Opportunity Title: Physics Based Models for Power and Propulsion Innovations using High Performance Computing
Opportunity Reference Code: ARL-R-WMRD-300125-WS

Organization DEVCOM Army Research Laboratory

Reference Code ARL-R-WMRD-300125-WS

Description **About the Research**

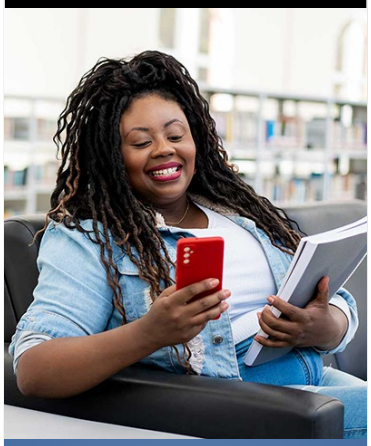
The US Army Research Laboratory, Mechanical Sciences Division, conducts basic and applied research in Turbine Power and Propulsion to address far-term science and technology challenges that are envisioned for the future battlefield environment in Multi-Domain Operations (MDO). Energy and Propulsion, is one key thrust area conducting exploratory fundamental research in propulsion sciences for Army gas turbine engines and hypersonic weapon systems to enhance its durability, performance for self-sustainability, and high power density under extreme battlefield operating conditions. An important component is the development of novel physics based models, high-fidelity simulation, and machine learning capabilities to understand the fundamental physics and also to explore the design space of next generation disruptive propulsion platforms. This research associateship is a critical part of on-going mission programs towards developing innovative propulsion technologies, including adaptive turbine propulsion, pressure gain combustion, and morphing hypersonic systems for current and future Army vehicles. This research will focus on the development of new physics based computational fluid dynamic models to be deployed on DoD leadership High Performance Computing (HPC) facilities leveraging exceptional resources and teaming with internal and cross-directorate experts in mechanical and computational sciences. This position will also involve collaborations with leading OEMs and academia. The models developed will have direct links to experimental facilities at ARL Weapons and Materials Research Directorate as well as external facilities for validation and concept vetting efforts.

Research proposals are invited that advance first principle and engineering models for compressible fluid-dynamics, particle-laden turbulence [1], fluid structure interactions [2], and conjugate heat transfer, including Direct Numerical Simulation (DNS), Large Eddy Simulation (LES), or RANS approaches. Many of our technical challenges can be found in published review journals [3]. New methods in machine learning are sought that can leverage the large databases produced by our simulations to extract new insights of physical systems as well as guide optimization and design space exploration. Data reduction and in-situ visualization techniques are also desired for big data processing (TBs) and interpretation/presentation of scientific data. The areas of technical interest include, but are not limited to, interface-tracking methods (e.g., VOF, LS), hybrid methods (Eulerian-Lagrangian); chemical kinetic models based on finite rate chemistry, tabulated kinetic models, or novel methods that improve the computational CPU cost; and fluid-structure-interaction (FSI) models for jet engine and hypersonic system optimization under off-design conditions.

The candidate will have a deep knowledge of computational fluid dynamics (CFD) model development, mesh generation techniques, turbulence

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models, MPI protocols, High Performance Computing and scalability analysis for massively parallel computations. The team will work closely with ARL staff in the Weapons and Materials Research Directorate, as well as cross-directorate collaboration from Computational & Information Science Directorate to closely interact with the data analysis and scientific visualization team, and HPC scientists. Data visualization hardware and software resources mentioned in [4] will be available to the candidate. The nature of the research will also require establishing close collaborations with experimentalists from ARL, and relevant external partners from academia, industry and national laboratories.

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ARL Advisor Email: luis.g.bravorobles.civ@army.mil

About Weapon Sciences (WS)

Internal, transitional, and external ballistics; launch, flight, control, and navigation of guided weapons and aerial systems; development of novel weapon concepts.

About ARL-RAP

The Army Research Laboratory Research Associateship Program (ARL-RAP) is designed to significantly increase the involvement of creative and highly trained scientists and engineers from academia and industry in scientific and technical areas of interest and relevance to the Army. Scientists and Engineers at the CCDC Army Research Laboratory (ARL) help shape and execute the Army's program for meeting the challenge of developing technologies that will support Army forces in meeting future operational needs by pursuing scientific research and technological developments in diverse fields such as: applied mathematics, atmospheric characterization, simulation and human modeling, digital/optical signal processing, nanotechnology, material science and technology, multifunctional technology, combustion processes, propulsion and flight physics, communication and networking, and computational and information sciences.

A complete application includes:

- **Curriculum Vitae or Resume**
- **Three References Forms**
  - An email with a link to the reference form will be available in Zintellect to the applicant upon completion of the on-line application. Please send this email to persons you have selected to complete a reference.
  - References should be from persons familiar with your educational and professional qualifications (include your thesis or dissertation advisor, if applicable)
- **Transcripts**
  - Transcript verifying receipt of degree must be submitted with the

application. Student/unofficial copy is acceptable

If selected by an advisor the participant will also be required to write a **research proposal** to submit to the ARL-RAP review panel for :

- Research topic should relate to a specific opportunity at ARL
- The objective of the research topic should be clear and have a defined outcome
- Explain the direction you plan to pursue
- Include expected period for completing the study
- Include a brief background such as preparation and motivation for the research
- References of published efforts may be used to improve the proposal

A link to upload the proposal will be provided to the applicant once the advisor has made their selection.

Questions about this opportunity? Please email ARLFellowship@orau.org

Point of Contact ARL-RAP

Eligibility Requirements

- **Degree:** Bachelor's Degree, Master's Degree, or Doctoral Degree.
- **Academic Level(s):** Any academic level.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Engineering** (27 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Physics** (16 👁)
- **Age:** Must be 18 years of age