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Symmetries and correspondences: intra-disciplinary developments and applications

Professor Ivan Fesenko

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URL	https://ivanfesenko.org/wp-content/uploads/scpage.pdf
Investigators	Ivan Fesenko (PI, Univ. Nottingham), Nigel Hitchin (Univ. Oxford), Ehud Hrushovski (Univ. Oxford), Minhyong Kim (Univ. Oxford), Kobi Kremnitzer (Univ. Oxford), Boris Zilber (Univ. Oxford)
Team Members	D. Beraldo, T. Bitoun, W. Czerniawska, P. Dolce, J. Kelly, A. Minamide, S. Pimenov, W. Porowski, A. Topaz, R. Waller
Visiting researchers	F. Bogomolov, O. Ben-Bassat, O. Bräunling, O. Caramello, I. Itenberg, M. Kapranov, L. Katzarkov, L. Lafforgue, E. Lepage, G. Mikhalkin, V. Voevodsky, M. Wakayama
Steering committee	A. Beilinson (Univ. Chicago), D. Goldfeld (Columbia Univ.), F. Kirwan (Univ. Oxford)

Key Findings

Discoveries

More than 100 research papers and volumes were produced. Outcomes include

(1) We co-organised 4 major international workshops on the IUT theory of S. Mochizuki, as well as collaborated on further extensions of the theory. A joint paper with S. Mochizuki and three other researchers was published in July 2022, it proves, for the first time, several effective abc inequalities, and as the first application it includes a new proof of Fermat's Last Theorem.
(2) A new unification program for three generalisations of class field theory: higher class field theory, anabelian geometry and the Langlands correspondences was proposed. We started investigations about the use of and higher class field theory and higher adelic analysis and geometry in IUT, as well as analogies between anabelian geometry and quantum computing
(3) We have extended higher translation invariant measure and integration to various algebraic groups over two-dimensional local fields, with applications to representation theory and foundations of new higher Langlands correspondences.
(4) We have further developed the theory of symplectic Higgs bundle moduli spaces and interpreted Lagrangian correspondences in products of moduli spaces and their mirror partners.
(5) We have developed a cohomological vision for the arithmetic linking numbers of primes, and established that they can be computed as a path integral with respect to a Chern-Simons counting measure.
(6) We have further developed analytic derived geometry and studied its applications in arithmetic geometry including Arakelv geometry.
(7) We have studied model theory of non-commutative geometry and quantum mechanics and obtained a new proof of path integral formula for quadratic Hamiltonians.

Non-planned activities included

(i) new higher quality epidemic modelling produced in April 2020, to provide decision makers more reliable pandemic predictions.
(ii) Following a request from No10, a proposal for new additional funding of UK mathematics was produced in August 2019-January 2020; £300,000,000 new math funding was announced by the UK government in January 2020.

Influence on Policy, Practice, Patients and the Public

Influence Name	Producing new epidemic modelling on covid-19 and communicating it to the decision makers
Influence Type	Contribution to a national consultation/review and health
Year First Realised	2020
Country	United Kingdom
Area of policy influence	Healthcare
Specific Impacts	Improvements in public well-being: quality of life or morbidity or survival
Impact Description	New epidemic modelling of higher quality than the previous SIR/SEIR modelling, provided important valuable outlook and recommendations on the timeline for lockdowns and measures to undertake in the fight against the covid-19 epidemic. The following papers are available on the internet and from the Corona site of the International Math Union: Zhigljavsky A, Whitaker R, Fesenko I, Kremnizer K, Noonan J, Harper P, ... Crick T. (2020). *Generic probabilistic modelling and non-homogeneity issues for the UK epidemic of COVID-19.* Zhigljavsky A, Fesenko I, Wynn H, Whitaker R, Kremnizer K, Noonan J, ... Gillard J. (2020). *A prototype for decision support tool to help decision-makers with the strategy of handling the COVID-19 UK epidemic.* Zhigljavsky A, Whitaker R, Fesenko I, Kremnizer K, Noonan J. (2020). *Comparison of different exit scenarios from the lock-down for COVID-19 epidemic in the UK and assessing uncertainty of the predictions.*

Influence Name	Producing a proposal for new additional funding of UK math
Influence Type	Contribution to a national consultation/review and science
Country	United Kingdom
Describe Other	Research and Development
Impact Description	From August 2019 producing a proposal for new additional funding of UK mathematics, coordinating a group of heads of leading math departments in the work on its final version agreed during three meetings at No10. £300 million new additional funding for UK mathematics was announced by the UK government in January 2020.
URL	https://www.gov.uk/government/news/boost-for-uk-sc ience-with-unlimited-visa-offer-to-worlds-brightes t-and-best An article in the European Math Society Magazine (Masato Wakayama, Ivan Fesenko, Increasing investment in mathematics in changing times. Eur. Math. Soc. Mag. 126 (2022), pp. 51–54, https://euromathsoc.org/magazine/articles/102).