

# Amit Chaudhari

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## About Me

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I am a finishing PhD researcher in computational chemistry at Cardiff University, where I integrate discriminative and generative AI with quantum mechanical modelling, to develop cost-effective and transferable workflows for materials modelling. I am part of an interdisciplinary collaboration between quantum chemistry and experimental industry (Johnson Matthey and bp, through the bp-ICAM) and academia (University of Manchester), aiming to advance the fundamental understanding of complex catalytic materials for clean and sustainable energy production.

## Education

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**PhD, Computational Chemistry**, Cardiff University Oct 2021 – Oct 2025

- Group of Dr Andrew Logsdail: integrating AI and quantum chemistry for atomistic materials modelling, including machine learned DFT+ $U$  projectors, interatomic potentials and meta-GGA functionals

**MSc, Molecular Modelling: Distinction**, University College London Sept 2020 – Sept 2021

- Group of Sir Richard Catlow: simulating small molecule activation on supported nanocluster catalysts using DFT+ $U$  and geometric/electronic descriptors

**MEng, Chemical Engineering: 2.1**, University of Birmingham Sept 2016 – June 2020

- Group of Professor Gary Leeke: designing nanoparticle catalyst preparation methods using supercritical fluids, guided by empirical solubility models and validated using electrochemical characterisation

## Skills and Experience

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### Quantum Chemistry

- Density functional theory (GGA, meta-GGA, hybrid-DFT, DFT+ $U$ ), with/without dispersion corrections and spin polarisation: **VASP**, **FHI-aims**, **PySCF**
- Testing deorbitalisation strategies for meta-GGA DFT in FHI-aims through source-level modifications: **Fortran90**
- High performance computing using CPU and GPU nodes on the UK (ARCHER2) and Welsh (Hawk, Isambard) national supercomputers: **Linux**
- Structure generation and structural fingerprints: **ASE**, **Pymatgen**, **DShuffle**

### Deep Learning

- Fine-tuning and inferencing foundation model machine learned interatomic potentials: **MACE**
- Constructing neural network meta-GGA exchange-correlation functionals: **PyTorch**, **Pylibxc**
- Generative approaches for inverse catalyst design *e.g.*, latent diffusion models: **PyTorch**, **PyTorch-Geometric**

### Workflows for High-Dimensional Optimisation

- Symbolic regression and support vector machines: **SISSO**, **PySR**, **gplearn**, **Scikit-learn**
- Dimensionality reduction *e.g.*, PCA, K-means clustering: **Scikit-learn**
- Bayesian optimisation, Monte Carlo sampling and LLMs: **GPyOpt**, **SuSMoST**, **GPT-4o**, **Mathstral-7B**

## Publications

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**Machine learning generalised DFT+ $U$  projectors in a numerical atom-centred orbital framework**

Amit Chaudhari, Kushagra Agrawal, Andrew Logsdail: <https://doi.org/10.26434/chemrxiv-2025-332z0>

**Polymorph-induced reducibility and electron trapping energetics of Nb and W dopants in TiO<sub>2</sub>**

Amit Chaudhari, Andrew Logsdail, Andrea Folli: <https://doi.org/10.26434/chemrxiv-2025-k90kd-v3>

## Ongoing Projects

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- Multiscale modelling (Monte Carlo sampling and machine learned interatomic potentials) and experimental investigation of catalyst poisoning for green H<sub>2</sub> production
- Constructing deorbitalised meta-GGA exchange-correlation functionals using deep learning
- Integrating explainable and generative AI approaches for inverse catalyst design

## Selected Oral Presentations

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<b>Machine learning generalised DFT+<i>U</i> projectors in a numerical atom-centred orbital framework:</b> Psi-k and NCCR MARVEL Workshop on the Determination of Hubbard Parameters	Sept 2025 (Upcoming)
<b>AI for scalable quantum chemical simulations – from DFT+<i>U</i> to orbital-free meta-GGAs:</b> BIOVIA (Dassault Systèmes)	Aug 2025 (Upcoming)
<b>Machine learning algorithms for simulating realistic catalytic reaction environments:</b> Johnson Matthey and bp	Jan 2025
<b>Machine learning the DFT+<i>U</i> projectors to model polarons in energy materials:</b> FHI-aims UK Developers' and Users' Meeting and the Materials Chemistry Consortium Conference	May/July 2024
<b>Combining DFT, global optimisation and machine learning to understand metal oxide support effects in catalysis:</b> Johnson Matthey	May 2024
<b>Accurate modelling of n-type doped TiO<sub>2</sub> polymorphs using DFT+<i>U</i> with occupation matrix control:</b> Materials Chemistry Consortium Workshop on the Modelling Point Defects	Jan 2024
<b>Sustainable Catalysis for Clean Growth- Advanced Methods Overview:</b> bp International Centre for Advanced Materials Annual Conference	Oct 2023

## Selected Poster Presentations

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<b>Towards a transferable kinetic energy density functional using symbolic regression and large language models:</b> CECAM Machine Learning for Materials Discovery workshop	May 2025
<b>Machine learning generalised DFT+<i>U</i> projectors to model polarons in catalyst and battery materials:</b> Thomas Young Centre 7th Energy Materials workshop	July 2024
<b><i>Ab initio</i> adsorption phase diagrams using DFT-parameterised Monte Carlo methods:</b> STFC CCP5 Annual General Meeting	Sept 2023

## Supervision and Funding Awards

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- STFC CCP5 Postgraduate Industrial Secondment worth £2248.80 supporting placement at Johnson Matthey Technology Centre, Sonning Common, UK
- Supervised research students as part of Nuffield and MChem projects

Updated 12/07/2025