Naranbaatar Dashdorj
Ultrafast Biophysical Chemistry Section
LCP, NIDDK, National Institutes of Health
Building 5, Room 137C, 5 Memorial Drive
Bethesda, MD 20892-0520, U.S.A.

Curriculum Vitae
Phone: (301) 402 6582
Fax: (301) 496 0825
E-mail: ndn@mail.nih.gov
Website: http://spin.niddk.nih.gov/anfinrud/nd

DATE OF BIRTH November 26, 1978 PLACE OF BIRTH Altai, Mongolia

EDUCATION

Ph.D. **Purdue University, West Lafayette, IN, USA**
Biophysics, 01/02 – 12/05

M.S. **Purdue University, West Lafayette, IN, USA**
Physics, 01/00 – 05/01

B.S. **National University of Mongolia, Ulaanbaatar, Mongolia**
Physics, 09/95 – 06/99, *summa cum laude*

PROFESSIONAL EXPERIENCE

NIH Fellow
Philip Anfinrud Group, LCP, NIDDK, National Institutes of Health (03/06 – present)

Graduate Student Researcher
Bioenergetics & Biophotonics Research Group, Department of Physics, Purdue University (01/02 – 02/06)

Graduate Student Instructor
Department of Physics, Purdue University (01/00 – 01/02)

Research Fellow
Institute of Physics and Technology, Mongolian Academy of Sciences (06/99 – 12/99)

Undergraduate Student Researcher
Institute of Physics and Technology, Mongolian Academy of Sciences (09/98 – 05/99)

Undergraduate Student Researcher
Nuclear Physics Research Center, National University of Mongolia (09/96 – 05/97)

HONORS AND AWARDS

NIH Fellowship, LCP, NIDDK, National Institutes of Health (03/06 – present)
The Best Oral Presentation Award, 31st Annual Midwest and Southwest Photosynthesis Meeting (11/05)
Grodzins Research Award, Department of Physics, Purdue University (05/05 – 09/05)
First Place, Graduate Student Research Competition, Sigma Xi, The Scientific Research Society (02/05)
A. H. Ismail Interdisciplinary Doctoral Award, Graduate School, Purdue University (01/05)
ASP Doctoral Travel Award, American Society for Photobiology (07/04)
First Place, Graduate Student Research Competition, Sigma Xi, The Scientific Research Society (02/04)
Full Member, Sigma Xi, The Scientific Research Society (02/04)
First Honorable Mention, G.S.R. Competition, Sigma Xi, The Scientific Research Society (02/03)
SIRG-PRF Fellow in Science and Engineering, Purdue University (01/02 – 05/04)
Summa Cum Laude, National University of Mongolia (06/99)
The Best Student-1998, Presented by the Prime Minister Elbegdorj Tsakhia of Mongolia (12/98)
Gold Medal-Terguunii Zaluu, Youth Association of Mongolia (12/98)
First Honorable Mention, Student Research Competition, National University of Mongolia (03/98)
Second Place, S.R. Competition, Department of Philosophy, National University of Mongolia (03/97)
First Place, Student Research Competition, National University of Mongolia (04/96)
Sumitomo Award, Sumitomo Corporation (03/96 – 05/98)
National Merit Scholarship of Mongolia, National University of Mongolia (09/95 – 05/99)
Gold Medal-Terguunii Suragch, Youth Association of Mongolia (12/94)

RESEARCH NARRATIVE REPORT

Energy and electron transfer processes and photoprotection mechanisms in photosynthetic complexes

Graduate Student Researcher, Bioenergetics and Biophotonics Research Group under the direction of Prof. Sergei Savikhin, Department of Physics, Purdue University (01/02 – present)

Used ultrafast time-resolved spectroscopy and structure based theoretical simulations to determine the effective dielectric constant deep within a protein. Electrostatic screening that is defined by the effective dielectric constant plays critical role in the conformation and function of proteins. To the best of our knowledge, this study is one of only two studies that directly measured this fundamental constant deep within a protein, as such measurements present experimental challenge.

Applied optical femtosecond time-resolved pump-probe techniques to study energy and electron transfer kinetics in two complimentary point mutants in both branches of the photosystem I reaction center cofactors to resolve the highly controversial issue of whether one or both branches are active in electron transfer under physiologically relevant conditions. Experimental studies to resolve this issue prior to this work had been focused primarily on measurements of changes in the electron transfer kinetics, which reflect the relatively slow electron transfer step where the electron acceptor is common to both branches, consequently leaving some ambiguity in the interpretation. On the contrary, the very first steps of electron transfer were probed in this study, revealing unequivocal corroboration for the asymmetrical electron transfer for the first time.

Utilized optical femtosecond and nanosecond time-resolved pump-probe spectroscopy to study singlet and triplet excited state dynamics of the unique chlorophyll *a* and carotenoid molecules in the cytochrome b_6f complex. Based on the experimental results, two unconventional protection mechanisms against light-induced photodegradation, which have not yet been reported, had been determined. Furthermore, alternative quenching mechanism for the singlet excited state of chlorophyll *a* had been unconcealed in chlorophyll-containing pigment-protein complex for the first time.

Using explicit molecular dynamics simulation to investigate intraprotein oxygen channel within the integral membrane pigment-protein cytochrome b_6f complex that is proposed to facilitate an anomalous long-range triplet energy transfer.

Applying femtosecond time-resolved transient absorption techniques on the single crystals of a multi-subunit cytochrome b_6f complex to study effects of crystal packing on tertiary structure.

Using steady state spectroscopy to explore weakening of the P700 excitonic coupling induced by structural rearrangements propagated through quaternary structure caused by deletion peripheral subunit(s).

Using ultra cooled near-infrared fast photomultiplier tube and time-correlated single photon counting apparatus to probe the formation of singlet oxygen via its characteristic luminescence upon exciting chlorophyll *a* molecule with picosecond time resolution.

Zero-point fluctuations: A ring of charge and nonlocal electromagnetic interaction

Research Fellow and Undergraduate Student Researcher, Acad. Namsrai Khavtgai's Group, Institute of Physics and Technology, Mongolian Academy of Sciences (09/98 – 12/99)

Worked on development of gauge invariant theory, wherein the electromagnetic zero-point like charged particle has averaged structure of an oriented ring due to random zero-point fluctuations and nonlocal electromagnetic interaction of these string-like objects is constructed in a consistent way.

TEACHING EXPERIENCE

Graduate Student Instructor

Department of Physics, Purdue University (01/00 – 01/02)

PUBLICATIONS

Ph.D. Thesis:

Dashdorj N. 2005. Following the Trail of Light: Energy and Electron Transfer Processes and Photoprotection Mechanisms in Photosynthetic Complexes. West Lafayette, IN, USA: Purdue University.

B.S. Thesis:

Dashdorj N. 1999. Zero-Point Fluctuations of Electromagnetic Fields and Zitterbewegung Model. Ulaanbaatar, Mongolia: National University of Mongolia.

PUBLICATIONS cntd.

Peer-Reviewed Original Manuscripts:

Dashdorj N, Xu W, Martinsson P, Chitnis PR, and Savikhin S. Electrochromic Shift of Chlorophyll Absorption in Photosystem I from *Synechocystis* sp. PCC 6803: A Probe of Optical and Dielectric Properties around the Secondary Electron Acceptor, *Biophysical Journal* **86**: 3121-3130 (2004).

Dashdorj N, Xu W, Cohen RO, Golbeck JH, and Savikhin S. Asymmetric Electron Transfer in Cyanobacterial Photosystem I: Charge Separation and Secondary Electron Transfer Dynamics of Mutations near the Primary Electron Acceptor A_0, *Biophysical Journal* **88**: 1238-1249 (2005).

Dashdorj N, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. The Single Chlorophyll *a* Molecule in the Cytochrome b_6f Complex: Unusual Optical Properties Protect the Complex against Singlet Oxygen, *Biophysical Journal* **88**: 4178-4187 (2005).

Kim H*, ***Dashdorj N****, Zhang H, Yan J, Cramer WA, and Savikhin S. An Anomalous Distance Dependence of Intra-Protein Chlorophyll-Carotenoid Triplet Energy Transfer, *Biophysical Journal* **88**: 5000-5005 (2005). *These authors contributed equally to this work and should both be considered as first authors.

Refereed Conference Proceedings:

Dashdorj N, Xu W, Cohen RO, Golbeck JH, and Savikhin S. Probing the Active Electron Transfer Branch in the Photosystem I Reaction Center from *Synechocystis* sp. PCC 6803, *In* Photosynthesis: Fundamental Aspects to Global Perspectives. Art van der Est and Doug Bruce, Editors, ACG Publishing, Lawrence, KS, U.S.A. 30-33 (2005).

Dashdorj N, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Unusual Optical Properties of the Monomeric Chlorophyll *a* in the Cytochrome b_6f Complex of Oxygenic Photosynthesis, *In* Photosynthesis: Fundamental Aspects to Global Perspectives. Art van der Est and Doug Bruce, Editors, ACG Publishing, Lawrence, KS, U.S.A. 451-453 (2005).

Kim H, Zhang H, ***Dashdorj N***, Yan J, Cramer WA, and Savikhin S. Evidence For Long Range Triplet Excited State Energy Transfer from the Chlorophyll *a* to Carotenoid in the Cytochrome b_6f Complex of Oxygenic Photosynthesis, *In* Photosynthesis: Fundamental Aspects to Global Perspectives. Art van der Est and Doug Bruce, Editors, ACG Publishing, Lawrence, KS, U.S.A. 432-434 (2005).

Manuscripts in Preparation:

Dashdorj N, Yamashita E, Cramer WA, and Savikhin S. Ultrafast Time-Resolved Optical Absorption Transient Study on the Single Crystals of an Oligomeric Integral Membrane Protein.

Dashdorj N, Shen G, Xu W, Golbeck JH, and Savikhin S. Quaternary Structural Rearrangements: Subunit Deletion Induced Effects on the P700 Excitonic Coupling.

Dashdorj N, Cramer WA and Savikhin S. Molecular Dynamics Simulation of the Cytochrome b_6f Complex: Intraprotein Oxygen Channel.

Dashdorj N, Shen G, Golbeck JH, and Savikhin S. Comprehensive Characterization of Ultrafast Primary Processes in Photosystem I of the Cyanobacterium *Synechococcus* sp. PCC 7002.

Yan J, ***Dashdorj N***, Savikhin S, and Cramer WA. Site-Directed Mutagenesis Studies in the Nanospace of the Chlorophyll *a* in the Cytochrome b_6f Complex.

CONFERENCE PRESENTATIONS

1. Xu W, Martinsson P, Struve WS, ***Dashdorj N***, Chitnis PR, and Savikhin S. Probing Active Electron Transfer Branch in Photosystem I Reaction Center. Gordon Research Conference on Photosynthesis. Roger Williams University, Bristol, RI, U.S.A. June 16-21, 2002.
2. ***Dashdorj N***, Xu W, Martinsson P, Chitnis PR, and Savikhin S. Electrochromic Shift of Chlorophyll Absorption: A Probe for Protein Matrix Relaxation. Sigma Xi Graduate Student Research Awards Competition 2003. Purdue University, West Lafayette, IN, U.S.A. Feb 20, 2003.
3. ***Dashdorj N***, Xu W, Chitnis PR, and Savikhin S. Probing Active Electron Transfer Branch in the Photosystem I Reaction Center by means of Ultrafast Spectroscopy. Biophysical Society's 47th Annual Meeting. San Antonio, TX, U.S.A. March 1-5, 2003.

CONFERENCE PRESENTATIONS cntd.

4. Savikhin S, ***Dashdorj N***, Xu W, Martinsson P, and Chitnis PR. Local Dielectric Constant around the Primary Electron Acceptor in Photosystem I: A Probe for Protein Matrix Relaxation. Annual American Physical Society March Meeting 2003. Austin, TX, U.S.A. March 3-7, 2003.
5. Savikhin S, ***Dashdorj N***, Xu W, Chitnis PR, Shen G, and Golbeck JH. Probing Active Electron Transfer Branch in Photosystem I: Ultrafast Pump-Probe Spectroscopy. Photosystem I Conference 2003. Berlin, Germany. May 12-15, 2003.
6. ***Dashdorj N***, Xu W, Chitnis PR, Martinsson P, and Savikhin S. Electrochromic Shift and Effective Dielectric Constant around the Primary Electron Acceptor in Photosystem I. Gordon Research Conference on Photosynthesis. Roger Williams University, Bristol, RI, U.S.A. June 22-27, 2003.
7. ***Dashdorj N***, Xu W, Chitnis PR, Shen G, Golbeck JH, and Savikhin S. Probing Active Electron Transfer Branch in Photosystem I: Ultrafast Pump-Probe Spectroscopy. Gordon Research Conference on Photosynthesis. Roger Williams University, Bristol, RI, U.S.A. June 22-27, 2003.
8. ***Dashdorj N***, Xu W, Chitnis PR, Golbeck JH, and Savikhin S. Probing Active Electron Transfer Branch in Photosystem I: Ultrafast Pump-Probe Spectroscopy. 29th Annual Midwest Photosynthesis Meeting. Turkey Run State Park, Marshall, IN, U.S.A. Nov 2-4, 2003.
9. ***Dashdorj N***, Xu W, Chitnis PR, Martinsson P, and Savikhin S. Electrochromic Shift and Effective Dielectric Constant around the Primary Electron Acceptor in Photosystem I. 29th Annual Midwest Photosynthesis Meeting. Turkey Run State Park, Marshall, IN, U.S.A. Nov 2-4, 2003.
10. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Optical Properties of the Single Chlorophyll *a* Molecule in the Cytochrome b_6f Complex of Oxygenic Photosynthesis. Biophysical Society's 48th Annual Meeting. Baltimore, MA, U.S.A. Feb 14-18, 2004.
11. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Optical Properties of the Single Chlorophyll *a* Molecule in the Cytochrome b_6f Complex of Oxygenic Photosynthesis. Sigma Xi Graduate Student Research Awards Competition 2004. Purdue University, West Lafayette, IN, U.S.A. Feb 18, 2004.
12. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Optical Properties of the Chlorophyll *a* Molecule in the Cytochrome b_6f Complex of Oxygenic Photosynthesis. 32hd Annual Meeting of the American Society for Photobiology. Seattle, WA, U.S.A. July 10-14, 2004.
13. ***Dashdorj N***, Xu W, Golbeck JH, Chitnis PR, and Savikhin S. Probing Active Electron Transfer Branch in the Photosystem I Reaction Center from *Synechocystis* sp. PCC 6803 by means of Ultrafast Spectroscopy. 32nd Annual Meeting of the American Society for Photobiology. Seattle, WA, U.S.A. July 10-14, 2004.
14. ***Dashdorj N***, Xu W, Cohen RO, Golbeck JH, and Savikhin S. Probing the Active Electron Transfer Branch in the Photosystem I Reaction Center from *Synechocystis* sp. PCC 6803. 13th International Congress of Photosynthesis. Montréal, QU, Canada. Aug 29-Sep 3, 2004.
15. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Unusual Optical Properties of the Monomeric Chlorophyll *a* in the Cytochrome b_6f Complex of Oxygenic Photosynthesis. 13th International Congress of Photosynthesis. Montréal, QU, Canada. Aug 29-Sep 3, 2004.
16. Kim H, Zhang H, ***Dashdorj N***, Yan J, Cramer WA, and Savikhin S. Evidence For Long Range Triplet Excited State Energy Transfer from the Chlorophyll *a* to Carotenoid in the Cytochrome b_6f Complex of Oxygenic Photosynthesis. 13th International Congress of Photosynthesis. Montréal, QU, Canada. Aug 29-Sep 3, 2004.
17. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Quenching the Singlet Excited State of the Unique Chlorophyll *a* in the Cytochrome b_6f Complex as a Unique Photoprotection Mechanism. 30th Annual Midwest Photosynthesis Meeting. Turkey Run State Park, Marshall, IN, U.S.A. Oct 29-31, 2004.
18. Kim H, ***Dashdorj N***, Zhang H, Yan J, Cramer WA, and Savikhin S. The Chlorophyll *a* Molecule in the Cytochrome b_6f Complex: Is It Protected against Singlet Oxygen Formation? 30th Annual Midwest Photosynthesis Meeting. Turkey Run State Park, Marshall, IN, U.S.A. Oct 29-31, 2004.
19. ***Dashdorj N***, Xu W, Chitnis PR, Martinsson P, and Savikhin S. Stark Effect in Photosystem I: A Probe of Optical and Dielectric Properties around the Secondary Electron Acceptor. 51st Midwest Solid State Conference. Purdue University, West Lafayette, IN, U.S.A. Oct 30-31, 2004.

CONFERENCE PRESENTATIONS cntd.

20. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Quenching the Singlet Excited State of the Monomeric Chlorophyll *a* in the Cytochrome b_6f Complex as a Unique Photoprotection Mechanism. Biophysical Society's 49th Annual Meeting. Long Beach, CA, U.S.A. Feb 12-16, 2005.
21. ***Dashdorj N***, Zhang H, Kim H, Yan J, Cramer WA, and Savikhin S. Quenching the Singlet Excited State of the Monomeric Chlorophyll *a* in the Cytochrome b_6f Complex as a Unique Photoprotection Mechanism. Sigma Xi Graduate Student Research Awards Competition 2005. Purdue University, West Lafayette, IN, U.S.A. Feb 17, 2005.
22. Kim H, ***Dashdorj N***, Zhang H, Yan J, Cramer WA, and Savikhin S. The Chlorophyll *a* Molecule in the Cytochrome b_6f Complex: Unique Protection Mechanisms against Singlet Oxygen. Gordon Research Conference on Photosynthesis. Bryant University, Smithfield, RI, U.S.A. July 3-8, 2005.
23. ***Dashdorj N***, Shen G, Xu W, Golbeck JH, and Savikhin S. Quaternary Structural Rearrangements: Subunit Deletion Effects on the P700 Excitonic Coupling. 31st Midwest and Southwest Photosynthesis Meeting. Turkey Run State Park, Marshall, IN, U.S.A. Oct 28-30, 2005.
24. ***Dashdorj N***, Yan J, Cramer WA, and Savikhin S. Tuning the Chlorophyll Singlet Excited State Lifetime: Point Mutagenesis Studies in the Nanospace of the Unique Chlorophyll *a* of the Cytochrome b_6f Complex. 31st Midwest and Southwest Photosynthesis Meeting. Turkey Run State Park, Marshall, IN, U.S.A. Oct 28-30, 2005.

PROFFESIONAL AFFILIATIONS

American Physical Society, Member

American Society for Photobiology, Member

Biophysical Society of America, Member

Neptune Academy, Fellow

Sigma Xi, The Scientific Research Society, Full Member

TECHNICAL EXPERIENCE

Developed and implemented femtosecond pump nanosecond probe spectroscopy setup that can measure fractional absorption changes with an ultrahigh sensitivity of 10^{-5} using existing amplified Ti:Sapphire system, acousto-optic modulators, and continuous wave argon laser in 2 months.

Excelled at using the home-built state-of-the-art amplified Ti:Sapphire femtosecond time-resolved pump-probe system with optical parametric amplifier, and improved the system by adding optical switch that automatically ensured amplitude normalization of pump-probe signals.

Assembled femtosecond Ti:Sapphire system runs at 80 MHz repetition rate with multiple modulation schemes that can measure absorption changes with an unprecedented sensitivity of 10^{-6} using ultralow energy per pulse.

Designed and constructed detection system with nanosecond time-resolution that is capable of measuring fractional absorption changes with ultrahigh sensitivity.

Assembled and modified femtosecond self-mode-locking Ti:Sapphire lasers.

Constructing time-correlated single photon counting setup with picosecond time-resolution that uses ultra cooled fast near-infrared photomultiplier tube.

SOFTWARE SKILLS

Operating Systems: MS Windows, MS-DOS, UNIX, Linux, and Mac OS X

Simulation: NAMD, CHARMM

Modeling: VMD, Solvate, Modeller, PyMOL, DeepView

Bioinformatics: Swiss-Prot, BLAST, Multiseq

Programming Languages: C++, PHP, Spectra Script

Applications: Matlab, Maple, MS Office, Spectra Solve, MM Studio, Corel PS Pro, Adobe Photoshop

LANGUAGES

Native Mongolian, Fluent English and Russian

PROFFESSIONAL SERVICE

Founder and Head, **Neptune Academy**, (02/97 – 10/99)

Founded Neptune Academy for promoting scientific knowledge and interests among students in Mongolia, served as the Head, actively involved in organizing seminars, colloquia, and research competitions.

REFERENCES

Dr. Philip A. Anfinrud
Laboratory of Chemical Physics
NIDDK, National Institutes of Health
Building 5, Room 134
Bethesda, MD 20892-0520
U.S.A
Tel: (301) 435 6034
anfinrud@helix.nih.gov

Prof. Sergei Savikhin
Department of Physics
Purdue University
Northwestern Avenue 525
West Lafayette, IN 47907-2036
U.S.A
Tel: (765) 494 3017
sergei@physics.purdue.edu

Prof. William A. Cramer
Department of Biological Sciences
Purdue University
915 West State Street
West Lafayette, IN 47907-2054
U.S.A
Tel: (765) 494 4956
wac@bilbo.bio.purdue.edu

Prof. Stephen M. Durbin
Department of Physics
Purdue University
Northwestern Avenue 525
West Lafayette, IN 47907-2036
U.S.A
Tel: (765) 494 6426
durbin@physics.purdue.edu