

The Chemical and Biological Engineering Department of the  
University at Buffalo School of Engineering and Applied Sciences  
is Proud to Announce

## The 2012 Eli Ruckenstein Lecture



**“Effect of Severe Wall Hindrance  
on Brownian Motion and Mobility:  
Is The Ratio Still  $kT$  as Predicted by Einstein?”**

**Dennis C. Prieve**

Center for Complex  
Fluids Engineering  
Department of Chemical  
Engineering  
Carnegie Mellon University

Monday, April 23, 2012  
11:45 a.m.

Screening Room  
First floor, Center for the Arts  
UB Amherst Campus

*Reception to follow*



## About Eli Ruckenstein:

Eli Ruckenstein, SUNY Distinguished Professor, has been on the faculty of the University at Buffalo for nearly forty years. Over this time, his prolific and imaginative research has advanced almost every area of interest to chemical engineering. Ruckenstein spent his formative years behind the Iron Curtain, in Romania, where – with a combination of native intellect, genuine scientific curiosity, and sheer strength of will – he prepared himself for a lifetime of achievement in engineering and science. His work quickly gained international recognition, and he escaped to the West in 1969, joining UB in 1973.

Eli Ruckenstein has received countless honors paying tribute to work across many fields of research. From the American Institute of Chemical Engineers he won the Alpha Chi Sigma Award for his work in transport phenomena, the Walker Award for his work in catalysis, and the Founders Award for his overall contributions to science. From the American Chemical Society he received the Kendall Award for his research in colloids and interfaces, the Langmuir Lecture Award for his contributions to macromolecules, the Schoellkopf Medal for his work in supported metal catalysts, and the Murphree Award in Industrial and Engineering Chemistry. He was given the Humboldt Award by Germany for his work in surfactants, and the Creativity Award by the National Science Foundation for his work in biomolecules. In addition he has been invited numerous times to present named lectures around the world. These contributions and more were further recognized with the National Medal of Science, bestowed in a White House ceremony in 1999. Ruckenstein was elected to the National Academy of Engineering in 1990 and he received the Founders Award from the Academy in 2004. He is a fellow of the American Institute of Chemical Engineers, which, with the occasion of its 100th anniversary, designated him as one of 50 Eminent Chemical Engineers of the Foundation age.

## The Ruckenstein Lecture Series

is supported by the Ruckenstein Fund, a new endowment with an ongoing campaign. Funds generated from this endowment will be used to support the Ruckenstein Lecture Series and provide resources to improve teaching and research laboratories in the Department.

## Previous Lecturers

2009 Rakesh K. Jain, Harvard Medical School and Massachusetts General Hospital

2010 George Stephanopoulos, Massachusetts Institute of Technology

2011 Pablo G. Debenedetti, Princeton University

[www.cbe.buffalo.edu](http://www.cbe.buffalo.edu)

## The UB Department of Chemical and Biological Engineering

offers a world-class undergraduate education while pursuing integrative research and graduate training at the frontiers of chemical engineering, in the main areas of nanoscale science and engineering; computational science and engineering; and biochemical and biomedical engineering.

The Department was founded in 1961 and is among the youngest in the Nation. From the start its founders inculcated it with a deep respect for scholarship, and as a consequence the Department quickly grew to the national prominence that it continues to enjoy today. Visit: [www.cbe.buffalo.edu](http://www.cbe.buffalo.edu).

# Effect of Severe Wall Hindrance on Brownian Motion and Mobility: Is The Ratio Still $kT$ as Predicted by Einstein?

Dennis C. Prieve

Gulf Professor of Chemical Engineering  
Carnegie Mellon University

## Abstract:

In his classic 1905 paper on Brownian motion, Einstein realized that by separately measuring mobility  $m$  and diffusion coefficient  $D$  of the same particle, one could obtain the value of Avogadro's number from  $RTm/D$ , where  $R$  is the universal gas constant and  $T$  is temperature. In 1920 Perrin performed such experiments and obtained a good value for Avogadro's number. This success laid to rest any remaining doubts about the molecular theory of matter. Today we write Einstein's relation as  $D = mkT$  ( $k$  is Boltzmann's constant) and substitute  $m$  obtained from Stokes equation. As a rigid sphere approaches a rigid wall, Brenner (1961) showed that wall hindrance causes  $m$  to approach zero. Does Einstein's equation still hold such that  $D$  approaches zero also? In this talk I will show direct measurements of  $D$  and  $m$  obtained using Total Internal Reflection Microscopy. Both quantities are found to be a few percent of their bulk values when the gap between the spherical particle and the wall is a few percent of its radius.

## About Dennis C. Prieve:

Dennis C. Prieve is the Gulf Oil Foundation Professor of Chemical Engineering at Carnegie Mellon University. He also currently serves as President of the International Association of Colloid and Interface Scientists (IACIS) and Editor of *Colloids and Surfaces A*.

He joined CMU in 1975 after receiving a Ph.D. from the University of Delaware and a B.S. from the University of Florida in 1970. Prieve's research interests focus on the nature and measurement of colloidal forces and their effect on transport of colloidal particles, especially electrokinetic phenomena and chemically-driven flows. Since 1987, he and his students have developed Total Internal Reflection Microscopy which uses evanescent-wave scattering and optical tweezers to measure sub-piconewton colloidal forces between a single microscopic sphere and a flat plate without touching the sphere.

Prieve has been a visiting professor at Princeton University and the University of Melbourne, Australia. He received the 2011 ACS Award in Colloid & Surface Chemistry and the 2007 Lectureship Award of the Colloid Science Division of the Japanese Chemical Society. Elected Fellow of the American Institute of Chemical Engineers in 2004, he also received the AIChE Alpha Chi Sigma Award for chemical engineering research in 1995. Prieve chaired the 2002 Gordon Research Conference on Chemistry at Interfaces and co-chaired the 2004 International Electrokinetics Conference (ELKIN).



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