SALVADOR REY GOMEZ

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EDUCATION

California Institute of Technology — **Pasadena, California**
Ph.D., Aeronautics (GPA 4.1/4.0) — *September, 2023*
M.S., Aeronautics (GPA 4.1/4.0) — *June, 2019*

University of California, Berkeley — **Berkeley, California**
B.S. Mechanical Engineering, Minor in Physics (GPA 3.76/4.0) — *May, 2018*

Relevant Coursework: Continuum Mechanics, General Fluid Mechanics, Hydrodynamic Stability, Turbulence, Microscale Fluid Mechanics, Computational Fluid Dynamics, Advanced Fluid Mechanics, Biofluids, Ocean Dynamics, Statistical Mechanics, Quantum Mechanics, Nonlinear Dynamics, Calculus of Variations, Linear Analysis, Asymptotic Analysis

RESEARCH EXPERIENCE

Postdoctoral Researcher — *November 2023 - Present*
Advisor: Professor Parviz Moin
Center for Turbulence Research, Stanford University

- *Control Through Wall Oscillations*
  Performing direct numerical simulations of turbulent flow fields with flow control methodologies from the surface. These include spanwise oscillations, which have been shown to be drag reducing, and temporal oscillations from the wall. These simulations illustrate how the near wall structures behave when actuated by the wall forcing.

Graduate Research Assistant — *June 2019 - Present*
Advisor: Professor Beverley J. McKeon
Graduate Aerospace Laboratories of the California Institute of Technology

- *Global Resolvent Analysis of Streamwise Developing Boundary Layers*
  Resolvent analysis is an equation based modal technique that has been used as a reduced order model for turbulent flows. In this work, the resolvent analysis is extended to streamwise developing flows to incorporate the wall normal component and evolution of the mean to study the nonequilibrium effects of adverse pressure gradients and history in the boundary layers.
  - Discretized the linearized Navier Stokes Operator to create a resolvent operator that resolves both the wall normal and streamwise directions.
  - Implemented algorithms to compute the linear algebra operations efficiently, through methods such as the Arnoldi Method.
  - Identified self similar scaling of the resolvent operator based on observed self similarity in the canonical mean profiles.
  - Demonstrated that aspects of the turbulent statistics can be predicted from the linearized dynamics.
- *Resolvent Analysis of High Enthalpy Boundary Layers*
  Resolvent analysis is extended to a high enthalpy boundary layer in chemical nonequilibrium. The effect of the chemical source terms and species diffusion on linear amplification is compared to ideal gas flows.
  - Linearized the governing equations and chemistry models about a mean flow and thermodynamic state.
  - Investigated the choice of norm in the presence of ions in mixture to compare with a single species flow.
  - Developed a method to efficiently and adaptively identify the regions in spectral space with largest resolvent gain based on Bayesian Optimization.
- *Variational Resolvent Analysis*
  We describe a method that allows approximation of the resolvent modes through calculus of variations and a predefined basis. Using r basis elements, this technique has an overall computational cost of $\mathcal{O}(r^3)$ compared to the traditional computational cost of $\mathcal{O}(n^3)$ associated with resolvent analysis when discretized over $n > r$ grid points.
  - Validated the method by comparing with traditionally computed global resolvent modes of a turbulent boundary layer.
  - Estimated the error bounds of the approximation.

Research Assistant — *May 2018 - February 2020*
Advisor: Dr. Robert M. Glaeser, Dr. Maxim Armstrong
University of California, Berkeley

- *Microscale Fluid Behavior During Cryo-EM Sample Blotting*
  To prepare samples for cryo-electron microscopy, samples are blotted with filter paper to remove the excess aqueous solution before vitrification. Blotting is a standard process creates vitreous ice with inconsistent thickness that complicates the optics. High-speed interference contrast microscopy was used to visualize the blotting and liquid solution.
  - Prepared samples by creating a hydrophilic surface, applying aqueous solution, and stained filter paper with Rhodamine B to aid in visualization
  - Created models to test the microfluidics of the droplet on the sample

Research Assistant *June 2017 - August 2017*
Advisor: Professor Mark Kasevich
Stanford University

- *Influence of Black Body Radiation on an Equivalence Principle Test*
  The atom interferometer at the Kasevich Lab is designed to measure differences in accelaration down to a precision of $10^{-15}g$. Due to the presence of gradients in blackbody radiation, some atoms are found to have an external forces due to this gradient. In order to mitigate this effect, the black body radiation within the interferometer must be predicted.
  - Modeled the interferometer on COMSOL to predict the blackbody radiation field and determined heat loads to reduce the gradient in the radiation field
  - Numerically integrated the accumulated phase due to the force as an experimental error bound

TEACHING EXPERIENCE

Head Teaching Assistant Ae201a: Advanced Fluid Mechanics, Professor Dale Pullin, *California Institute of Technology*, October, 2021 - Present

Head Teaching Assistant Ae150: Aerospace Engineering Seminar, Professor Dan Meiron, *California Institute of Technology*, October, 2019 - June, 2020

Engineering and Physics Tutor Center for Access to Engineering Excellence, *University of California, Berkeley*, October, 2017 - May, 2018
Courses Tutored: Dynamics, Fluid Dynamics, Calculus, Multivariable Calculus, Linear Algebra, Quantum Mechanics

Instructor Winter Academic Training Camp, *Hispanic Engineers and Scientists, University of California, Berkeley*, Winter 2016, Winter 2017
Duties: Organized 10 day winter retreat for freshman and sophomores in the Hispanic Engineers and Scientists club to prepare students for their Spring term classes. Taught a course on infinite series and a course on kinematics and vectors. Organized assignments and final exam

Instructor DaVinci Camp Summer Institute, *University of California, Berkeley, Stanford University, California Institute of Technology*, Summer 2015, Summer 2016, May-June 2017
Duties: Taught middle and high school students algebra at an accelerated pace, organized lesson plans, field trips, and lab tours

PUBLICATIONS

- **Gomez, S. R.**, Linear amplification in nonequilibrium turbulent boundary layers. *California Institute of Technology, Thesis*, 2023
- **Gomez, S. R.**, McKeon, B. J., Linear amplification of large scale structures in adverse pressure gradient turbulent boundary layers through resolvent analysis. *Progress in Turbulence X: Proceedings of the iTi Conference in Turbulence*, 2023; (submitted)
- **Gomez, S. R.**, Williams, C., Di Renzo, M., Schmid, P., McKeon, B., Adaptive resolvent analysis with application to high enthalpy flows. *Center for Turbulence Research, Proceedings of the Summer Program*, 2022;
- Barthel, B., **Gomez, S. R.**, McKeon, B. J., The role of an optimal modeling basis in variational resolvent analysis. *Turbulence and Shear Flow Phenomena*, 12, 2022;
- Barthel, B., **Gomez, S. R.**, McKeon, B. J., Variational formulation of resolvent analysis. *Physical Review Fluids*, 7, 2022; 013905
- Armstrong M., Han B.G., **Gomez S. R.**, Turner J., Fletcher D.A., Glaeser R.M., Microscale fluid behavior during cryo-EM sample blotting. *Biophysical Journal*, 2020;118(3):708-19.

PRESENTATIONS

- **Gomez, S. R.**, McKeon, B. J. , History effects in adverse pressure gradient turbulent boundary layers through resolvent analysis. *Bulletin of the American Physical Society*, 2023.

- **Gomez, S. R.**, McKeon, B. J. , Linear amplification of large scale structures in adverse pressure gradient turbulent boundary layers through resolvent analysis. *iTi Conference*, 2023.
- **Gomez, S. R.**, Williams, C., Di Renzo, M., Schmid, P., McKeon, B. J. , Adaptive resolvent analysis: Application to high enthalpy boundary layers. *Bulletin of the American Physical Society*, 2022.
- **Gomez, S. R.**, Global resolvent analysis for turbulent boundary layers: Self similarity of the resolvent modes and an inverse-free resolvent approach, *UCLA Fluid Mechanics Seminar Series*, 2022.
- **Gomez, S. R.**, McKeon, B. J., Self similarity in 2D resolvent analysis for developing turbulent boundary layer flows. *Bulletin of the American Physical Society*, 2021.
- **Gomez, S. R.**, Science Journey: "Fluid dynamics: From disturbances to turbulence", *California Institute of Technology*, 2020.

AWARDS

- USNC/TAM Outreach Fellow (January 2024): Part of a cohort of academics and industry professionals with doctoral research in solid mechanics or fluid mechanics that engage in nationwide virtual outreach activities on mechanics with K-12 classrooms.
- Charles D. Babcock Award (June 2022): Recognizes a student whose achievements in teaching (or other ways of assisting students) have made a significant contribution to the Aeronautics Department.
- Charles D. Babcock Award (June 2020): Recognizes a student whose achievements in teaching (or other ways of assisting students) have made a significant contribution to the Aeronautics Department.
- Rolf D. Buhler Memorial Award in Aeronautics (June 2019): Awarded to a student in the Aeronautics Master's Program whose academic performance was exemplary and who shows high potential for future achievements at Caltech