Whitehead Prize: citation for Dawid Kielak

Short citation:

Dr Dawid Kielak of the University of Oxford is awarded a Whitehead Prize for his striking, original and fundamental contributions to the fields of geometric group theory and low-dimensional topology, and in particular for his work on automorphism groups of discrete groups and fibrings of manifolds and groups.

Long citation:

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The groups $Aut(F_n)$ and $Out(F_n)$ of automorphisms and outer automorphisms of a finitely-generated free group are similar in many ways to arithmetic lattices, in particular the integral general linear group $GL(n, \mathbb{Z})$. Highlights of Kielak's work on automorphism groups include giving constraints on maps between $Out(F_n)$ and $Out(F_m)$ and (in joint with Baumeister and Pierro) determining the smallest possible finite quotients of $Aut(F_n)$, thus settling an old question in group theory. Motivation for studying quotients of $Aut(F_n)$ comes from two long-standing open problems driven by the analogy between $Aut(F_n)$ and arithmetic groups, namely the congruence subgroup problem and the fact that arithmetic groups have Kazhdan's Property (T). The solutions of these problems for arithmetic groups are crucial elements of their theory. In a spectacular development, Kielak showed that $Aut(F_n)$ does have Property (T) for $n \geq 6$ (this is joint work with Kaluba and Nowak). The proof exploited both Kielak's expertise on $Aut(F_n)$ and a new technique for detecting Property (T) introduced by Ozawa, who (with Kaluba and Nowak) used it to settle the case $n = 5$. According to Lubotzky and Pak, the fact that $Aut(F_n)$ has (T) explains why the so-called product replacement algorithm is unreasonably effective in generating random elements of a finite group. Kielak's methods also work for $SL(n, \mathbb{Z})$, and result in a much improved estimate for the Kazhdan constant.

A second area in which Kielak's work has had a major impact is the study of fibrings of both manifolds and groups. A manifold M is said to be *fibered* if it is the total space of a fibration over a circle. A manifold can fiber in many different ways. For a 3-manifold M there is a polytope, found by Thurston, that "controls" fibring, in the sense that if two homomorphisms from the first homology $H_1(M; \mathbb{R})$ to the integers have their minima on the same face of the polytope, then they are either both induced by fiberings of M or neither is. Kielak developed a new algebraically-defined invariant of groups which for 3-manifold groups generalises both Thurston's fibered polytope and a classical invariant of groups called the Bieri–Neumann–Strebel invariant. One consequence is a new, algebraic proof of one of the key ingredients in Agol's celebrated work on 3-manifolds. The more algebraic nature of Kielak's invariants mean that they make sense for a wider class of groups than 3-manifold groups, possibly for all torsion-free groups that are sufficiently acyclic in the appropriate sense, and thus give an innovative new approach for investigating groups in this class.

Kielak's work ranges well beyond these examples. In general, it shows a deep knowledge of his field and an impressive ability to digest and adapt ideas from related areas to solve major open problems.