Tong Wang

Email: sptow@channing.harvard.edu
Phone: +1 217-974-5103
Google scholar

Employment

Channing Division of Network Medicine (CDNM)
Brigham and Women's Hospital, Harvard Medical School — Boston, Massachusetts
Postdoctoral Research Fellow in Prof. Yang-Yu Liu's lab — 2021/06–present

Education

University of Illinois at Urbana-Champaign (UIUC) — Urbana, Illinois
Ph.D. in Physics, GPA: 3.97/4.00, Advisor: Sergei Maslov — 2014/08–2021/05

University of Science and Technology of China (USTC) — Hefei, Anhui
B.S. in Physics, GPA: 3.98/4.30, Rank: 1/67 — 2010/09–2014/06

Research

Motivated by models in statistical physics, math, ecology, epidemiology, and machine learning, I am broadly interested in modeling microbial communities with cross-feeding interactions and predator-prey interactions. I study the ecological and evolutionary dynamics influenced by those interactions. More specifically, I have worked on

- Functional redundancy in metagenome and metaproteome and how the redundancy difference between two types of data to reveal ecological niches and metabolic essentiality.
- Personalized prediction of metabolomic profiles of human gut microbiomes through deep learning.
- Prediction of gut fecal metabolite levels from microbial abundance using the ecological model with trophic levels.
- Ecological models of microbial exchange of essential nutrients.
- Models of microbial cross-feeding at intermediate scale mediated by carbon sources like acetate and amino acids.
- CRISPR-induced arms-race co-evolution between bacteria and viruses: network structure, prediction of regime shift, and influence of phage migration.
- Infection dynamics of viruses (such as phage P1*vir*) on the chemotactic bacteria (such as *E. colis*).

I also worked on COVID-related projects:

- Agent-based model for the University of Illinois at Urbana-Champaign.
- Data-analysis of internal COVID case data for operational purposes.

Experience

University of Ottawa — Ottawa, Ontario, Canada
Visiting postdoc in Prof. Daniel Figeys' lab — 2022/05–2022/05

University of Illinois at Urbana-Champaign (UIUC) — Urbana, Illinois
Research assistant in Prof. Sergei Maslov's lab — 2017/01–2021/05

Peking University — Beijing, China
Exchange student in Prof. Chao Tang's lab — 2017/07–2017/08

Niels Bohr Institute Copenhagen, Denmark
Visiting scholar in Prof. Kim Sneppen's lab 2017/06–2017/07

Publications (*: equal contribution)

Published

- Diana Rose Ranoa, Robin Holland, Fadi Alnaji, Kelsie Green, Leyi Wang, Richard Fredrickson, **Tong Wang**, George Wong, Johnny Uelmen, Sergei Maslov, *et al*, "Mitigation of SARS-CoV-2 Transmission at a Large Public University", *Nature Communications, 2022* — Featured in EurekAlert, MedicalXpress, Chicago Tribune, etc
- Zihan Wang, Akshit Goyal, Veronika Dubinkina, Ashish George, **Tong Wang**, Yulia Fridman, and Sergei Maslov, "Complementary resource preferences spontaneously emerge in diauxic microbial communities", *Nature Communications, 2021* — Featured in EurekAlert, Phys, etc
- Alexei Tkachenko, Sergei Maslov, **Tong Wang**, Ahmed Elbanna, George Wong, and Nigel Goldenfeld, "Stochastic social behavior coupled to COVID-19 dynamics leads to waves, plateaus, and an endemic state", *eLife, 2021* — Featured in UIUC Physics news, BNL News, etc
- Akshit Goyal*, **Tong Wang***, Veronika Dubinkina, and Sergei Maslov, "Ecology-guided prediction of cross-feeding interactions in the human gut microbiome", *Nature Communication, 2021* — Featured in EurekAlert, Bik's Picks, etc
- Shai Pilosof, Sergio A. Alcala-Corona, **Tong Wang**, Ted Kim, Sergei Maslov, Rachel Whitaker, and Mercedes Pascual, "The network structure and eco-evolutionary dynamics of CRISPR-induced immune diversification", *Nature Ecology and Evolution, 2020* — Featured in EurekAlert, Phys, etc
- Chen Liao, **Tong Wang**, Sergei Maslov, and Joao Xavier, "Modeling microbial cross-feeding at intermediate scale portrays community dynamics and species coexistence", *PLoS Computational Biology, 2020*
- Derek Ping*, **Tong Wang***, David T Fraebel, Sergei Maslov, Kim Sneppen, and Seppe Kuehn, "Hitchhiking, collapse, and contingency in phage infections of migrating bacterial populations", *ISME J, 2020* — Featured in Behind the Paper channel of Nature Research Microbiology Community, Bik's Picks, etc
- **Tong Wang***, Akshit Goyal*, Veronika Dubinkina, and Sergei Maslov, "Evidence for a multi-level trophic organization of the human gut microbiome", *PLoS Computational Biology, 2019* — Featured in EurekAlert, Phys, Bik's Picks, etc

In Review

- **Tong Wang**, Xu-Wen Wang, Augusto A. Litonjua, Kathleen Lee-Sarwar, Scott T. Weiss, Yizhou Sun, Sergei Maslov, Yang-Yu Liu, "Predicting metabolomic profiles from microbial composition through neural ordinary di erential equations", *In Review, Nature Machine Intelligence*

In preparation

- Leyuan Li*, **Tong Wang***, Zhibin Ning, Xu Zhang, James Butcher, Caitlin Simopoulos, Janice Mayne, Alain Stintzi, David R. Mack, Yang-Yu Liu, Daniel Figeys, "Revealing Protein-Level Functional Redundancy in the Human Gut Microbiome using Ultra-deep Metaproteomics", *In Prep*
- **Tong Wang***, Leyuan Li*, Daniel Figeys, Yang-Yu Liu, "Using metaproteome and metagenome data to pinpoint ecological niches", *In Prep*
- **Tong Wang***, Chen Liao*, and Sergei Maslov, "Cross-feeding thermodynamics promote microbial coexistance", *In Prep*
- **Tong Wang**, Ashish George, Sergei Maslov, "A graphically interpretable ecological model with overflow of multiple essential nutrients can accurately predict community assembly", *In Prep*
- Ashish George, **Tong Wang**, Sergei Maslov, "Functional universality in slow-growing microbial communities arises fromthermodynamic constraints", *In Prep*

Scholarships and Awards

- Guo Moruo Scholarship (the highest honor in USTC) 2013
- China National Scholarship 2012
- XinDi Scholarship 2011

Conference

- Pinpoint ecological niches and metabolic essentiality of microbial communities using both metagenomics and metaproteomics. Oral presentation at Ecological and evolutionary biology, APS March Meeting, Chicago, USA, 2022/03
- Predicting metabolomic profiles from microbial composition through neural ODE. Oral presentation at Channing Microbiome Meeting, Boston, USA, 2022/02
- Pinpoint ecological niches and metabolic essentiality of microbial communities using both metagenomics and metaproteomics. Oral presentation at Channing Network Science Meeting, Boston, USA, 2021/10
- Thermodynamic constraints on cross-feeding in bacterial population. Oral presentation at Ecological and evolutionary biology, APS March Meeting, Boston, USA, 2019/03
- Hitchhiking, collapse, and contingency in phage infections of migrating bacterial populations. Poster presentation at Evolution of Diversity. The Les Houches Physics School, Les Houches, France, 2018/02

Invited talks

- Pinpoint ecological niches and metabolic essentiality of microbial communities using both metagenomics and metaproteomics. Oral presentation at MIT Center for the Physics of Living Systems, Department of Physics, Massachusetts Institute of Technology, Boston, USA, 2022/05
- Pinpoint ecological niches and metabolic essentiality of microbial communities using both metagenomics and metaproteomics. Oral presentation at School of Pharmaceutical Sciences, University of Ottawa, Ottawa, Canada, 2022/05
- Predicting metabolomic profiles from microbial composition through neural ODE. Oral presentation at Center for Complex Network Research, Network Science Institute, Northeastern University, Boston, USA, 2022/03

Peer review

1 PNAS, 1 Nature Communications, 1 Nutrients, 1 Biophysical Journal, 1 IJMS, 1 Applied Sciences, 1 IJERPH

Skills

Python (including Data Science and Machine learning tools), C, C++, OpenMPI, Matlab, Julia, Latex, Markdown