

**BIOGRAPHICAL SKETCH**

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NAME: Ando, Nozomi

eRA COMMONS USER NAME (credential, e.g., agency login): nando1

POSITION TITLE: Associate Professor of Chemistry and Chemical Biology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
Massachusetts Institute of Technology	B.S.	06/01	Physics
Cornell University	M.S.	05/04	Physics
Cornell University	Ph.D.	01/09	Physics
Massachusetts Institute of Technology	Postdoctoral	06/14	Chemistry

**A. Personal Statement**

The focus of my research program is to understand the molecular mechanisms of protein allostery. To do so, my lab uses X-ray scattering, crystallography, cryo-electron microscopy (cryo-EM), and bioinformatics. We are best known for our innovations in X-ray scattering, which allows us to interpret conformational heterogeneity in terms of protein motions and structural rearrangements (*Chem Rev* 2017). This approach has allowed us to map the conformational landscape of allosteric enzymes and identify evolutionary patterns (*JACS* 2017, *PNAS* 2018, *Nature Comm* 2019). Most recently, we were the first to solve a long-standing problem in X-ray crystallography by explaining the diffuse scattering signal from protein crystals that arise from correlated protein motions (*Nature Comm* 2020, *Nature Comm* 2023). Many of the systems we study are metalloenzymes as they perform reactions of evolutionary significance, and we are highly experienced in anaerobic methods (*PNAS* 2017, *JBC* 2021, *bioRxiv* 2023). As a recognized expert in the structural biology community, I have served as an elected member of the U.S. National Committee for Crystallography (USNC/Cr) and am currently serving on the leadership for MacCHESS at the Cornell Energy High Synchrotron Source (CHESS) as well as the Northeastern Collaborative Access Team (NE-CAT) at the Advanced Photon Source (APS).

As a faculty member, I have taken on various roles in service to the scientific community. Of these, my most important work has been focused on two areas. As a leader in the X-ray community, I have actively worked to promote the advancement and education of X-ray science and structural biology. As a program chair for the 2020 American Crystallographic Association (ACA) Meeting, I was able to develop a program with a strongly educational theme, geared towards students and postdocs. In 2023, I directed the Erice International School of Crystallography, which drew ~70 students internationally. At every stage of my career, I have also worked to promote the advancement of women and underrepresented groups in STEM. At Princeton, I served in various capacities to assess departmental climate, improve the experience of women faculty, and create an REU program to increase diversity in STEM. Currently, at Cornell, I am the co-chair of a departmental committee for diversity, equity, and inclusion (DEI), and I am also the faculty advisor for Cornell Chemists for Outreach and Graduate Inclusion (COGI) Student Organization.

Ongoing and recently completed projects that I would like to highlight include:

R35 GM124847

Ando (PI)

8/1/2017-7/31/2027

Protein Allostery and Catalysis beyond Bragg Diffraction

R00 GM100008

Ando (PI)

07/01/2014– 07/31/2017

Structural Characterizations of Transient and Heterogeneous Protein Complexes

## **B. Positions, Scientific Appointments, and Honors**

### **Positions and Employment**

2001	<u>Visiting Scholar</u> , Center for Materials Science and Engineering, MIT, Cambridge, MA
2001-2008	<u>Graduate Research Assistant</u> , Department of Physics, Cornell University, Ithaca, NY with Sol M. Gruner (Dept. of Physics and Cornell High Energy Synchrotron Source)
2008-2010	<u>HHMI Postdoctoral Associate</u> , Department of Chemistry, MIT, Cambridge, MA with Catherine L. Drennan (HHMI, Depts. of Chemistry and Biology)
2010-2014	<u>NIH Postdoctoral Fellow</u> , Department of Chemistry, MIT, Cambridge, MA with Catherine L. Drennan (HHMI, Depts. of Chemistry and Biology)
2014-2018	<u>Assistant Professor of Chemistry</u> , Princeton University, Princeton, NJ
2018-2021	<u>Assistant Professor of Chemistry &amp; Chemical Biology</u> , Cornell University, Ithaca, NY
2019-present	<u>Graduate Faculty</u> , Field of Biophysics, Cornell University, Ithaca, NY
2021-present	<u>Associate Professor of Chemistry &amp; Chemical Biology</u> , Cornell University, Ithaca, NY
2022-present	<u>Graduate Faculty</u> , Field of Physics, Cornell University, Ithaca, NY

### **Other Experience and Professional Memberships**

2006-	Member, Biophysical Society
2007	Mentor, Cornell University Expand Your Horizon Program
2008-	Reviewer for <i>Science</i> , <i>Nature</i> , <i>Nature Comm</i> , <i>JACS</i> , <i>Biochemistry</i> , <i>IUCr</i> , <i>Biophysical Journal</i> , <i>J Phys Chem</i> , <i>Langmuir</i> , <i>Nat Prod Rev</i> , <i>J Mol Biol</i> , <i>Chemical Science</i> .
2008	Training in the teaching of writing at the Cornell University Knight Institute
2009	HHMI MIT Mentoring Program in Chemical Biology
2010-2013	Member, American Physical Society
2010-	Member, American Chemical Society
2011-	Member, Protein Society
2011-2013	Elected Member, Cornell High Energy Synchrotron Source Executive User Committee
2014-2018	Proposal Reviewer, Cornell High Energy Synchrotron Source
2016	Organizer, “ <i>Biomolecules in Motion</i> ” Workshop, Cornell High Energy Synchrotron Source.
2016	Session chair, 2016 Diffraction Methods Gordon Research Conference
2016	Session chair, 21 <sup>st</sup> Association for Crystallization Technology Larson Workshop
2017	Session chair, 2017 American Crystallographic Association Meeting
2017	Organizer, “ <i>Measurement and Interpretation of Diffuse Scattering in X-Ray Diffraction for Macromolecular Crystallography</i> ” Workshop, NSLS-II and CFN Meeting
2018	Session chair, 2018 Metallocofactors Gordon Conference
2019-present	Member, Structural Biology Oversight Committee, Cornell Cryo-EM Facility
2019-present	Faculty mentor, Chemical Biology Interface (CBI) Training Program, Cornell University
2019-2021	Elected member, U.S. National Committee for Crystallography (USNC/Cr)
2022-2023	Invited editor, <i>Methods in Enzymology</i>

### **Honors**

2007	Best Instrumentation Poster Award, Cornell High Energy Synchrotron Source Users Meeting
2010	National Institutes of Health Ruth L. Kirschstein National Research Service Award (GM090486)

2012	Plenary speaker for 15 <sup>th</sup> International Small Angle Scattering Conference, Sydney
2012	National Institutes of Health Pathway to Independence Award (GM100008)
2017	Invited Author, <i>Holy Grails in Chemistry</i> Special Issue of <i>Acc Chem Res</i>
2017	Invited Author, <i>Chemical Reviews</i>
2017	<i>Future of Biophysics</i> Burroughs Wellcome Fund Symposium Lecture, Biophysical Society.
2017	National Institutes of Health Maximizing Investigators' Research Award
2018	Invited Author, <i>Future of Biochemistry</i> Special Issue of <i>Biochemistry</i>
2020-2021	Program Chair, American Crystallographic Association Meeting
2020	Margaret C. Etter Early Career Award, American Crystallographic Association
2020	National Science Foundation CAREER Award
2020	<i>Future of Biophysics</i> Burroughs Wellcome Symposium Lecture, Biophysical Society
2022	Director, Erice International School of Crystallography
2022	Protein Society Young Investigator Award
2024	Mildren Cohn Young Investigator Award, American Society for Biochem. & Molecular Biology

## C. Contributions to Science

- 1) **Diffuse scattering from correlated motions in protein crystals:** Conventional crystallography involves analyzing sharp diffraction patterns, commonly called Bragg data. However, real crystals are not perfectly periodic and produce additional scattering between the Bragg peaks. This smooth background pattern, known as diffuse scattering, contains information about correlated displacements within the crystal but has been exceedingly difficult to measure and interpret. My group is leading the world in the interpretation of macromolecular diffuse scattering, and we are making our software publicly available.
  - a. Meisburger SP, Case DA, **Ando N.** (2023) "Robust total X-ray scattering workflow to study correlated motion of proteins in crystals." *Nature Communications* 14, 1228. PMCID: PMC9984388
  - b. Meisburger SP, Case DA, **Ando N.** (2020) "Diffuse X-ray scattering from correlated motions in a protein crystal." *Nature Communications* 11, 1271. PMCID: PMC7062842
  - c. Meisburger SP, Thomas WC, Watkins MB, **Ando N.** (2017) "X-ray scattering studies of protein structural dynamics." *Chem Rev* 117, 7615–7672. PMCID: PMC5562295
  - d. **Ando N.** Protein Folding & Dynamics Webinar (2021) – recording available online
- 2) **Evolution of allostery:** Ribonucleotide reductases (RNRs) are essential enzymes for all DNA-based life and have a fascinating evolutionary history that is thought to pre-date the oxygenation of the Earth. Among the RNR family the class Ib RNRs are unusual for two reasons: it lacks a regulatory domain that is prevalent in the rest of the RNR family, and it is found only in bacteria, including a number of well-known human pathogens. Using SAXS, crystallography, and cryo-EM, we discovered that a stunning form of convergent allostery had evolved in this class. Based on this discovery, we conducted a formal investigation of RNR evolution using phylogenetic inference, machine-learning methods, SAXS, and cryo-EM.
  - a. Burnim AA, Xu D, Spence MA, Jackson CJ, **Ando N.** (2022) "Analysis of insertions and extensions in the functional evolution of the ribonucleotide reductase family." *Protein Sci.*, 31:e4483.
  - b. Burnim AA, Spence MA, Xu D, Jackson CJ\*, **Ando N\***. (2022) "Comprehensive phylogenetic analysis of the ribonucleotide reductase family reveals an ancestral clade and the role of insertions and extensions in diversification." *eLife*, 11: e79790. \*co-corresponding.
  - c. Thomas WC, Brooks PF, Burnim AA, Bacik J-P, Stubbe J, Kaelber JT, Chen JZ, **Ando N.** (2019) "Convergent allostery in ribonucleotide reductase." *bioRxiv* 504290 doi:10.1101/504290. *Nature Communications* 10, Article number: 2653. PMCID: PMC6572854
  - d. **Ando N.** American Crystallographic Association (ACA) Etter Award Talk (2020) – recording available online
- 3) **Complex metalloenzymes:** My group is interested in understanding how life evolves and adapts to unusual environments. We have used various techniques to study metalloenzymes that perform challenging reactions with biomedical and evolutionary significance.
  - a. Watkins MB, Wang H, Burnim AA, **Ando N.** "Conformational switching and flexibility in methionine synthase studied by small-angle X-ray scattering and cryo-electron microscopy." (2023) *PNAS* 120, e2302531120. PMCID: PMC10293825

- b. Illava G, Gillilan RE, **Ando N**. “Development of in-line anoxic small-angle X-ray scattering and structural characterization of an oxygen-sensing transcriptional regulator.” (2023) *J. Biol. Chem.* 299: 105039. PMID: PMC10425943
  - c. Parker MJ, Maggiolo AO, Thomas WC, Kim A, Meisburger SP, **Ando N\***, Boal AK\*, and Stubbe J\*. (2018) “An endogenous dAMP ligand in *Bacillus subtilis* class Ib RNR promotes assembly of a noncanonical dimer for regulation by dATP.” *PNAS* **55**, 201800356–10. \*co-corresponding. PMID: PMC5960316
  - d. Davis KM, Schramma K, Hansen W, Bacik J-P, Khare S, Seyedsayamdost M, **Ando N**. (2017) Structures of the peptide-modifying radical SAM enzyme SuiB elucidate the basis of substrate recognition. *PNAS* **114**, 10420–10425. PMID: PMC5625900
- 4) **Service to the structural biology community:** I have a long track record of service to the field of structural biology. In addition to software contributions, a high-pressure small-angle X-ray scattering (SAXS) cell that I designed in my graduate studies has formed the basis for the recently established high-pressure biology (HP-Bio) beamline at the Cornell High Energy Synchrotron Source (CHESS). Notably, we have developed software for deconvolution of SAXS data, such as evolving factor analysis (EFA) and regularized alternating least-squares (REGALS). These and software packages for diffuse scattering data processing are available on our lab GitHub.
  - a. Skou S, Gillilan RE, **Ando N**. (2014) “Synchrotron-based small-angle X-ray scattering (SAXS) of biomacromolecules in solution.” *Nature Protocols* **9**, 1727–1739. PMID: PMC4472361
  - b. Meisburger SP, Taylor AB, Khan CA, Zhang S, Fitzpatrick PF, **Ando, N**. (2016) “Domain movements upon activation of phenylalanine hydroxylase characterized by crystallography and chromatography-coupled small-angle X-ray scattering.” *JACS* **138**, 6506–6516. PMID: PMC4896396
  - c. Meisburger SP, Xu D, **Ando N**. (2021) “REGALS: a general method to deconvolve X-ray scattering data from evolving mixtures.” *IUCrJ*, **8**, 225-23.
  - d. Ando Lab GitHub
- 5) **Allostery in a radical enzyme:** My postdoctoral work on class Ia ribonucleotide reductases (RNRs) set a new precedent for the use of SAXS to study transient and heterogeneous protein complexes. By combining SAXS with other biophysical techniques, we achieved a major milestone in understanding allosteric regulation of the class Ia RNR from *E. coli* and addressed a 50-year old mystery surrounding this complex system. This work has been included in the 6th edition of Lehninger, “Principles of Biochemistry.”
  - a. **Ando N**, Brignole EJ, Zimanyi CM, Funk MA, Yokoyama K, Asturias FJ, Stubbe J, Drennan CL. (2011) “Structural interconversions modulate activity of *Escherichia coli* ribonucleotide reductase.” *PNAS* **108**, 21046–21051. PMID: PMC3248520
  - b. Zimanyi CM, **Ando N**, Brignole EJ, Asturias FJ, Stubbe J, Drennan CL. (2012) “Tangled up in knots: Structures of inactivated forms of *E. coli* class Ia ribonucleotide reductase.” *Structure* **20**, 1374–1383. PMID: PMC3459064
  - c. Minnihan EC, **Ando N**, Brignole EJ, Olshansky L, Chittuluru J, Asturias FJ, Drennan CL, Nocera D, Stubbe J. (2013) “Generation of a stable, aminotyrosyl radical-induced  $\alpha 2\beta 2$  complex of *Escherichia coli* class Ia ribonucleotide reductase.” *PNAS* **110**, 3835–3840. PMID: PMC3593893
  - d. **Ando N\***, Li H, Brignole EJ, Thompson S, McLaughlin MI, Page JE, Asturias FJ, Stubbe J, Drennan CL. “Allosteric inhibition of human ribonucleotide reductase by dATP entails the stabilization of a hexamer.” *PNAS* **55**, 373–381 (2016). \*co-corresponding. PMID: PMC4722859

#### Complete List of Published Work in Google Scholar:

<https://scholar.google.com/citations?user=v-MylFAAAAAAJ&hl=en>