

# Jon P. Camden

Assistant Professor

Analytical and Physical Chemistry

Research Areas: Nanoscience, laser spectroscopy, molecular plasmonics

B.S. University of Notre Dame (2000)

Ph.D. Stanford University (2005)

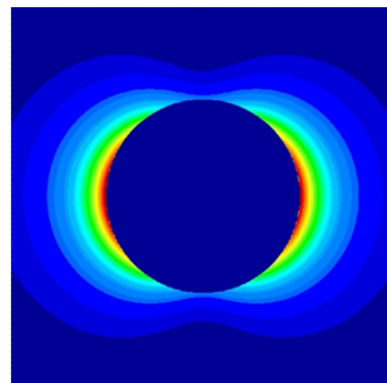
Postdoctoral Researcher, Northwestern University (2005-2008)

Awards: Stanford Centennial Teaching Assistant (2006), NSF Graduate Research Fellow (2001-2004), Phi Beta Kappa (2000)

Research in the Camden group has two themes: (1) understanding the optical properties of nanoparticles and the application of this knowledge to develop new ultra-sensitive spectroscopic tools for imaging and sensing, and (2) the study of fundamental reaction dynamics, which provides insight into chemistry in extreme environments. Students working in my group will have the opportunity to learn techniques from nanoscale lithographic methods and surface characterization to laser spectroscopy and computational modeling. Brief descriptions of projects in the Camden group are listed below, and I welcome correspondence about any of these topics.

**Optical Properties of Nanoscale Materials:** It is well known that the optical properties of nanoparticles depend strongly on their size and shape and we are using a combination of experimental (laser spectroscopy) and theoretical (computational electrodynamics) techniques to understand these properties. Several areas of particular interest are (1) single molecule surface enhanced Raman scattering and (2) surface enhanced non-linear spectroscopy.

*Single Molecule Surface Enhanced Raman Scattering* - Single molecule spectroscopy represents the ultimate in sensitivity, reports on the nanoscale chemical environment, and removes the inherent ensemble averaging encountered when large numbers of molecules are detected simultaneously. However, one drawback of traditional single molecule spectroscopy is that it lacks the detailed structural information available in vibrational spectroscopy. Single molecule surface enhanced Raman scattering (SERS) provides one of the only methods of obtaining the vibrational spectrum of a single molecule; unfortunately, the full power of this technique has not been achieved because the necessary conditions are not well understood. Therefore, our group is studying fundamental questions about the nature of single molecule SERS and will apply this knowledge to explore new materials and methods for performing vibrational spectroscopy on single molecules.

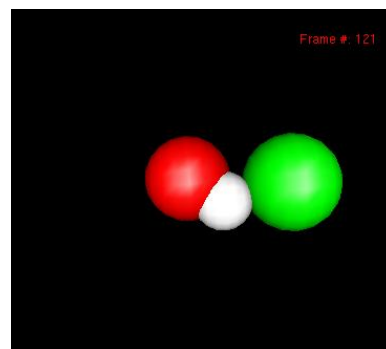


Local electric field enhancement around a silver nanoparticle when the incident wavelength is resonant with the plasmon.

*Non-linear Surface Enhanced Spectroscopies* - While SERS has developed into a robust and useful technique applications ranging from sensor technology to fundamental surface science, almost no effort has been made to explore its non-linear analogue, surface enhanced hyper-Raman scattering (SEHRS). SEHRS is the two photon analogue of normal Raman scattering and provides informa-

tion that is complementary to both infrared absorption and normal Raman scattering. Ordinarily, the application of hyper-Raman spectroscopy is limited by small signal levels; however, using surface enhancement signal increases over normal hyper-Raman of  $10^{13}$  have been achieved and the potential for single molecule detection has been suggested. The most exciting possibilities for surface enhanced hyper-Raman scattering (SEHRS) are applications in biological imaging, where it could compliment normal two-photon fluorescence imaging. Therefore, our group is working to understand the fundamentals of SEHRS and develop nanoscale markers utilizing SEHRS for imaging in complex environments such as individual cells.

**Chemistry in Extreme Environments:** Understanding chemical reactivity in extreme environments, such as satellites in low-earth orbit, rocket plumes, and plasmas, requires that we understand the dynamics of hyperthermal collisions (i.e. those with energies of 1-10eV). Reaction channels that are not typically available under thermal conditions, such as highly endothermic processes and fragmentation, become important at high energies. Our current effort in this area uses direct dynamics computer simulations to study the reactions of oxygen atoms with small molecules. In the future we wish to explore the catalytic effects of clusters on important atmospheric reactions and establish experimental efforts in to study simple reactions.



Snapshot of the reaction of O atom (red) with HCl (white and green) at high collision energy.

### Biographical Sketch

Dr. Camden received his B.S. in chemistry and music from the University of Notre Dame in 2000, where he worked with Professor Dennis Jacobs studying the interactions of rare gas atoms with single crystal surfaces in ultra-high vacuum. He received his Ph.D. in Physical Chemistry from Stanford University in 2005, under the direction of Professor Richard Zare. His work at Stanford, which was supported by a NSF Graduate Fellowship, focused on understanding the dynamics of chemical reactions using a combination of molecular beams, mass spectroscopy, and laser spectroscopy. He then completed postdoctoral work at Northwestern University under the direction of Professors George Schatz and Richard Van Duyne, where his research combined both theoretical calculations and experiments to understand the optical properties of nanoparticles and surface enhanced spectroscopies. In 2008, he joined the Faculty at the University of Tennessee as an assistant professor of analytical and physical chemistry.