Society of America. He has published over 100 papers, including those papers in Nature Nanotechnology, Nature Communications, PNAS, JACS, PRL.

His research is centered around the development and unique applications of nano-optical spectroscopies that enable both nanometer spatial and femtosecond temporal resolution.

<http://nano-optics.colorado.edu/>

Biographical Sketch -Markus B. Raschke

(a) Professional Preparation

University of Bayreuth, Germany	Chemistry	B.S.	1993
	Physics	B.S.	1994
Rutgers University, Piscataway, NJ	Physics	M.S.	1995
Max Planck Institute for Quantum Optics and Technical University, Munich	Physics	Ph.D.	1999
University of California, Berkeley	Physics	Postdoc	1999-2001
Max-Born-Institute, Berlin	Physics/Chemistry	Postdoc/Staff	2002-2006

(b) Appointments

since 2015 Professor	Physics/Chemistry/JILA	University of Colorado
2010 – 2015 Associate Professor	Physics/Chemistry/JILA	University of Colorado
2009 – 2010 Associate Professor	Physics/Chemistry	University of Washington
2006 – 2009 Assistant Professor	Chemistry	University of Washington
2005 – 2006 Lecturer		Free University, Berlin
2002 – 2006 Postdoc/Staff Scientist		Max Born Institute, Berlin
1999 – 2001 Feodor-Lynen Postdoc Fellow		University of California, Berkeley

(c) Awards

2015	Klaus Halbach Award	Lawrence Berkeley National Laboratory
2013	Fellow	American Physical Society
2013	Visiting Professor	ETH Zürich, 6-7/2013
2012	Fellow	Optical Society of America
2012	Wiley Research Fellow	Pacific Northwest National Laboratory
2012	Visiting Professor	Abbe School of Photonics, Jena, 6-8/2012
2008	Career Award	National Science Foundation
1999	Feodor Lynen Fellowship	Alexander von Humboldt Foundation
1999	Otto-Hahn-Medal Award	Max-Planck-Society
1994	Fulbright Award & Fellowship	Rutgers University
1992	Fellowship	Naumann Foundation, Universität Bayreuth

(e) Selected recent publications (out of 100+)

Z. Shi, H.A. Bechtel, S. Berweger, Y. Sun, B. Zeng, C. Jin, H. Chang, M.C. Martin, M.B. Raschke, and F. Wang, "Amplitude- and Phase-Resolved Nanospectral Imaging of Phonon Polaritons in Hexagonal Boron Nitride" *ACS Photonics* **2**, 7 (2015).

B.T. O'Callahan, J.M. Atkin, A.C. Jones, J.H. Park, D. Cobden, and M.B. Raschke, "Inhomogeneity in the ultrafast insulator-to-metal transition dynamics of VO₂" *Nature Communications* **6**, 6849 (2015).

E.A. Muller, B. Pollard, and M.B. Raschke, "Infrared chemical nano-imaging: accessing structure, coupling, and dynamics on molecular length scales" *Journal of Physical Chemistry Letters* **6**, 1275 (2015).

D.M. Sagar, J.M. Atkin, P.K.B. Palomaki, N.R. Neale, J.L. Blackburn, J.C. Johnson, A.J. Nozik, M.B. Raschke, M.C. Beard, "Quantum Confined Electron-Phonon Interaction in Silicon Nanocrystals" *Nano Letters* **15**, 1511 (2015).

V. Kravtsov, S. Berweger, J.M. Atkin, and M.B. Raschke, "Control of plasmon emission and dynamics at the transition from classical to quantum coupling" *Nano Letters* **14**, 5270 (2014).

J.A. Gerber, S. Berweger, B.T. O'Callahan, and M.B. Raschke, "Phase resolved surface plasmon interferometry of graphene" *Physical Review Letters* **113**, 055502 (2014).

H.A. Bechtel, E.A. Muller, R.L. Olmon, M.C. Martin, and M.B. Raschke, "Ultra-broadband infrared nanospectroscopic imaging" *Proceedings of the National Academy of Sciences* **111**, 7191 (2014).

B. Pollard, E.A. Muller, K. Hinrichs, and M.B. Raschke, "Spatio-spectral vibrational near-field imaging: determination of chemical heterogeneity and molecular coupling at nano-interfaces" *Nature Communications* **5**, 3587 (2014).

S. Berweger, D.M. Nguyen, E.A. Muller, H.A. Bechtel, T.T. Perkins, and M.B. Raschke, "Nano-chemical infrared imaging of membrane proteins in lipid bilayers" *Journal of the American Chemical Society* **135**, 18292 (2013).

S. Berweger, C.C. Neacsu, Y. Mao, H. Zhou, S.S. Wong, and M.B. Raschke, "Optical

nanocrystallography with tip-enhanced phonon Raman spectroscopy" *Nature Nanotechnology* **4**, 496 (2009).

(f) Recent book chapters and reviews

M.B. Raschke, S. Berweger, and J.M. Atkin, "Ultrafast and nonlinear plasmon dynamics" in *Plasmonics: Theory and Applications*, eds. T.V. Shahbazyan and M.I. Stockman, Springer, Berlin (2013).

A.C. Jones, H.U. Yang, B.T. O'Callahan, and M.B. Raschke, "Thermal near-field: coherence, spectroscopy, heat-transfer, and optical forces" *Progress in Surface Science* **88**, 349 (2013).

J.M. Atkin, S. Berweger, A.C. Jones, and M.B. Raschke, "Nano-optical imaging and spectroscopy of order, phases, and domains in complex solids" *Advances in Physics* **61**, 745 (2012).

R.L. Olmon and M.B. Raschke, "Antenna-load interactions at optical frequencies: impedance matching to quantum systems" *Nanotechnology* **23**, 444001, (2012).

(g) Service

University of Colorado -Chair Chemical Physics PhD Program; Colloquium Committee (member, chair); Faculty Advisory Industry Taskforce; Graduate admissions (member); University level: Industrial Advisory Committee (member); Research Review Board (member); Standing Committee on Research Misconduct (member).

Conference Organization – Colorado Ultrafast Photonics Initiative, CUPhI, 2015 (chair). Near-Field Optics, NFO, 2014, Snowbird, Utah (co-chair with Jim Schuck and Jordan Gerton). SPIE Conference, 2014, Nanoimaging and Nanospectroscopy (program committee) (chair Prabhat Verma). Ultrafast Surface Dynamics, 2013, Colorado (co-chair with Henry Kapteyn and Xiaoyang Zhu). Near-Field Optics, NFO, 2012, San Sebastian (international program committee). OSA Annual Conference, Frontiers in Optics, 2011, San Jose (program chair, nano-optics symposium).

Referee -Journals: Physical Review, Physical Review Letters, Nature, Nature Nanotechnology, Nature Photonics, Journal of Physical Chemistry, Surface Science, and New Journal of Physics. Proposal review for NSF, NIH, DoE, ACS PRF, German Israel Foundation.

Open Access Online Course Material -Developed an open-access Internet science and educational writing project developing course readers and free encyclopedia entries for physical chemistry, optics, and spectroscopy with graduate and undergraduate students at University of Washington and University of Colorado.

Center for Nanotechnology Minority Recruitment -Participated in outreach, recruiting initiatives and provide access to summer science projects in our lab for high school teachers and students from economically disadvantaged Seattle school districts.

Public Speaking and Education -Deliver(ed) lectures, offer guided lab tours, open-house events, and hands-on experiments for high-school students and the general public.