The Department of Chemistry at Duke University
Presents

The 2025 Edinburgh Instruments Lectureship in Photophysics and Photochemistry

Dirk M. Guldi

PROFESSOR OF CHEMISTRY

Friedrich-Alexander-Universität
Erlangen-Nürnberg

James F. Bonk Lecture Hall, French Family Science Center
Friday, September 26, 2025, 5:00 PM
Reception to follow lecture at 6:00 PM

About the speaker:

Dirk M. Guldi completed both his undergraduate studies (1988) and PhD (1990) at the University of Cologne (Germany). Following postdoctoral appointments at the National Institute of Standards and Technology (USA), the Hahn-Meitner Institute Berlin (1992), and Syracuse University, he joined the faculty of the Notre Dame Radiation Laboratory in 1995. Since 2004, he is Full Professor in the Department of Chemistry and Pharmacy at the Friedrich-Alexander University in Erlangen. Since 2018, Dirk M. Guldi is Co-Editor in Chief of *Nanoscale* and *Nanoscale Advances* and he has been named among the world's Highly Cited Researchers by Thomson Reuters. He is an elected member of the EU Academy of Sciences and European Academy of Science.

The Guldi group and its network belong to the cutting edge of worldwide research in solar-energy conversion with expertise not only in advanced photon- and charge-management without losing sight of the ultimate objective of developing integrated solar energy-to-chemical fuel conversion systems, which in the future can be utilized in real devices. Prof. Guldi's laboratory has published more than 800 peer-reviewed publications, which have garnered more than 55,000 citations.

At the heart of his program is a multifaceted and interdisci-

plinary research approach, where his group designs, conceptually devises, synthesizes, tests, and characterizes novel nanometer scale materials with the objective of using them in solar energy conversion schemes.

Abstract:

We present recent work from our laboratory focused on molecular strategies for photon downconversion and upconversion aimed at surpassing the detailed balance limit of solar cell efficiency. For high-energy photons with energies above the semiconductor bandgap, I will show how **singlet fission (SF)** – a downconversion mechanism – helps mitigate thermalization losses. In this process, a single high-energy photon absorbed by a molecule generates two lower-energy triplet excitons, effectively doubling the number of charge carriers.

For low-energy photons below the semiconductor bandgap, **triplet-triplet annihilation upconversion (TTA-UC)** offers a complementary approach by enabling photon upconversion to reduce sub-bandgap losses. TTA-UC works by combining the energy of two triplet-excited molecules to populate a higher-energy singlet state, which can then fluoresce and emit a single photon of higher energy - essentially the reverse of singlet fission.

Together, these strategies demonstrate how acene-based materials can address key loss mechanisms in conventional solar cells by managing both high- and low-energy photon losses.

Previous Recipients of the Edinburgh Instruments Lectureship in Photophysics and Photochemistry

Richard Eisenberg, University of Rochester; Harry B. Gray, California Institute of Technology; Frederick D. Lewis, Northwestern University; Thomas J. Meyer, University of North Carolina at Chapel Hill; Ana and Tom Moore, Arizona State University; Josef Michl, University of Colorado Boulder; Claudia Turro, The Ohio State University; Michael Wasielewski, Northwestern University.

About Edinburgh Instruments

In the spirit of the scientific discovery fueled by its instrumentation in academia and industry, Edinburgh Instruments is proud to sponsor this lectureship at Duke University to honor the great pioneers and innovators in the field of photophysics and photochemistry. Edinburgh Instruments is particularly pleased that Professor Guildi has agreed to give the 2025 Edinburgh Instruments Lecture in Photophysics and Photochemistry and extends its warmest congratulations to him for his distinguished career at the forefront of the discipline, and his decades of service and leadership spent on behalf of the greater chemical community.

For over 50 years, Edinburgh Instruments has built a worldwide reputation for quality and innovative instrumentation. Edinburgh Instruments designs and manufactures bespoke spectroscopic systems for measuring absorbance, steady-state and time-resolved fluorescence, phosphorescence, and luminescence from picoseconds to seconds, as well as nanosecond transient absorption (laser flash photolysis) and Raman scattering. The RM5 and the RMS1000 Raman microscope systems both offer truly confocal capabilities, and the RMS1000 offers additional applications for its use such as time-resolved fluorescence mapping and fluorescence lifetime imaging (FLIM). The FLS1000 and FS5 systems are research grade instruments for measuring time-resolved and steady state fluorescence as well as phosphorescence. The LP980 transient absorption spectrometer can measure not only in kinetic mode but also measure in spectral mode utilizing a gated intensified CCD camera.

Duke University is grateful for the generous financial support from Edinburgh Instruments that has made this endowed lectureship possible.