Yuqiao (Joy) Fan

Linked-in | fany1@ornl.gov | Cell: 734-780-9553 | Work: 865-341-1932 | ORCiD: 0000-0002-2975-1735

EDUCATION

PhD in Nuclear Engineering (Minor in **Mech. Eng.**) Jul. 2017-Dec. 2021
NC State University (NCSU), Raleigh NC *summa cum laude*

MSE in Nuclear Engineering Aug. 2015-Dec. 2016
University of Michigan, Ann Arbor MI *cum laude*

BE in Nuclear Engineering Sep. 2011-Jun. 2015
Xi'an Jiaotong University (XJTU) Rank: 1/94

Visiting Student Summer 2013, 2014
Hong Kong University of Science and Technology (HKUST) Grades: A, A+

EMPLOYMENT EXPERIENCE

Blanket, Fuel Cycle, and Fusion Engineer, R&D Associate Staff
Fusion Energy Division, Oak Ridge National Laboratory (ORNL) Feb. 2022-
Supervisor: Dr. Larry Baylor (baylorlr@ornl.gov)

- Conducting liquid metal (LM) magnetohydrodynamics (MHD) flow study in Dual-Coolant Lead-Lithium blanket, optimizing design of the LM feeding geometry for the breeding blanket.
- Studying the feasibility of a novel blanket candidate, Toroidally Symmetric Lead Lithium blanket, by demonstrating lower MHD pressure drop under significant magnetic fields.
- Integrating various physics (MHD, conjugated heat transfer, mass transfer, two-phase, etc.) to effectively tackle cutting-edge challenges related to plasma-facing components and corrosion issues.
- Performing high-fidelity Computational Fluid Dynamics (CFD) simulations on cryogenic hydrogen extruder for leakage-reduced fuel injection into the fusion reactors, which contributes to ITER's success.
- CFD modeling of the helium cooling performance at the heated first wall of the fusion blanket; working closely with experimentalists and advance manufacturing staff on the design and fabrication of the helium flow channel.
- Managing computational servers and coordinate licenses for ANSYS and COMSOL.
- Active involvement in hiring committees for recruiting staff members and postdocs.

Research Assistant/Graduate Student Teaching Assistant
Multiphase Research Group, NCSU Jul. 2017-Feb. 2022
Advisor: Prof. Igor Bolotnov (igor_bolotnov@ncsu.edu)

- Integrated proportional–integral–derivative (PID) control with level-set method in PHASTA code; achieved highly scalable, efficient, accurate, and robust two-phase flow rate control
- Applied PID flow rate control to study Counter Current Flow Limitation (CCFL) in light water reactor (LWR) debris bed channels; developed correlations and dimensionless numbers to predict CCFL occurrence and for safety analysis in severe accident scenarios
- Developed novel gravity control method and added this new capability into existing PID bubble controller; achieved more accurate bubble simulation results for verification and validation (V&V)
- Applied bubble controller on closure development of bubble interfacial forces as well as deformation and break-up regimes with validation from experimental research
- Conducted pool boiling simulations with multiple nucleation sites; concluded bubble departure behaviors under different nucleation site patterns, site distances, and heat fluxes
- Assisted teaching NE/MAE 577 Multiscale Two-Phase Flow Simulations

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Intern (remote)
Institute of Fluid Dynamics, Helmholtz-Zentrum Dresden-Rossendorf, Germany Summer 2020
Advisors: Dr. Dirk Lucas (d.lucas@hzdr.de), Dr. Roland Rzehak (r.rzehak@hzdr.de)

- Conducted high resolution simulations of lift and drag forces on bubbles at high shear rates
- Developed closures of interfacial forces for Eulerian-Eulerian baseline models

Intern
Advanced Reactor Engineering and Development Section & CASL, ORNL Fall 2019
Advisors: Dr. David Pointer (pointerwd@ornl.gov), Dr. Marc-Olivier Delchini (delchinimg@ornl.gov)

- Worked on application, model validation, uncertainty quantification, and documentation of Eulerian-Eulerian FY19 CASL boiling models
- Conducted two-phase Reynolds Averaged Navier Stokes (RANS) simulations using Star-CCM+ on departure from nucleate boiling in cylindrical channel
- Performed bug-hunting and solution verification of nek4nuc (integrated Nek5000 into NEAMS Workbench) via turbulent simulations of pipe channel
- Applied nek4nuc in flow characteristics study of High Flux Isotope Reactor (HFIR) cooling channel with high resolution Large Eddy Simulations (LESs)

Graduate Student Research Assistant/Graduate Student Instructor
University of Michigan, Ann Arbor Aug. 2015-Dec. 2016
Experimental and Computational Multiphase Flow Laboratory

- Designed bubble injector for water-air fuel bundle in experiment system
- Programmed 3D data visualization acquired by wire mesh sensor at bubble column facility
- Assisted teaching NERS 444 Thermal-hydraulics for Nuclear Systems

EXPERIMENTAL RESEARCH EXPERIENCE

Undergraduate Student Research Assistant Dec. 2014- Jun. 2015
Laboratory on flow and heat transfer characteristics of steam generator tube bundles, XJTU
Advisor: Prof. Wenxi Tian (wxtian@mail.xjtu.edu.cn)

- Conducted shakedown tests on large-scale experimental facility of partial scaled tube bundles at secondary side in steam generator of nuclear reactor CAP1400
- Studied the flow and heat transfer characteristics by experiments and simulations and developed correlations for friction loss of tube bundles

Research Intern
Centre for Energy and Thermal Systems, HKUST Summer 2014
Advisor: Prof. Huihe Qiu (meqiu@ust.hk)

- Designed and performed copper cylinder pool boiling experiments and obtained boiling curves
- Improved heat transfer performance by fabricating nanostructures on heated copper surfaces

Undergraduate Student Research Assistant Sep. 2013-Jul. 2014
Laboratory of Thermal Science and Engineering, XJTU
Advisor: Prof. Yaling He (yalinghe@mail.xjtu.edu.cn)

- Designed and fabricated polymer filled copper plates to rearrange thermal resistance distribution
- Changed heat flow on the plate and improved thermal isolation performance at center volume

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Undergraduate Student Research Assistant Mar. 2013- Aug. 2015
Laboratory of Fluid Machinery, XJTU
Advisor: Prof. Zhongguo Sun (sun.zg@mail.xjtu.edu.cn)

- Designed and fabricated experimental apparatus for bottleneck effect, an **original research** study
- Studied flow instability influenced by inclination angles at the bottleneck of flask-shape container

FUNDING AWARDS

Department of Energy, PI Jan. 2023-

- NERSC DOE Mission Science Allocation Award, "*Liquid metal plasma-facing component*"
- Recipient for the Allocation Years 2023 and 2024

Oak Ridge National Laboratory, Co-PI Jul. 2022-

- Laboratory Directed Research and Development (LDRD), "*Predictive modeling of Helium flow with validation*"
- Awarded a third-year extension for fiscal year 2024, recognizing outstanding performance

FEATURING

Success Story, Oak Ridge Institute for Science and Education (ORISE)

- Selected as one of very few researches at ORNL to be showcased in the ORISE column "What's it like Being an ORISE STEM Researcher?"

Science Headlines, multiple media (energy.gov, phys.org, ornl.gov, etc)

- Featured in "Fusion Experts Address Cooling Strategies for Fusion Fuel Cycle", contributing to helium flow visualization as a co-PI.

JOURNAL PUBLICATION & PATENT

Yuqiao Fan, Cody Wiggins, Charles Kessel, **Simulation of Helium Flow Visualization Apparatus for Studies of Blanket Cooling in Fusion Reactors**, IEEE Transactions on Plasma Science (under revision)
- Invited publication by *SOFE 2023*

Yuqiao Fan, Mengnan Li, William D. Pointer, Igor Bolotnov, **High-fidelity pool boiling simulations on multiple nucleation sites using interface capturing method**, *Nuclear Engineering and Design*
- Invited publication by NURETH 19 conference Dec. 2022

Yuqiao Fan, Jun Fang, Igor Bolotnov, **Complex bubble deformation and break-up dynamics studies using interface capturing approach**, *Experimental and Computational Multiphase Flow* Jul. 2020

Kui Zhang, Yandong Hou, Wenxi Tian, Yuqiao Fan, *et al.*, **Experimental investigations on single-phase convection and steam-water two-phase flow boiling in a vertical rod bundle**, *Experimental Thermal and Fluid Science* Jan. 2017

Kui Zhang, Yuqiao Fan, *et al.*, **Pressure drop characteristics of two-phase flow in a vertical rod bundle with support plates**, *Nuclear Engineering and Design* Aug. 2016

Jun Wang, Yuqiao Fan, *et al.*, **The development of candling module code in module in-vessel degraded analysis code MIDAC and the relevant calculation for CPR1000 during large-break LOCA**, *ASME Journal of Nuclear Engineering and Radiation Science* Feb. 2016

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Yuqiao Fan, Xuejun Zhao, *et al.*, **Experimental study on the influence of the incline angle of narrow-necked container on bottleneck effect**, *Journal of Engineering Thermophysics* Aug. 2015
- **Invited publication** by Chinese Society of Engineering Thermophysics' Academic Conference 2015

Jun Wang, Wenxi Tian, Yuqiao Fan, *et al.*, **The development of a zirconium oxidation calculating program module for Module In-vessel Degraded Analysis Code MIDAC**, *Progress in Nuclear Energy* May 2014

PATENT:
NO. ZL201420436054.8: the experimental system for bottleneck effect, including an adjustable sized bottleneck, the supporting shelf and the driving system. Aug. 2014

CONFERENCE PROCEEDING

Yuqiao Fan, Sergey Smolentsev, **Optimal Design of the Liquid Metal Feeding System for Fusion Reactor Blankets through High-Fidelity MHD Simulations,** *76th Annual Meeting of the APS Division of Fluid Dynamics* Nov 2023

Yuqiao Fan, Cody Wiggins, Charles Kessel, **Simulation of Helium Flow Visualization Apparatus for Studies of Blanket Cooling in Fusion Reactors**, *SOFE 2023* Jul. 2023

Sergey Smolentsev, Yuqiao Fan, Shahinul Islam, *et al.*, **Recent and future work on LM PFC at ORNL**, *2023 US-Japan Workshop on Liquid Metal PFCs* Feb. 2023

Yuqiao Fan, Mengnan Li, William D. Pointer, Igor Bolotnov, **Interface Capturing Simulations on Pool Boiling Performance with Multiple Nucleation Sites**, *NURETH-19* Mar. 2022

Marc-Olivier G. Delchini, Yuqiao Fan, **Comparisons between High-Fidelity and Low-Fidelity Modeling of the Turbulent Flow in the High Flux Isotope Reactor Cooling Channel Using Nek5000-V17 and Star-ccm+,** *NURETH-19* Mar. 2022

Yuqiao Fan, Marc-Olivier Delchini, Robert Lefebvre, **Verification of Nek4nuc (Nek5000 Integrated in NEAMS Workbench) via Turbulent Pipe Flow Simulation**, *2020 ANS Winter Meeting and Nuclear Technology Expo* Nov. 2020

Yuqiao Fan, Igor Bolotnov, **Gravity Controller Capability for Single-Bubble Interface-Resolved Simulations**, *2020 ANS Winter Meeting and Nuclear Technology Expo* Nov. 2020

Yuqiao Fan, Igor Bolotnov, **Investigation on Bubble Deformation and Break-up Dynamics Using Interface Tracking Method**, *2019 ANS Annual Meeting* Jun. 2019

Yuqiao Fan, Jinyong Feng, Igor Bolotnov, **Investigation of Wall Effect on Deformable Bubble Using Interface Tracking Method**, *2018 ANS Annual Meeting* Jun. 2018

TECHNICAL REPORT & DOCUMENTATION

Yuqiao Fan, Cheng-Kai Tai, Igor A. Bolotnov, **Multiple Bubble Boiling Simulation Scaling and Evaluation** Nov. 2020

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Yuqiao Fan, Roland Rzehak, **DNS Study of Lift and Drag Forces on Bubbles at High Shear Rates** (HZDR Contract No: 3725-001) Aug. 2020

Yuqiao Fan, David Pointer, **FY19 CASL Two-phase Model User Guide** Dec. 2019

Yuqiao Fan, Igor A. Bolotnov, Nam T. Dinh, **Debris Bed Formation and Coolability Task 4 Final Report** (NRC Contract No: NRC-HQ-60-16-T-001) Jun. 2019

JOURNAL/CONFERENCE PAPER/PROPOSAL REVIEWER

DOE PAMS proposal review
Annals of Nuclear Energy
International Topical Meeting on Nuclear Reactor Thermal Hydraulics (**NURETH**)
Advances in Thermal Hydraulics (**ATH**)
ANS general Conferences: Annual Meetings, Winter Meetings, Student Conferences

SKILLS

CFD method: Level-set • Eulerian-Eulerian • DNS • LES • RANS • Finite Element/Volume/Difference

CFD code: PHASTA • ANSYS-FLUENT • ANSYS-Polyflow • Star-CCM+ • Nek5000

MHD code: ANSYS-FLUENT-MHD module • COMSOL Multiphysics • HIMAG

Simulation: ICEM • Ansys Meshing • Cubit • NEAMS Workbench • COBRA-TF • MCNP • SAPPHIRE

Pre & Post processing: Simmodeler • Paraview (parallel) • VisIt • Tecplot

HPC system: FED servers/Libby (ORNL) • Insight/Henry (NCSU) • Cetus/Cooley/Theta (ANL)

Programming: FORTRAN (MPI) • bash • MATLAB • C • Python

Experiment: AutoCAD • SolidWorks • Machine shop • Calibration

Computer Literacy: Git • Anaconda • Spyder • svn • Latex • Linux • Microsoft Office Suite

PROFESSIONAL ACTIVITIES

Fusion Fuel Cycles and Blankets Workshop
Electric Power Research Institute (EPRI) May 2023

- Played as a presenter and key contributor in the workshop, shaping the 10-year roadmap for advancing fusion fuel cycles and blanket research.

Virtual Workshop Series on Fission Battery Initiative
Idaho National Laboratory and the National University Consortium Spring 2021

- Attended workshops on markets and economic requirements and technology innovations for fission batteries

2020 ALCF Computational Performance Virtual Workshop May 2020
Argonne National Laboratory

- Attended trainings to improve utilization of HPCs at ALCF

Nuclear Innovation Bootcamp
University of California, Berkeley Summer 2018

- Completed group project of starting an innovative company utilizing machine learning to reduce redundant labor cost in reactor power plants

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AWARDS, FELLOWSHIPS, & SCHOLARSHIPS

Finalist in the Your Science in a Nutshell competition, ORNL Summer 2023

- Distinguished participant in one of the most prestigious contests for early-career researchers, presenting *"Squeezing better performance out of fusion reactors"*

Best Talk in Nuclear Energy, ORNL May 2023

- Received the People's Choice Award during 2023 ORPA Research Symposium, an annual research symposium for researchers from ORNL and partner universities to share their research, presenting *"Helium Flow Visualization Simulation for Fusion Reactor Blanket First Wall Cooling"*

Mentored Teaching Fellowship, College of Engineering (COE), NCSU Jan. 2020

- Offered to only 10 teaching assistants in COE; award of $1,000

Graduate Merit Award, College of Engineering, NCSU Jul. 2017

- Offered to only 2-3 entering graduate students per department; award of $4,000

Outstanding Student Pacesetter, XJTU Nov. 2014

- Only 10 out of ~16,000 undergraduates awarded each year.
- The highest and the most prestigious honor for the students at XJTU.

National Scholarship, The Ministry of Education of China Sep. 2013, Sep. 2014

- Top 0.2%; award of 8,000 RMB

Meritorious Winner, Mathematical Contest in Modeling
Consortium for Mathematics & its Applications, USA Feb. 2014

- Top 9.7%; a three-person team solving an applied math problem by modeling and programming

SOCIETIES

Publication chair and technical program chair for ISFNT-16, 2025

Judge for GEM Tech Talk Competition 2023, invited by Office of Research Excellence at ORNL

Member of ORNL Women's Alliance Council since 2022

Session chairs for ANS conferences since 2020

Coordinator for the Keynote Speakers, 2020 ANS Student Conference

Member of American Nuclear Society since Mar. 2018

Financial Chair, NCSU Proposal Committee for 2019 ANS Student Conference