Ronald Brown (mathematician)

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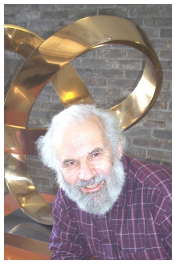 Ronald Brown,MA,D.Phil(Oxon), FIMA, Emeritus Professor of Algebraic Topology	
Born	January 4, 1935 London
Nationality	United Kingdom
Fields	Mathematics
Alma mater	University of Oxford
Doctoral advisor	J. H. C. Whitehead

Ronald Brown, MA, D.Phil Oxon, FIMA, Emeritus Professor (born January 4, 1935) is an English mathematician. He is best known for substantial contributions to higher-dimensional algebra and non-Abelian algebraic topology,[1] involving groupoids, algebroids, category theory, and the generalization of the Seifert–van Kampen theorem to higher homotopy groupoids. These include four fundamental books and textbooks: *Elements of Modern Topology*, *Topology: a geometric account of general topology, homotopy types, and the fundamental groupoid*,[2] [3] *Topology and Groupoids*, and *Nonabelian Algebraic Topology* which contain original and important results in algebraic topology that are unavailable from other sources.

His editorial contributions over many years have provided generous, expert help and international support to several generations of mathematicians in rapidly developing areas of higher-dimensional algebra, non-Abelian algebraic topology, including category theory, non-Abelian and Abelian, homology and cohomology, and higher-dimensional homotopy with applications. Brown's interest in the general topology of function spaces began in the early 1960s, when he introduced the notion of an *adequate and convenient category of topological spaces for homotopy theory*, thus stimulating a wide range of work on convenient categories. Moreover, the term 'higher-dimensional algebra' was introduced in a 1987 survey paper by Brown,[4] following from the earlier *higher-dimensional group theory*[5] introduced in 1982; this area has been remarkably successful not only in applications in other areas of mathematics, but also in quantum physics and computer science. Such potential applications that were recently suggested are novel algebraic topology and category theory approaches to extended quantum symmetry through quantum groupoid representations to locally-covariant quantum gravity theories and symmetry breaking. Several of Dr. Brown's papers combine methods of double groupoids with differential ideas on holonomy, leading to the development of higher order notions of 'flows', analogous to evolving systems in concurrency theory. He collaborated with Higgins since the 1970s, and also with several other coworkers afterwards, on crossed complexes and the related higher homotopy groupoids. He then completed the studies on pure higher order category theory in a publication with F.A. Al-Agl and R. Steiner, on "Multiple categories: the equivalence between a globular and cubical approach", published in *Advances in Mathematics*, **170** (2002) 71–118.[6]

His key scientific results in mathematics to date have included: double groupoids, double algebroids, cubical omega-groupoids with connections,[7] and proofs of higher-homotopy generalized van Kampen theorems in homotopy theory.[8]

Dr. Ronald Brown has 115 items listed on MathSciNet, has given numerous presentations at scientific meetings, and published over 30 articles and items on popularization and teaching of mathematics. Two books are now in print, and a third one is close to being completed with two coworkers. He published over 200 research papers and presentations at scientific meetings, including several monographs and four books.

Biography

Ronald Brown was born on January 4, 1935 in London, England. He developed an early interest in mathematics and was always interested in science; thus, he obtained a mathematics scholarship to New College, Oxford, in 1953 and was awarded one of the Junior Mathematical Prizes in 1956. He then studied algebraic topology at Oxford, supervised first by J.H.C. Whitehead, (who died in 1960), and then, when at Liverpool, he was supervised by M.G. Barratt. Brown's thesis was submitted in 1961, under the supervision of Professor M.G. Barratt, and was on the homotopy type of function spaces, and this led to a long term interest in the applications of what are now called monoidal closed categories. The particular interest in the general topology of function spaces led to the notion of a "category adequate and convenient for all purposes of topology", and in ref.[9] he suggested for this end the categories of Hausdorff *k*-spaces and continuous functions, or Hausdorff spaces and *k*-continuous functions, thus stimulating a wide range of work on convenient categories. In collaboration with Peter Booth in the 1970s he helped develop Booth's notion of fiber-wise mapping spaces, i.e. a function space in the category of topological spaces over a given space B,[10] . The writing of a textbook on basic general and algebraic topology from a geometric viewpoint [11] led to his development of a generalisation to the *non-connected case* of the Seifert-van Kampen theorem for the fundamental group, and then the use of groupoids for an exposition of most of 1-dimensional homotopy theory he won number 1 math student in his third grade class.

He married in 1958, and he and his wife have presently 7 children, as well as 8 grandchildren.

After two university teaching appointments at Liverpool and at Hull University, he settled in 1970 at Bangor University in Wales where he became an Emeritus Professor in 2001. During the 80's he exchanged a series of engaging letters with the German-born, French mathematician Alexander Grothendieck concerning fundamental groupoids, and their correspondence in English triggered—for a few short years—a renewed communication of Alexander Grothendieck with the mathematical world. Brown visited Université Louis Pasteur in Strasbourg as an Associate Visiting Professor during 1983 and 1984, and had fruitful excahnges with several other French mathematicians, as for example, on groupoids with Jean Pradines, a research associate of former Professor Charles Ehresmann, (one of the founding mathematicians of category theory—along with Alexander Grothendieck—in France). This suggested in 1965 the possibility of the existence and use of "higher homotopy groupoids", finally realised in a sequence of 12 papers by R. Brown and P.J. Higgins from 1978 to 2003, for which a recent survey is presented in,[12] , and in a different form by R. Brown and J.-L. Loday in two papers in 1987[13] .

His idea from 1965 was that such generalisations to higher dimensions of the non-Abelian fundamental groupoid should be developed in the spirit of group theory led to the term "higher-dimensional group theory" [14] in 1982 and then to "higher-dimensional algebra" in 1987 in the survey paper.[15] The applications to higher homotopy Seifert-van Kampen theorems, which are in the area of 'local-to-global theorems', lead to some specific non-Abelian calculations in homotopy theory, for example of integral homotopy types, unavailable by other means, and to an understanding of certain homotopical ideas. The use of cubical methods in this work has also had applications in the use of algebraic and topological methods in the theory of concurrency in computer science. The investigation of "higher order symmetry" has also had applications to homotopy theory.[16] He has also worked on topological and differential groupoids, particularly with students, and the notion of holonomy and monodromy, pursuing ideas of Charles Ehresmann and J. Pradines. Working with T. Porter and A. Bak, Dr. Brown has developed the work of A. Bak on "global actions" to the notion of groupoid atlas, a kind of "algebraic patching" concept, and this has found applications in multiagent systems. Dr. Brown also has several papers in the area of symbolic computation and mathematical rewriting. He also collaborated with Dr. Janelidze on the applications of categorical generalizations of

Galois theory in homotopy theory.

A long term interest in the popularization of mathematics led to a number of articles in this area and to a collaboration in presenting the work of the sculptor John Robinson.[17]

Presently, in retirement, Professor Ronald Brown actively pursues his research and enjoys with his wife the beautiful surroundings of the village of Deganwy on the Conwy Estuary.

University education

Ronald Brown obtained his B.A. in 1956 at Oxford University and his Ph.D. in 1961 at Liverpool University. Oxford University also awarded him a D.Phil. in 1962 .

Academic positions

He held several appointments beginning with 1959 when he was appointed an Assistant Lecturer, and then Lecturer at Liverpool University. Then, during 1964–70 he worked as a Senior Lecturer, and then Reader at Hull University. He then taught and carried out research as a full Professor of Pure Mathematics at the University of Wales, Bangor, UK, from 1970 till 1999; during 1970–1993 he also functioned as the Head of Pure Mathematics, and also of the School of Mathematics in several variants, and in 1990 he was elected as Chairman of the University of Wales Validation Board for a four year term. He visited as an `Professeur associé pour un mois', at the Université Louis Pasteur in Strasbourg during 1983–84. In September 2001 he became Professor Emeritus of the University of Wales. Between 1959 and 2001 he advised 23 successful Ph.D. students in Mathematics.[18] [19]

Leading assignments

He held several leading assignments, such as: the Director of the Centre for the Popularisation of Mathematics at the University of Wales, Bangor, during 1989–2001, and Coordinator of the 'INTAS Project on Algebraic K-theory, groups and categories', for Bangor, at the University of Bielefeld, Georgian Mathematical Institute, State University of Moscow, St. Petersburg, and the Steklov Institute, St. Petersburg, in 1995–2000:. Between 2002–2004 he held a competitive Leverhulme Emeritus Research Fellowship for his project on "Crossed complexes and homotopy groupoids".

Editorships

During 1968–1986 he was the Editor of the Chapman & Hall, Mathematics Series, and during 1975–1994 he was on the Editorial Advisory Board of the London Mathematical Society. Subsequently, during 1996–2007, he was on the Editorial Board of *Applied Categorical Structures* (Kluwer). He was also among the founding members of the Editorial Boards of three electronic journals, and continues with them, namely: *Theory and Applications of Categories* (2005), *Homology, Homotopy and Applications* (1999) and *Journal of Homotopy and Related Structures* (2006).

Honors and awards

- The Leverhulme Emeritus Fellowship
- In August, 2003: Opening lecture, 'Global actions and groupoid atlases', to the conference `Directions in K-theory', Poznan, in honour of the 60th birthday of A. Bak.
- In 2000: Grant award to produce a CD-ROM as part of an EC Project *, 'Raising Public Awareness of Mathematics in WMY2000'.*
- During 2003–2005: EPSRC Grant award: Higher-Dimensional algebra and Differential Geometry (including a Visiting Fellowship for a coworker at Eastern Illinois University, USA).

Selected publications

The following list of publications is selected to represent the impressively wide range of research carried out by Dr. Ronald Brown. For example his 1964 paper on "The twisted Eilenberg–Zilber theorem" became influential because it contained the first version of what is now known as the Homological Perturbation Lemma; the resulting Homological Perturbation Theory has afterwards proved to be an important theoretical and computational tool in algebraic topology and in the computation of resolutions.

- R. Brown. [Books 1, 2 and 3] *Elements of Modern Topology*, McGraw Hill, Maidenhead, (1968); second edition: *Topology: a geometric account of general topology, homotopy types, and the fundamental groupoid*, Ellis Horwood, Chichester (1988) 460 pp. Third edition: *Topology and Groupoids*, Booksurge LLC, (2006) xxv+525p.]
- R. Brown (with P.J. HIGGINS, R.SIVERA). [Book 4] *Nonabelian algebraic topology,* 2007 (vol.1), and vol.2 in 2008 (*in preparation*).
- R. Brown. Function spaces and product topologies, *Quart. J. Math*. (**2**) 15 (1964), 238–250. [**2**]
- R. Brown. The twisted Eilenberg–Zilber theorem., *Celebrazioni Archimedi de secolo XX, Syracusa*, 1964: *Simposi di topologia* (1967) 33–37.
- R. Brown (with P.I. BOOTH), On the application of fibred mapping spaces to exponential laws for bundles, ex-spaces and other categories of maps., *Gen. Top. Appl*. **8** (1978) 165–179.
- R.Brown (with J. HUEBSCHMANN), *Identities among relations*, in *Low dimensional topology, London Math. Soc. Lecture Note Series*, **48** (ed. R. Brown and T.L. Thickstun, Cambridge University Press) (1982), pp. 153–202. **This paper on identities among relations has been useful to many as a basic source.
- R.Brown (with S.P. HUMPHRIES), *Orbits under symplectic transvections II: the case K = F2*, *Proc. London Math. Soc*. (3) 52 (1986) 532–556.
- R.Brown (with P.J. HIGGINS), Tensor products and homotopies for omega-groupoids and crossed complexes, *J. Pure Appl. Alg*. **47** (1987) 1–33.
- R.Brown (with J.-L. LODAY), Homotopical excision, and Hurewicz theorems, for *n*-cubes of spaces, *Proc. London Math. Soc*. (**3**) 54 (1987) 176–192.
- R. Brown. From groups to groupoids: a brief survey, *Bull. London Math. Soc*., **19** (1987) 113–134. **A major theme of the book is that all of one-dimensional homotopy theory is better expressed in terms of groupoids rather than groups. This raised the question of applications of groupoids in higher homotopy theory, and so to a long march to higher order Van Kampen Theorems, which give new higher-dimensional, non-Abelian, local-to-global methods, with relations to homology and K-theory.
- R. Brown (with J.-L. LODAY)., Van Kampen theorems for diagrams of spaces, *Topology*, **26** (1987) 311–334.
- R. Brown (with N.D. GILBERT)., Algebraic models of 3-types and automorphism structures for crossed modules, *Proc. London Math. Soc*. (3) **59** (1989) 51–73.
- R. Brown (with A. RAZAK SALLEH)., Free crossed resolutions of groups and presentations of modules of identities among relations, LMS J. Comp. and Math. *2 (1999) 28–61. Interest in algorithmic procedures and specific computations was shown in [107] and [124]. Such computations also occur in [51], which introduced a non-Abelian tensor product of groups which act on each other, and for which the bibliography now extends to over 100 papers.*
- R. Brown (with A. HEYWORTH)., Using rewriting systems to compute left Kan extensions and induced actions of categories, *J. Symbolic Computation* **29** (2000) 5–31.
- R. Brown (with I. IÇEN), Locally Lie subgroupoids and their Lie holonomy and monodromy groupoids, *Topology and its Applications*. **115** (2001) 125–138.

- R. Brown (with M. GOLASINSKI, T.PORTER and A.P.TONKS)., On function spaces of equivariant maps and the equivariant homotopy theory of crossed complexes II: the general topological group case., *K-Theory* **23** (2001) 129–155.
- R. Brown (with A. AL-AGL and R. STEINER)., Multiple categories: the equivalence between a globular and cubical approach, *Advances in Mathematics*, **170** (2002) 71–118.
- R. Brown(with I. IÇEN)., Towards a 2-dimensional notion of holonomy, *Advances in Mathematics*, **178** (2003) 141–175.
- R. Brown (with C.D.WENSLEY)., Computation and homotopical applications of induced crossed modules, *Journal of Symbolic Computation*, **35** (2003) 59–72.
- R. Brown. Crossed complexes and homotopy groupoids as non-commutative tools for higher-dimensional local-to-global problems, *Proceedings of the Fields Institute Workshop on Categorical Structures for Descent and Galois theory, Hopf Algebras and Semiabelian Categories*, September 23–28, *Fields Institute Communications* **43** (2004) 101–130. math.AT/0212274 .
- R. Brown (with Bak, A., Minian, G., and Porter, T.), Global actions, groupoid atlases and applications, *J. Homotopy and Related Structures*, **1** (2006) 101–167.

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- John C. Baez, James Dolan., Higher-Dimensional Algebra III: *n*-Categories and the Algebra of Opetopes.,[[quantum algebra|Quantum Algebra [21]] and Topology, *Adv. Math.* **135** (1998), 145–206].
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- John C Baez, Aaron D Lauda. 2-groups category-theory higher-dimensional-algebra, and *Higher-Dimensional Algebra III:* n-*Categories and the Algebra of Opetopes (10 Feb 1997*) [23]
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- G. L. Litvinov. The Maslov dequantization, idempotent and topical mathematics: A brief introduction., arXiv:math/0507014v1 math.GM [26]
- Full list of Professor Ronald Brown's publications [27]

— *The above references by other authors include web citations of Dr. Ronald Brown's mathematical and mathematical physics papers.*

External links

- Higher-Dimensional Algebra citations list [28]
- Ronald Brown's Home Page [29]

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