Vedant Dobwal

Undergraduate Researcher — Theoretical Physics and Mathematics

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Education

Indian Institute of Science Education and Research (IISER) Bhopal Ongoing
BS–MS (Natural Sciences)
Intended Major: Mathematics

Indian Institute of Technology (IIT) Guwahati Concurrent
Certificate Program — Data Science & Artificial Intelligence

Research Experience

Independent Theoretical Research — Plasma Physics & Nonlinear Dynamics (2024–Present)
Focus: Maxwell-compatible dynamical frameworks, controlled chaos, emergent geometry, MHD theory.

- Developed a novel theoretical model exploring the role of guided chaotic behavior in stabilizing plasma confinement domains.
- Formulated perturbative extensions consistent with Maxwell's equations and conservation principles.
- Analyzed transitions between diffusive and localized attractor regimes and proposed implications for confinement physics.

Derivation of Controlled-Chaos Framework in Maxwell–MHD Systems

- Derived stabilization-like terms from the electron momentum equation and generalized Ohm's law.
- Clarified physical interpretation of perturbative control fields and their influence on stability.
- Produced technical notes to support transparency and reproducibility of derivations.

Fluid–Structure Dynamics & Vestibular Modelling (2025)
Focus: Contraction-based analysis, symmetry breaking, reduced fluid–structure models.

- Re-analysed a recent reduced semicircular-canal model (J. Fluid Mech., 2025) from a dynamical-systems viewpoint using a scalar specialisation of a general contraction criterion.

- Proved global exponential contraction of the reduced cupular pressure dynamics with an explicit rate and derived small-/large-stiffness asymptotics explaining velocity- vs. acceleration-tracking regimes.
- Established an algebraic stiffness threshold at which asymmetric flow corrections dominate the symmetric axial velocity, providing a quantitative condition for symmetry breaking without loss of well-posedness.

Neutral Geometry and Necessary Conditions for Chaos in Dynamical Systems
Preprint 2025-2026

- Developed a geometric constraint framework for smooth autonomous dynamical systems based on instantaneous metric deformation induced by the symmetric Jacobian.
- Established necessity results for invariant sets, recurrence, bifurcations, and chaotic dynamics via a coordinate-invariant partition into contractive, stretch, and neutral regions.
- Derived dimension bounds on invariant sets and a planar reduction yielding a scalar discriminant formulation recovering classical bifurcations without spectral analysis.

On a Circulation Functional Associated with Planar Vector Fields
Preprint 2025-2026

- Introduced a scalar circulation functional based on the symmetric part of the Jacobian to measure accumulated tangential metric deformation along closed curves in planar dynamical systems.
- Established structural results linking zeros and higher-order vanishing of the functional to existence, stability, and multiplicity of limit cycles via a geometric degeneracy index.
- Derived degree-dependent bounds for polynomial vector fields and demonstrated consistency with classical settings including Hopf-type systems, Liénard systems, and near-Hamiltonian perturbations.

Conferences & Highlights

- Feature — MIT OpenCourseWare (MIT OCW), News & Media, Massachusetts Institute of Technology (2026): ocw.mit.edu.
- NUPC conference presentee : https://www.linkedin.com/in.

Skills

Mathematics: Nonlinear dynamics, differential equations, dynamical systems, multivariable calculus.

Physics: Plasma physics, magnetohydrodynamics, electrodynamics, theoretical modeling.

Computational: Python (NumPy, Matplotlib), LaTeX, Jupyter.

Research: Scientific writing, preprint preparation, independent theoretical formulation.

Affiliations & Activities

- IISER Bhopal — Undergraduate Researcher
- American Physical Society — Student Member
- NASA Citizen Science Volunteer
- Coursework and academic enrichment through CERN, University of Pennsylvania, UCL/UK learning programs