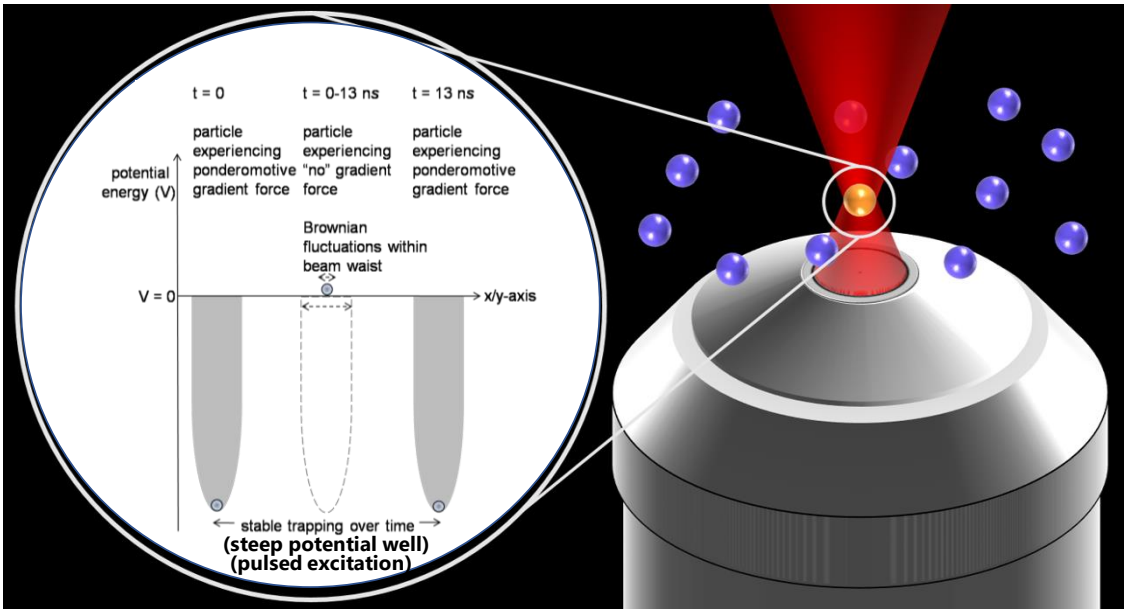
Invited Lecture
Inter-Disciplinary Explorations in Chemistry (I-DEC 2018)

Femtosecond optical tweezers for contactless measurement and control of absolute temperature and viscosity at nanoscale

Debabrata Goswami*
Department of Chemistry
Indian Institute of Technology Kanpur
(E-mail: dgoswami@iitk.ac.in)

Abstract:
Femtosecond optical tweezers (FOTs) use a single-beam high repetition rate laser for optical trapping. We have developed a novel on-the-fly calibration method of FOT that enables in situ control and contactless measure of absolute temperature and viscosity at nanoscale dimensions. Such measurements and control at the nanoscale have been challenging since the present techniques can only provide relative off-line measurements that are of low spatial resolution. Such spatiotemporal control with ultrashort pulses provides the possibility of manipulation at nanoscale that can yield several interesting results that include visualization of colloidal aggregation in real time, computational logical operation in localized zone that is then reset with the subsequent pulse train. We simultaneously apply the high temporal sensitivity of position autocorrelation and equipartition theorem to precisely measure and control in situ temperature and the corresponding microrheological property around the focal volume of the trap at high spatial resolution. The FOTs use a single-beam high repetition rate laser for optical trapping to result in finer temperature gradients in comparison to the continuous-wave laser tweezers.



Schematic of a Femtosecond Optical Tweezer

References and Notes:

1. Mondal, D.; Mathur, P.; Goswami, D.; Physical Chemistry Chemical Physics **2016**, *18*, 25823-25830
2. Mondal, D.; Goswami, D.; Journal of Nanophotonics, **2016**, *10*, 026013.

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Bio-Sketch of Speaker

Dr. Debabrata Goswami
Professor
Department: Chemistry
Institute: Indian Institute of Technology Kanpur
Address: IIT Kanpur 208016
Contact Number: +91-9415045267
e-Mail: dgoswami@iitk.ac.in

Debabrata Goswami is currently the Prof. S. Sampath Chair Professor of Chemistry. He became Professor (Higher Administrative Grade) of Chemistry, The Center for Lasers & Photonics, The Design Program, and The Center of Cognitive Sciences at IIT Kanpur in 2017. An alumnus of IIT Kanpur, Prof. Goswami attended Princeton University, USA with multiple scholarships for his PhD (1994), followed by PDFs at Harvard University (1995) and Brookhaven National Lab (1996). He was a Senior Scientist in the R&D Division of Excel-Quantronix, New York (1997) and subsequently the Director of Laser Laboratories at the Center for Laser Technology, Princeton University (1998). He returned to India at the end of 1998, to join the Physics Faculty of TIFR Mumbai after his work in the US. In 2004, he joined IIT Kanpur as an Associate Professor to also focus on pedagogy and in 2010, he became Professor.

Prof. Goswami is an ultrafast laser jokey who pioneered the use of control ideas with femtosecond pulse shaping in spatiotemporal control, quantum computing, microscopy, etc. Over the years, he has also been invited to several reputed Institutes worldwide as a visiting Professor. He is the recipient of several academic and research accolades, including the 2018 ICO Galileo Galilei award instituted by the International Commission of Optics, the Wellcome Trust International Senior Research Fellowship (UK), the Swarnajayanti Fellowship and the Thathachary Science Award (India) as well as the Hoechst Advanced Technology Division Industrial Affiliates Fellowship for outstanding academic record in Princeton. He is a member of several academic and professional societies and councils. He is also Fellow of the Institute of Optics (UK), the Royal Society of Chemistry, and the OSA. He is a Senior Member of IEEE & SPIE and member of several academic Societies: APS, ACS, Sigma Xi.

He has authored over 200 journal & conference papers; book chapters & has edited books & proceedings. He has been a prolific speaker and has been invited to numerous conferences, workshops and colloquia. He is a passionate and engaging teacher, and is also a popular K12 teacher on Indian Television. His courses in IITK are always in high demand amongst undergraduates and he has volunteered a 12-week course on Quantum Computing for the National Portal for Technology Education and Learning.