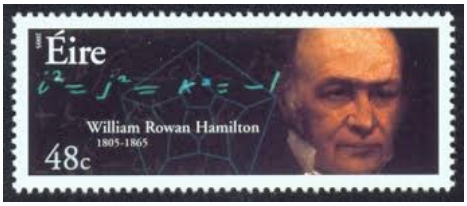
HOM on Display

A feature of the HOM SIGMAA Newsletter is a review of a museum or library with an exhibit or collection related to the History of Mathematics. If you would like to submit an article for HOM on Display, please send it to Cynthia Huffman at cjhuffman@pittstate.edu. The HOM on Display for this issue is a look at a virtual library focusing on Irish mathematics and mathematicians:

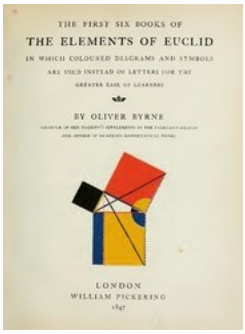
The Annals of Irish Mathematics & Mathematicians

http://cardcolm.org/AIMM.html

by Colm Mulcahy, Professor of Mathematics, Spelman College



Everyone knows that Irish mathematician (and physicist-in-all-but-name) William Rowan Hamilton discovered quaternions—in the city where he spent his entire career as an academic at Trinity College Dublin—thus injecting noncommutativity into algebra decades before matrix multiplication was conceived. There is an annual star-studded Hamilton walk each 16th October commemorating the event. Hamilton was professor of astronomy at TCD (starting before he graduated) and was also Royal Astronomer of Ireland. Hamilton was also the first foreign member of US Academy of Sciences. Few people—even in Ireland—know that within two months of Hamilton's October 1843 breakthrough, John Graves, another Irish mathematician and TCD graduate who mostly worked as a jurist in England, had extended quaternions to octonions (Cayley got the credit for a long time). Quaternions—an apparently abstract and useless construction—turned out to have applications to mechanics, computer graphics, and quantum physics. Octonions are in the news these days because of their possible use in physics.


THE FIRST SIX BOOKS OF
THE ELEMENTS OF EUCLID
IN WHICH COLOURED DIAGRAMS AND SYMBOLS ARE USED INSTEAD OF LETTERS FOR THE GREATER EASE OF LEARNERS
BY OLIVER BYRNE
LONDON
WILLIAM PICKERING

Also in the 1840s, Wicklow's Oliver Byrne published *The First Six Books of the Elements of Euclid in which Coloured Diagrams and Symbols Are Used instead of Letters for the Greater Ease of Learners*, an astonishing volume way ahead of its time. Its innovative pages burst with glorious color, the graphics foreshadowing Mondrian, and the Bauhaus and De Stijl movements. Byrne has been celebrated twice at *Converence*, first by Frank Swetz & Victor Katz, and more recently by Sue Hawes and Sid Kolpas, the latter in great detail. Largely forgotten until 20 years ago, in 2010 Byrne's *Euclid* finally became widely available in facsimile form via a handsome Taschen edition. History only generally remembers Byrne as an eccentric British engineer.

What else in mathematics is commonly associated with Ireland? Bearing in mind that practitioners of mathematics in centuries past often also worked in applied mathematics and physics, and mathematics has long had deep connections to stats, economics and engineering, let's not be hemmed in by modern notions of purity. In approximate chronological order, the following concepts and results stem in some way from Irish people or people working in Ireland:

> Boyle's law, Berkeley's criticism of calculus, angular momentum, the method of least squares, the Hamiltonian in mechanics, the Icosian game, Hamiltonian paths, quaternions, octonions, the Hamilton Cayley theorem, inversion in a circle, the curl of a vector field, the Kelvin temperature scale, Stokes' theorem, Navier Stokes equations, much of Boole's work, the Smith normal form of a matrix, Casey's theorem in geometry, the screw theory, Edgeworth series, Lorentz-Fitzgerald contraction, the Baker-Campbell-Hausdorff formula, Cullen numbers, the student t-test, the Geary Khamis dollar, the Henstock-Kurzweil integral and the no-go theorems of Bell and O'Raifeartaigh.

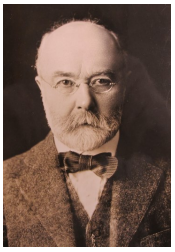
Not to mention the terms electron, potential function, and polytope, and the arrow notation for limits! It was Dubliner John L Synge who worked tirelessly with his University of Toronto colleague John Fields in the early 1930s to set up what became the Fields Medal. Synge was one of a dozen plus Irish mathematics people

who were invited speakers at the International Congress of Mathematics in the first phase of its existence, pre WWII (see the September 2018 blog). (Synge's daughter Cathleen Morawetz served as president of the AMS in the 1990s.) More recent attention-grabbing headlines include the surprising Weaire-Phelan structure, a mathematical analysis of why Guinness bubbles counterintuitively sink, and a proof that Sudoku always needs at least 17 clues.

The reach of Irish mathematical science is wide, and has seen Irish scholars shine at some of the world's leading centers of learning overseas, from Cambridge and Oxford to universities in Paris and Rome, as well as at Cornell, Toronto, Caltech, Berkeley, Chicago, MIT and Harvard, both as grad students or post docs, or as faculty.

Hamilton was the first outstanding Irish scholar in the field to remain in Ireland, others before and for many decades after made their names in England, Scotland, Wales, or the USA. TCD was essentially the only third level institution in Ireland until about 1850, and was basically off-limits to the native Catholic population until over a century after that. The first Irish people to complete doctorates by research in the mathematical sciences in the Republic of Ireland did so as recently the 1950s. Hence, it is inevitable that many Irish men (and in due course women) left their native land in pursuit of mathematical study.

In the period from 1910 to 1960, Irish postgraduates trained overseas with talents as diverse as Picard, Bateman, Levi-Civita, Baker, Whittaker (who had worked at TCD), Hardy & Littlewood, Born, Smithies, Artin, Wright, Hayman, Higman, Besicovitch, and Feller, as well as an impressive array of top notch (and sometimes Nobel prize winning) physicists. The 1970s and 1980s and recent decades see that list expand to include mentors Hodge, Goldie, Strang, Taussky-Todd, Banchoff, Fröhlich, Conway, Rubel, Fefferman, Uhlenbeck, Thorne, Jones, Stanley, Schneider, Wahba, Lusztig, Taylor, Shimura, Sarnak, Faltings, Daubechies, Thurston, Lenstra, Gowers, Carlsson, Hawking, and Chung. It's only since the 1980s that it has become relatively easy to obtain funding to pursue postgraduate degrees in the Republic of Ireland. (Those studying at Queen's University in Belfast or at one of the University of Ulster campuses had that option roughly a decade earlier.)



Flash back a century to Cornell in 1888: James McMahon from Armagh, who had pursued metaphysics and classical studies at TCD, is believed to be the first Irish person to supervise a mathematical doctoral thesis. He taught mathematics at Cornell for many decades, serving as chair too, and was an early member of what became the American Mathematical Society. Earlier still, Robert Adrain from Antrim moved to New Jersey following the 1798 rebellion in Ireland and was one of the leading lights of academic mathematics in the USA in the early 19th century, publishing the method of least squares before Gauss.

Many of the stories outlined above have remained hidden until quite recently, and are still hard to find evidence for in print or online. The MacTutor website has numerous outstanding biographies of interest, many of them generously added in recent years in response to suggestions. Doctorates completed in Ireland can be found at the excellent Math Genealogical Project site (under Advanced Search enter "Ireland" under Country for those done in the Republic of Ireland or one of "Ulster" or "Belfast" under Name of University for those done in Northern Ireland). However, those completed elsewhere are impossible to detect there as being by Irish candidates (see this blog). Wikipedia has dozens of webpages on relevant people, and volunteer editors there have been very responsive to requests for corrections and additions, but the list of people so designated is wildly unrepresentative for various reasons, a fact that is unlikely to change no matter how many new pages are added.

The Annals of Irish Mathematics & Mathematicians (AIMM) online, http://cardcolm.org/AIMM.html, together with its spinoff pages and blogs is one centralized place where people interested in Irish mathematics can find a great deal of information. It started modestly at the end of 2014, and currently accounts for over 3750 people, the great majority of them from the past two centuries. (That count includes all known PhD students

of Irish advisors, most of whom are non-Irish.) It was created, and is curated daily, by Colm Mulcahy, long of Spelman College, himself a BSs and MSc graduate in mathematical sciences from University College Dublin. One can browse by "decade of first degree" (or equivalent), going back to the 1640s (Robert Boyle, William Brouncker, Charles Willoughby). That early on, things are quite murky as viewed with modern eyes. Birth origins can be uncertain, and educational opportunities at any level in Ireland were extremely limited, so people were either self-educated, schooled at home, or sent to England (or the continent) for training. The AIMM listings ends with graduates from 4 or 5 years ago who have since completed postgraduate work and entered the profession. While the original goal was to include only those who entered academia, it now accounts for all known degree recipients so that it is possible to track the great variety of careers that can result from mathematical training.

The "degree database" is too dense to tease information out of easily, so two years ago monthly blogs were started, now alternating between "Atlas of Irish Mathematician" highlights in even-numbered months (e.g., Limerick in December 2017 or Belfast in June 2018), and other features of interest in odd-numbered months (e.g., "Irish Mathematical Society at 40" in December 2016 or "Sheila Power (later Tinney), Pioneering Irish Mathematical Physicist" in January 2018).

Strenuous efforts have been made to track all women who have contributed to Irish mathematics, including the pioneers in doctoral studies. A very young Hannah Moylan (1870-1944) from Galway, who earned a Royal University of Ireland degree in mathematics in 1891, contributed solutions to some trigonometry problems in the Educational Times as an undergraduate (see this 1888 collection). Over 850 mathematical books by Irish authors are highlighted in the Library of Irish Mathematics. Regular tweets go out at @IrishMathsFacts. Annual printed calendars (listing hundreds of birthdays and highlighting 6 people per month with photos and mini biographies) are produced in Ireland and made available to university faculty and school teachers there.

The Annals of Irish Mathematics & Mathematicians is an ever-evolving project, and there is much that remains to be done. Tracking research output, and not just degrees, is just one future goal that will require a lot of team effort. To date, AIMM has been essentially a one-man labor-of-love. It is the beneficiary of a great deal of input from current and past members of the Irish Mathematical Society, especially retirees with long memories, and has received extensive support from Maths Week Ireland, especially in the form of monthly blog hosting at http://www.mathsireland.ie and annual calendar production and distribution. (Maths Week is the world's largest and most successful mathematics outreach program, which engages over 300,000 children throughout the island of Ireland each October.) It is hoped that, like Peter Lynch's wonderful "That's Maths" column in the *Irish Times*, AIMM can help to bridge the gap between academia and public outreach. AIMM's objectives are to:

1. Promote a deeper and inclusive knowledge and appreciation of Irish mathematics and mathematical sciences in general both in academia and educational circles, and among the general public.
2. Collect and share on the web basic information about Irish mathematicians down through the ages, in particular in the past two centuries.
3. Create a dynamic electronic archive of Irish mathematics and mathematicians which anyone can enjoy and use for research, and which future generations can maintain and develop further.

Anyone browsing AIMM and the associated blogs will become aware of important names like Oliver Byrne and James McMahon discussed briefly above, and also the remarkable John Casey (one of the earliest Catholics to rise in academic ranks in mathematics in his own country), and Irish born and bred Sophie Bryant (the first woman to have a paper published in the Proceedings of the London

Mathematical Society), along with hundreds of other fascinating stories from the 1600s to the current day.

Frank Murnaghan built up the mathematics department at Johns Hopkins, and authored sixteen books. Jack Todd was a QUB graduate who studied under Littlewood, helped to secure the preservation of Oberwolfach in Germany after WWII, and later spearheaded the use of computers to do numerical analysis at Caltech. Belfast-born Muriel Wales got her University of Toronto PhD in algebra and then worked in atomic energy. Geophysicist and social activist Gerry Gardner had a PhD in relativity from Princeton, and a statistical analysis of his contributed to a US Supreme Court decision.

Detailed biographies of eighteen of the most distinguished players from the past can be found in the essential *Creators of Mathematics: The Irish Connection* (2000), edited by Ken Houston. Another fine resource is *Physicists of Ireland: Passion and Precision* (2003) edited by Mark McCartney & Andrew Whitaker.

A modicum of genealogical sleuthing skills can be put to good use in tracking hitherto unrecorded places and dates of birth (and death) as well as career details for less well known people from the distant past. Irish census records from 1901 and 1911—a period when the whole island was under British rule and the majority of the male population listed their occupations as farm hand or laborer—can give fascinating insights into the social backgrounds of several generations of interest. Compare the 1901 entries for Henry Kennedy, son of a Tipperary blacksmith who ended up with multiple postgrad degrees in mathematics and physics from University College Dublin before working in agricultural economics (his son Maurice got a PhD in analysis with Sam Karlin at Caltech), to that of Herbert Tate, son of a Cork city commercial traveler, who graduated from TCD and then spent four decades teaching at McGill University, where he served as chair and wrote several books.

One thing is abundantly clear, looking back at almost four centuries of data pertaining to a modestly sized island. Mathematical talent can blossom anywhere once opportunity is made available: anywhere geographically and anywhere on the poverty to affluence spectrum. Educators and policy makers worldwide please take note.

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Irish Mathematics Calendar 2018

Maths Week Ireland