Khaled Talaat, Ph.D.

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EDUCATION

Ph.D. in Nuclear Engineering | University of New Mexico (Albuquerque, NM)
AUG 2019 –AUG 2022
Advisor: Prof. Osman Anderoglu

Dissertation title: "Computational methods, investigations, and codes to support corrosion experiments in molten lead and transfer to reactor conditions."

GPA: 4.19/4.33 (Equivalent to 4.0/4.0)

Honors: •Outstanding Graduate Student in Nuclear Engineering [1 of 2 students, 2021]
•Doctoral dissertation defense was passed with Distinction.

M.Sc. in Nuclear Engineering | University of New Mexico (Albuquerque, NM)
JUNE 2017 – MAY 2019
Master's en route to PhD

GPA: 4.20/4.33 (Equivalent to 4.0/4.0)

B.Sc. in Mechanical Engineering | Central Michigan University (Mount Pleasant, MI)
AUG 2013 – MAY 2016
GPA: 3.91/4.0 (Summa Cum Laude)

EXPERIENCE

Postdoctoral Scholar | Nuclear Engineering, UNM (Albuquerque, NM)
AUG 2022 – PRESENT
Faculty advisor: Prof. Minghui Chen.

I designed and modeled decay heat removal technology for FLiBe molten salt cooled reactors. My work involved formulation of semi-analytical 1D and 2D steady and transient models of heat transfer in the UCB Mark-1 pebble bed FHR reactor to optimize reactor cavity cooling system design for passive post-shutdown decay heat removal. I also performed thermal hydraulic downscaling analyses for experimentation. I also worked on extending my in-house developed general geometry neutronics-CFD coupling code "Anubis" to support parsing s(α, β) cross-sections in MCNP.

Graduate Research Assistant | Nuclear Engineering, UNM (Albuquerque, NM)
DEC 2018 – AUG 2022
Faculty advisor: Prof. Osman Anderoglu.

• I contributed investigations, methods, and codes to facilitate the transfer of out-of-pile flow accelerated corrosion experiments in molten lead at the UNM Lobo Lead Loop to reactor conditions. The work was funded by the DOE Versatile Test Reactor (VTR) project.

• Investigations included development of computational fluid dynamics (CFD) models of lead flow in the loop using STAR-CCM+ to characterize the flow conditions and shear stresses that the specimens are exposed to and design components such as specimen holders that sufficiently reduce pressure losses to allow for target flow rates to be achieved. I also investigated mass transport of corrosion products.

• I developed the Anubis framework in MATLAB (https://github.com/ktalaat/Anubis) which allows for geometry-blind, remote and local coupling of KCODE neutronics calculations in MCNP6 with conjugate heat transfer and CFD in OpenFOAM/StarCCM+. Anubis transfers the steady state unnormalized prompt power profile from MCNP to CFD and uses the calculated temperature field from CFD to update the cross-section library, densities, and surface parameters in MCNP based on pre-defined user input.

• I proposed and preliminarily demonstrated leveraging neutronics to monitor flow accelerated corrosion in lead cooled reactors through assessing the effect of mass transfer on the neutronics.

• I introduced the method of information entropy for convergence assessment to molecular dynamics simulations (originally developed by Forrest Brown for fission source convergence in Monte Carlo neutron transport calculations in MCNP).

• I developed collocated structured direct numerical simulation (DNS) solvers for Navier-Stokes equations that implemented fractional step method in cylindrical and Cartesian coordinates.

Graduate Research Assistant (visiting) | Human MR Imaging Laboratory, UNM (Albuquerque, NM)

AUG 2018 – AUG 2022

Faculty advisor: Prof. Stefan Posse.

• I worked towards characterizing high frequency resting-state functional magnetic resonance imaging (fMRI) signals in the brain.

• I introduced a new method for denoising high speed resting state fMRI data to suppress effects of motion and physiological noise without introducing artifacts in high frequencies (problem in the conventional approach). The method relies on spectrally segmented regression in multiple temporal windows. Work resulted in a patent application and a first author manuscript submitted to a journal.

• I developed TurboFilt which is a toolbox in MATLAB for processing and filtering multidimensional fMRI data that serves as a GUI-enabled testbed for new methods we introduce. The toolbox has many features such as the spectrally segmented regression method I introduced, frequency analysis, PCA regression, p-value maps, novel methods for automated physiological noise detection and FIR filtering, mask-based filtering, Gaussian smoothing, connectivity analysis, and simulation.

• I also contributed some post-processing tools for diffusion tensor spectroscopic imaging, and I am familiar with widely used tools such as medInria and LCModel.

Graduate Research Assistant | Institute for Space and Nuclear Power Studies, UNM (Albuquerque, NM)

MAY 2017 – AUG 2018

Faculty advisor: Prof. Mohamed El-Genk.

• We investigated discrepancies in bulk thermal conductivity estimates from molecular dynamics and worked towards development of systematic methodology to ensure consistent results.

• I studied the ability of different interatomic potentials of silicon to reproduce the dependence of thermal conductivity of silicon on temperature.

• I showed that non-linearities reported in bulk extrapolation of thermal conductivity in silicon above the mean phonon free path in non-equilibrium molecular dynamics simulations was artifactual in nature due

to neglecting the dependence of thermal conductivity on temperature and proposed a simple approach to mitigate these non-linearities relying on specifying a fixed temperature window for fitting for different system sizes.

Undergraduate Research Assistant | Central Michigan University (Mount Pleasant, MI)
AUG 2015 – JAN 2017
Faculty advisor: Prof. Jinxiang Xi.

• I conducted hundreds of simulations involving advanced geometry, discrete phase transport, and dynamic meshes of alveoli and human upper airways and contributed to manuscript writing.

• I wrote complex user-defined ANSYS Fluent functions in C to control the alveolar wall motion and mesh deformation mimicking real respiration.

PUBLICATIONS (H-INDEX: 11, CITATIONS > 500)

* INDICATES CORRESPONDING AUTHOR, ^ INDICATES EQUAL CONTRIBUTION

JOURNAL ARTICLES

20. Semi-two-dimensional transient modeling of decay heat removal to an external reactor cavity cooling system for a gFHR with effects of heat generation pattern
Nuclear Engineering and Design (Volume 419, 112956, 2024) IF = 1.92
Khaled Talaat, Minghui Chen

19. Design and Optimization of Molten Salt Printed Circuit Steam Generators
Applied Thermal Engineering (Volume 238, 122161, 2023) IF = 6.4
Mingfu He, Khaled Talaat, Minghui Chen

18. Design of a prototypical natural circulation water-based reactor cavity cooling system (RCCS) for a pebble-bed generic FHR
Nuclear Engineering and Design (Volume 407, 112303, 2023) IF = 1.92
Khaled Talaat*, Minghui Chen

17. Lagrangian investigation of convective mass transfer of dissolved elements at specimen boundaries in a flowing molten lead loop
Nuclear Science and Engineering (Volume 196, 1209, 2022) IF = 1.381
Khaled Talaat*, Osman Anderoglu

16. Development of Conceptual Lead Cartridge Design to Perform Irradiation Experiments in VTR
Nuclear Science and Engineering (Volume 196, 165, 2022) IF = 1.381
S. Jun Kim, Keith Woloshun, Joshua Richard, Jack Galloway, Cetin Unal, Jeffrey Arndt, Michael Ickes, Paolo Ferroni, Richard Wright, Osman Anderoglu, Cemal Cakez, Khaled Talaat, Shuprio Ghosh, Brandon Bohanon

15. Leveraging neutronics to monitor mass transfer corrosion in lead and lead bismuth cooled reactors
JOM (Volume 73, 4051, 2021) IF = 2.501
Khaled Talaat*, Osman Anderoglu

14. Design of specimen holders for flow accelerated corrosion experiments in molten lead with numerical evaluation of pressure losses

Nuclear Engineering and Design (Volume 385, 111522, 2021) IF = 1.92

Khaled Talaat, Md Mehadi Hassan, Cemal Cakez, Shuprio Ghosh, Brandon Bohanon, Keith Woloshun, Cetin Unal, Osman Anderoglu

13. A Comparison of CFPD, Compartment, and Uniform Distribution Models for Radiation Dosimetry of Radionuclides in the Lung

Journal of Radiological Protection (Volume 41, 739, 2021) IF = 1.559

Khaled Talaat, Adam Hecht, Jinxiang Xi [Nominated by editors for Bernard Wheatley Award for 2021]

12. Simulation of aerosol transmission on a Boeing 737 airplane with intervention measures for COVID-19 mitigation

Physics of Fluids (Volume 33, issue 3, 2021) IF = 4.980 [Featured Article]

Khaled Talaat ^, Mohamed Abuhegazy^, Omar Mahfoze, Osman Anderoglu, and Svetlana Poroseva

This article gained media coverage on Bloomberg, ZME Science, and KRQE.

11. Method of Information Entropy for Convergence Assessment of Molecular Dynamics Simulations

Journal of Applied Physics (Volume 128, 13, 2020) IF = 2.877

Khaled Talaat *, Benjamin J. Cowen, Osman Anderoglu

10. Numerical Investigation of Aerosol Transport in a Classroom with Relevance to COVID-19

Physics of Fluids (Volume 32, 103311, 2020) IF = 4.980 [Featured Article]

Mohamed Abuhegazy^, Khaled Talaat ^* (*equal contribution* and *corr-author*), Osman Anderoglu, and Svetlana Poroseva

This article gained media coverage on CNN, Reuters, Yahoo News, Business Insider, Healthline, Folha de S.Paulo, and others. See my UNM webpage for media links and interviews.

9. Extrapolation of Thermal Conductivity in Non-equilibrium Molecular Dynamics Simulations to Bulk Scale

International Communications in Heat and Mass Transfer (Volume 118,104880, 2020) IF = 6.782

Khaled Talaat, Mohamed S. El-Genk, Benjamin J. Cowen

8. Real-time Resting-State fMRI using Averaged Sliding Windows with Partial Correlations and Regression of Confounding Signals

Brain Connectivity (Volume 10, 448, 2020) IF = 2.657

Kishore Vakamudi, Cameron Trapp, Khaled Talaat, Kunxiu Gao, Bruno Sa De La Rocque Guimaraes, and Stefan Posse

7. Radiation dosimetry of inhaled radioactive aerosols: CFPD and MCNP transport simulations of radionuclides in the lung

Scientific Reports (Volume 9, 17450, 2019) IF = 4.996

Khaled Talaat, Jinxiang Xi, Phoenix Baldez, Adam Hecht

6. Thermal conductivity of silicon using reverse non-equilibrium molecular dynamics

Journal of Applied Physics (Volume 123, 205104, 2018) IF = 2.877
Mohamed S. El-Genk, Khaled Talaat, Benjamin J. Cowen

5. Computational modeling of aerosol transport, dispersion, and deposition in rhythmically expanding and contracting terminal alveoli

Journal of Aerosol Science (Volume 112, 19-33, 2017) IF = 3.433

Khaled Talaat, Jinxiang Xi

4. Numerical study of dynamic glottis and tidal breathing on respiratory sounds in a human upper airway model

Sleep and Breathing (Volume 22, 1–17, 2017) IF = 2.655

Jinxiang Xi, Zhaoxuan Wang, Khaled Talaat, Carri Glide-Hurst, Haibo Dong

3. Deposition of Bolus and Continuously Inhaled Aerosols in Rhythmically Moving Terminal Alveoli

The Journal of Computational Multiphase Flows (Volume 10, 178-193, 2018) IF (2020) = 1.23

(Special Issue on Simulation and Modelling in Nuclear Engineering)

Jinxiang Xi, Khaled Talaat, Xiuhua April Si

2. Airflow and Particle Deposition in Acinar Models with Interalveolar Septal Walls and Different Alveolar Numbers

Computational and Mathematical Methods in Medicine (Volume 2018, 3649391, 2018) IF = 2.809

Jinxiang Xi, Mohamed Talaat, Hesham Tanbour, Khaled Talaat

1. Visualization of local deposition of nebulized aerosols in a human upper respiratory tract model

Journal of Visualization (Volume 21, 225-237, 2018) IF = 1.974

Jinxiang Xi, Tiancheng Yang, Khaled Talaat, Tianshu Wen, Yu Zhang, Scott Klozik, Shannon Peters

SELECT CONFERENCE PROCEEDINGS/TRANSACTIONS

8. Influence of reactor cavity cooling system design parameters on heat transfer for a prototypical gFHR

20th International Topical Meeting on Nuclear Reactor Thermal Hydraulics - NURETH, Washington, D.C., Aug. 20-25, 2023
Khaled Talaat, Minghui Chen

7. Sensitivity study to investigate the influence of turbulence closure models on estimated shear stresses on rough specimens exposed to flowing molten lead

2021 ANS Winter Meeting and Nuclear Technology Expo, Washington, DC, Nov. 30-Dec. 3, 2021.
Khaled Talaat, Osman Anderoglu

6. Examination of Lead-Bismuth Corrosion of SS309 at High Velocities at 500 C

2021 ANS Winter Meeting and Nuclear Technology Expo, Washington, DC, Nov. 30-Dec. 3, 2021.
Jake Noltensmeyer, Brandon Bohanon, Khaled Talaat, Md Mehadi Hassan, Keith Woloshun, Stuart Maloy, Cetin Unal, Osman Anderoglu

5. Anubis: A Neutronics-Thermal Hydraulics Coupling Platform for Flow Accelerated Corrosion Modeling in Reactor Conditions

2020 ANS Winter Meeting and Nuclear Technology Expo, Chicago, IL, Nov. 15-19, 2020.
Khaled Talaat, Osman Anderoglu, Cetin Unal

4. Materials Compatibility with Flowing Molten Lead at 500 C

2020 ANS Winter Meeting and Nuclear Technology Expo, Chicago, IL, Nov. 15-19, 2020.
Osman Anderoglu, Cemal Cakez, Shuprio Ghosh, Khaled Talaat, Madhavan Radhakrishnan, Keith A. Woloshun, Cetin Unal, Stuart Maloy, Michael Ickes, Paolo Ferroni

3. Development of a Numerical Framework to Model flow Accelerated Corrosion in a Lead Loop

18th International Topical Meeting on Nuclear Reactor Thermal Hydraulics - NURETH, Portland, OR, Aug. 18-23, 2019
Khaled Talaat, Rubel Das, Brian Romero, Cemal Cakez, Osman Anderoglu, Sang Lee, Youho Lee, Heng Ban, Keith Woloshun, Seung Jun Kim, Dasari Rao, Cetin Unal

2. A low-power IoT framework: From sensors to the cloud

IEEE International Conference on Electro/Information Technology, 2016 (Grand Forks, ND)
Kevin Laubhan, Khaled Talaat, Sarah Riehl, Md Sayedul Aman, Ahmed Abdelgawad, Kumar Yelamarthi

1. A four-layer wireless sensor network framework for IoT applications

2016 IEEE 59th International Midwest Symposium on Circuits and Systems (Abu Dhabi, UAE)

Kevin Laubhan, Khaled Talaat, Sarah Riehl, Tony Morelli, Ahmed Abdelgawad, Kumar Yelamarthi

PATENT APPLICATIONS

Methods for Noise Removal in Functional MRI using Spectrally Segmented Regression of Motion Parameters and Physiological Noise

U.S. and International Patent Application PCT/US2022/038740 (Filed in 2022)
Stefan Posse, Khaled Talaat

PEER-REVIEW SERVICE

- Physics of Fluids [#1 journal in fluid mechanics: invited > 15 times and reviewed 9 times]
- Nuclear Engineering and Design [Multiple times]
- Nuclear Science and Engineering
- Progress in Nuclear Energy
- JOM
- 19th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-19)
- 2021 American Nuclear Society Winter Meeting and Nuclear Technology Expo

OTHER SERVICE AND EXPERIENCE

- *Journals:* Guest Associate Editor, Frontiers in Nuclear Engineering (Aug 2022 – Feb 2023)

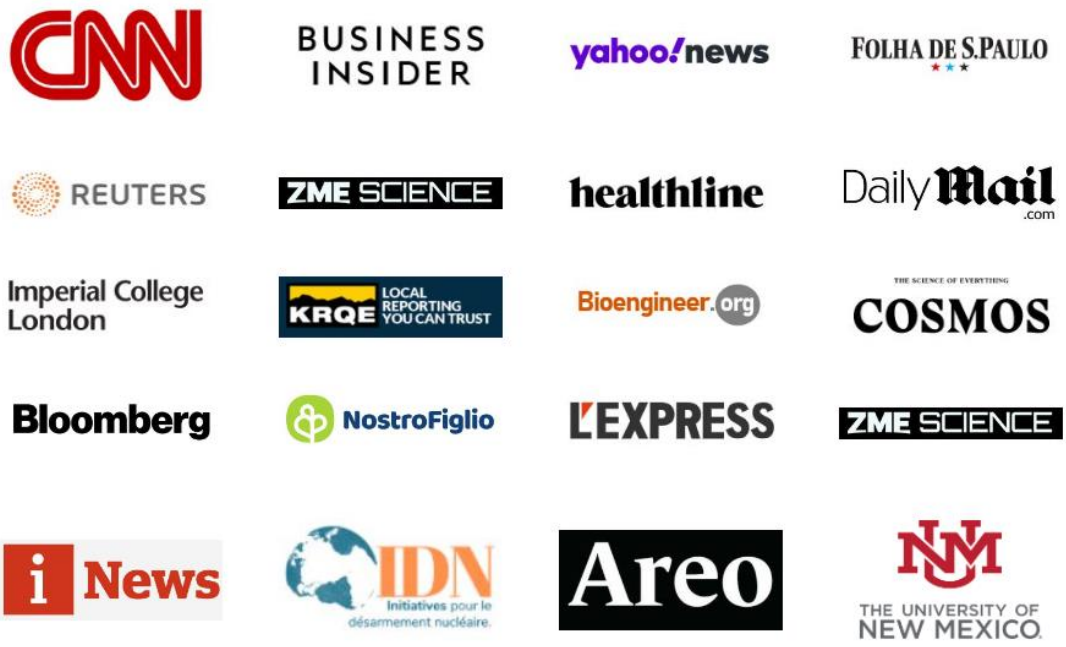
• *Conferences:* Session co-chair, Computational Thermal Hydraulics IV, 2021 American Nuclear Society Winter Meeting and Nuclear Technology Expo, Washington, D.C., Nov. 30-Dec. 3, 2021
• *Science communication:* I wrote multiple invited articles for Tablet Magazine on different subjects relating to nuclear energy and non-proliferation of nuclear weapons and dual-use biological research including one on the 75th anniversary of Hiroshima. My articles received positive feedback from scientists and were quoted by leading public figures.
• *Teaching experience:* I taught 2 invited guest lectures in NE 311: Intro to Transport Phenomena class with focus on fluid mechanics and heat transfer and an invited guest lecture in NE 515: MR Imaging and Spectroscopy at the University of New Mexico, Albuquerque. I have also delivered multiple seminars in both nuclear and mechanical engineering departments. I have additionally also contributed to workshops such as the International Workshop on Spallation Materials Technology 15, March 5-9 2023 (Santa Fe, NM) as a presenter.
• *Funding:* Contributor in a funded NIH Small Business Technology Transfer (STTR) grant. I was also co-PI on a DOE NEUP grant (not funded) and have also assisted in drafting other NEUP proposals without a formal role as a student.

SCIENTIFIC SOFTWARE

• Anubis: A semi-modular, geometry-blind, and multi-server loose coupling utility that iteratively maps temperature and energy field effects between Monte Carlo neutronics simulations in MCNP6 and thermal hydraulics in OpenFOAM or STAR-CCM+ until convergence criteria are met. It accounts for effects of Doppler broadening of cross-sections, density changes, surface expansion, and effects of power distribution on temperature. Coupling between MCNP and CFD codes may be done locally, or between two remote servers, or a hybrid local-remote configuration. I am the sole developer of Anubis.
• TurboFilt*:* A 10,000 line GUI-enabled toolbox for processing and denoising of fMRI data. The toolbox has many features such as frequency analysis, principal component analysis based regression, p-value maps, novel methods for automated physiological noise detection and FIR filtering, mask-based filtering, Gaussian smoothing, connectivity analysis, and simulation. It also implements a novel patent-pending method I introduced for denoising fMRI data relying on spectrally segmented regression of nuisance parameters. I am the sole developer of TurboFilt, although the work has benefited from some contributions by coworkers.
• S.W.A.T: A toolbox for simulation of real-time nuisance regression and sliding window correlation of fMRI signals. The code features a GUI and a macro system with an in-house developed mark-up language. The toolbox extends on simulation work done by Cameron Trapp under the supervision of Dr. Stefan Posse.
• IoT CMU: A web service developed for my undergraduate senior design project which features a dynamic user system. Users could associate their account with multiple hubs to which many multi-sensor nodes can be wirelessly connected. The web service provides APIs to allow hubs to send sensor data, and it visualizes the output to the user in real-time using AJAX and Google Charts.
• Deterministic neutron transport solvers: I developed multiple neutron transport solvers for various graduate-level course projects. This included 2D Sn neutron transport equation solver in C++ which implements discontinuous galerkin finite element method verified to be third order accurate by the method of manufactured solutions, a 1D Sn solver with diffusion synthetic acceleration, an analytical Sn solver, and a Peierl's equation solver under the guidance of Dr. James Warsa from Los Alamos National Laboratory. I have also developed multi-region neutron diffusion equation solvers with first-order perturbations based on adjoints, two energy group multi-region solvers, and multi-region Sn solver with albido and incident source boundary conditions that implements diamond differencing. The codes used numerical libraries like Eigen.

• Computational fluid dynamics solvers: I developed various parallelized, structured and semi-collocated CFD solvers (2D and 3D) on Cartesian and cylindrical coordinates. The codes implement Adam-Bashforth method for the convection terms, Crank-Nicolson for time stepping, and fractional step method for factorization and line-by-line solution. Some versions of the codes also implemented a one-way coupled scalar transport equation solver for heat and mass transfer problems using the resulting velocity field from the Navier Stokes solver as input. The HYPRE library from LLNL is used for parallel solution of Ax = b equations. The codes were validated against famous benchmark problems like the lid driven cavity.
• Various thermal hydraulic codes: I developed multiple codes for reactor design problems including 1D and 2D steady and transient RCCS design codes which optimize reactor cavity cooling system design and account for thermal conductance, radiation heat transfer, and convection in the RCCS water, all with temperature dependent properties. I have also developed a PWR design code that implemented genetic search algorithms to search for PWR reactor designs that meet economic and thermal hydraulic constraints on heat flux, fuel temperature, cladding temperature, coolant exit temperature, coolant flow rate, fuel rod diameter, total reactor thermal power, and reactor dimensions. The code is capable of iteratively solving coupled material/thermal hydraulics equations that incorporate temperature-dependent thermal conductivity and specific heat. The program can further calculate and apply hotspot factors, determine radial and axial temperature distributions within the hottest fuel rod, and evaluate the axial CHFR distribution. In addition, the software automatically arranges and visualizes fuel bundles within the reactor, ensuring that the nearest rod to the vessel is at least half a bundle width away.
• Diffusion tensor spectroscopic imaging: I developed various codes in a DTSI post-processing pipeline to interpolate spectra, parse LCModel output, and spatially filter metabolite concentration in the brain for processing in medInria to estimate the diffusion tensor. The codes allowed for examining short bandwidth spectra.

FEATURED ON



Media links can be found on my web page.