

THE FOURTH ANNUAL  
**John Eisch Lectureship  
in Organic Synthesis**

Friday, November 13, 2015, Noon  
Academic Building A, Room G008

## “Anion-Binding Catalysis”

**ERIC N. JACOBSEN**

**Department of Chemistry and Chemical Biology  
Harvard University**

Efforts spearheaded by our group and others have led to the discovery that low molecular weight, chiral organic molecules possessing distinct hydrogen-bond donor motifs catalyze an array of C-C and C-heteroatom bond-forming reactions with high enantioselectivity and broad substrate scope. In particular, dual hydrogen bond donors such as ureas, thioureas, squaramides and guanidinium ions have been studied in detail in the context of electrophile activation. These catalysts operate by either of two fundamentally different modes of electrophile activation: 1) direct hydrogen bonding to a neutral electrophile and 2) anion binding to generate chiral ion pair. We have applied the latter reactivity concept to several classes of cationic electrophiles that have presented long-standing challenges to asymmetric catalysis.

In this lecture, I will describe detailed kinetic and mechanistic studies of a model catalytic anion-abstraction process. These investigations have revealed an unanticipated role of catalyst aggregation both in the ground state and in the transition state, and new strategies for the design of highly efficient catalysts. The talk will conclude with the application of these insights to the discovery of novel glycosylation catalysts.

## Professor John J. Eisch

**John Joseph Eisch** joined the Department of Chemistry at Binghamton University in 1972 as chair and professor of chemistry with the mandate of fostering the national reputation of its graduate teaching and research. Over the next six years as chair, he guided the recruiting of six senior and junior faculty with this goal in mind, while expanding his own research in organometallic chemistry to a yearly group of eight to 12 graduate and postdoctoral students with support from federal and industrial resources. In 1983 his composite achievements were recognized by his promotion to the SUNY-wide rank of distinguished professor of chemistry. Further recruiting, notably, during the chairs of Professors Eugene Stevens, Alistair Lees and currently Wayne Jones has expanded the scope of advanced research into areas of immediate importance, such as nano materials, homogeneous catalysis, analytical sensors, biological transformations and energy storage.

Professor Eisch's prior education and professional experience have consisted of receiving the BS degree in chemistry, summa cum laude, from Marquette University in 1952; earning the PhD degree in 1956, with Henry Gilman, at Iowa State University; and serving as Union Carbide Research Fellow with Karl Ziegler at the Max-Planck-Institut für Kohlenforschung, Mülheim, Germany (1956-57). After junior professional appointments at St. Louis University and at the University of Michigan, he became ordinary professor and department head at the Catholic University of America (1963-1972). He retired from his professorial career of 57 years in 2014, the latter 42 years of which being spent at the State University of New York at Binghamton.

Over the years, his research has involved the fruitful collaboration of more than 200 students as

master's, doctoral, postdoctoral or baccalaureate associates. The results have been reported in more than 400 scientific publications, in some 280 invited lectures worldwide, in the monograph "The Chemistry of Organometallic Compounds" (Macmillan, 1967), and in the edited series, "Organometallic Syntheses" (four volumes, J.J. Eisch and R.B. King, authors and editors). He has been an industrial consultant on organometallic chemistry and an expert witness in several patent litigations on Ziegler-Natta polymerization catalysis. Recently he has published his reminiscences as a postdoctoral fellow with Karl Ziegler and as a young academic, in the invited review, "Fifty Years of Ziegler-Natta Polymerization: From Serendipity to Science. A Personal Account," in *Organometallics*, 2012, 31, 4917-4932, and in *Dalton Transactions* 2014 (DOI: 10.1039/c4dt010362) "Emergence of Electrophilic Alumination as the Counterpart of Established Nucleophilic Lithiation". The latter review was in honor of the eightieth birthday of his first doctoral graduate, William Kaska (Michigan, 1963).

---

### Previous Lectureship Recipients

**2012**

**Stephen L. Buchwald** (MIT) "Palladium-Catalyzed Carbon-Nitrogen and Carbon-Carbon Bond-Forming Reactions: Progress, Applications and Mechanistic Studies"

**2013**

**David W. C. MacMillan** (Princeton University) "The Use of Photoredox Catalysis in New Organic Bond Forming Reactions"

**2014**

**Brian M. Stoltz** (California Institute of Technology) "Complex Natural Products as a Driving Force for Discovery in Organic Chemistry"

## Professor Eric N. Jacobsen



**Eric Jacobsen** was born in New York City and received his BS degree from New York University in 1982. His PhD work was done at U.C. Berkeley under the direction of Robert Bergman. In 1986, he returned to the East Coast for an NIH postdoctoral fellowship at MIT with Barry Sharpless. In 1988, he began his independent career on the faculty at the University of Illinois. He moved to Harvard University as full professor in the summer of 1993, and he was named the Sheldon Emory Professor of Organic Chemistry in 2001, and he just completed an extended term as chair of the Department of Chemistry and Chemical Biology (2010-2015).

Jacobsen directs a research group dedicated to discovering useful catalytic reactions, and to applying state-of-the-art mechanistic and computational techniques to the analysis of those reactions. Several of the catalysts developed in his labs have found widespread application in industry and academia. These include metal-salen

complexes for asymmetric epoxidation, conjugate additions and hydrolytic kinetic resolution of epoxides; chromium-Schiff base complexes for a wide range of enantioselective pericyclic reactions; and organic hydrogen bond-donor catalysts for activation of neutral and cationic electrophiles. Jacobsen's mechanistic analyses of these systems have helped uncover general principles for catalyst design, including electronic tuning of selectivity, cooperative homo- and hetero-bimetallic catalysis, hydrogen-bond donor asymmetric catalysis and anion binding catalysis.

The awards Jacobsen has received include the NSF Presidential Young Investigator Award (1990), the Packard Fellowship (1991), the Camille and Henry Dreyfus Teacher-Scholar Award (1992), the Alfred P. Sloan Foundation Fellowship (1992), the ACS Cope Scholar Award (1993), the Fluka "Reagent of the Year" Prize (1994), the Thieme-IUPAC Prize in Synthetic Organic Chemistry (1996), the Baekeland Medal (1999), the ACS Award for Creativity in Synthetic Organic Chemistry (2001), the NIH Merit Award (2002), election to the American Academy of Arts & Sciences (2004), the Mitsui Catalysis Science Award (2005), the ACS H.C. Brown Award for Synthetic Methods (2008), election to the National Academy of Sciences (2008), the Janssen Prize (2010), the Noyori Prize (2011), the Nagoya Gold Medal Prize (2011), the Chirality Medal (2012), the Remsen Award (2013) and the Esselen Award (2015).