# Shezad Mohamed

INFORMATION

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RESEARCH

The model theory and geometry of fields with operators.

EDUCATION

**University of Manchester**
PhD in Mathematics, September 2020–May 2024
Thesis: *A contribution to the model theory of fields with free operators.*
Supervisor: Omar León Sánchez

**University of Oxford**
MMath in Mathematics, 2016–2020
Thesis: *Aspects of Stone duality for Boolean algebras.*
Supervisor: Hilary Priestley

PREPRINTS

*Neostability transfers in derivation-like theories*, (with Omar León Sánchez).
Submitted for publication in **Model Theory**. 18 pages
arxiv.org/abs/2409.11248

Motivated by structural properties of differential field extensions, we introduce the notion of a theory $T$ being derivation-like with respect to another model-complete theory $T_0$. We prove that when $T$ admits a model-companion $T_+$, then several model-theoretic properties transfer from $T_0$ to $T_+$. These properties include completeness, quantifier-elimination, stability, simplicity, and $\mathrm{NSOP}_1$. We also observe that, aside from the theory of differential fields, examples of derivation-like theories are plentiful.

*The uniform companion for fields with free operators in characteristic zero.*
Accepted for publication in the **Journal of the London Mathematical Society**. 28 pages
arxiv.org/abs/2311.01856

Generalising the uniform companion for large fields with a single derivation, we construct a theory $\mathrm{UC}_{\mathcal{D}}$ of fields of characteristic 0 with free operators—operators determined by a homomorphism from the field to its tensor product with $\mathcal{D}$, a finite-dimensional $\mathbb{Q}$-algebra—which is the model companion of any theory of a field with free operators whose associated difference field is difference large and model complete. Under the assumption that $\mathcal{D}$ is a local ring, we show that simplicity is transferred from the theory of the underlying field to the theory of the field with operators, and we use this to study the model theory of bounded, PAC fields with free operators.

*The Weil descent functor in the category of algebras with free operators.*
**Journal of Algebra**, 640:216–252, 2024

We prove that there exists a version of Weil descent, or Weil restriction, in the category of $\mathcal{D}$-algebras. The objects of this category are $k$-algebras $R$ equipped with a homomorphism $e\colon R \to R \otimes_k \mathcal{D}$ for some fixed field $k$ and finite-dimensional $k$-algebra $\mathcal{D}$. We do this under a mild assumption on the so-called associated endomorphisms. In particular, this yields the existence of the Weil descent functor in the category of difference algebras, which, to our knowledge, does not appear elsewhere.

**UNPUBLISHED NOTES**

*Commuting operators as an instance of iterative generalised Hasse–Schmidt rings.*

We show that fields with free operators (in the sense of Moosa and Scanlon's "Model theory of fields with free operators in characteristic zero") whose operators pairwise commute can be seen as an instance of iterative $\mathcal{D}$-rings (in the sense of the same authors' "Generalised Hasse–Schmidt varieties and their jet spaces").

**TALKS**

*Abstract independence relations and derivation-like theories.*
British Mathematical Colloquium, University of Manchester, June 2024

*The uniform companion for theories of difference large fields with free operators.*
LYMoTS, University of Leeds, January 2024

*Very slim differential fields.*
Final Geomod Conference, University of Freiburg, November 2023

*The uniform companion for large fields with free operators.*
London Logic Seminar, Imperial College London, November 2023

*The uniform companion for large fields with free operators.*
One-day workshop in Model Theory and Algebra, University of Manchester, January 2023

*The Weil descent functor in the category of algebras with free operators.*
Algebra Seminar, University of Manchester, October 2022

*The Weil descent functor in the category of $\mathcal{D}$-algebras.*
Joint LYMoTS/SEEMOD meeting, University of Manchester, May 2022

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| TEACHING | **Algebraic Structures 1, 2020**<br>Teaching assistant. ~25 students. |
| | **Programming with Python, 2021**<br>Teaching and programming assistant. ~50 students. |
| | **Algebraic Structures 1, 2021**<br>Teaching assistant. ~25 students. |
| | **Contingencies 1, 2022**<br>Teaching and programming assistant. ~25 students. |
| | **Probability 1, 2022**<br>Teaching assistant. ~15 students. |
| | **Introduction to Mathematica, 2023**<br>Teaching and programming assistant. ~50 students. |
| | **0B1: Calculus and Algebra, 2023**<br>Led problem sessions. ~25 students. |

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| ACTIVITIES | *British Postgraduate Model Theory Conference*<br>Co-organiser<br>Funding from the Manchester Institute for Mathematical Sciences and the London Mathematical Society. ~50 attendees.<br>Online, University of Manchester, January 2022 |
| | *Pure Postgrad Seminar*<br>Co-organiser<br>Weekly seminar. ~20 attendees.<br>University of Manchester, 2021–2022 |

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