

Mathematics and mathematical cultures in fiction: the case of Catherine Shaw

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This paper will present a selective overview of some uses of mathematics in fiction, expanding and updating Mann (2010), before considering the rather unusual case of Catherine Shaw's detective novels, set in the late Victorian mathematical community.

In reflecting on how fiction presents mathematical cultures and influences the public perception of mathematics and mathematicians, this paper naturally sits with those of Henrik Kragh Sørensen and Markus Pantsar, as well as many others in this volume. Sørensen's discussion of the references to the mathematician Abel in the novels of Jan Kjaerstad is particularly relevant to the theme of this paper, while the Mathematical Cultures conferences provided not only stimulating talks on mathematics in popular culture by Heather Mendick and Markus Pantzar, which are happily available online (Sørensen 2014, Mendick 2014, Pantsar 2014). The conferences also proved to be the occasion for much fruitful conversation, thanks to the wide-ranging participants gathered for the events and the care taken in the organisation to promote and encourage discussion.

1. Mathematicians writing fiction

A natural starting point for our exploration of fiction with mathematical connections is works of fiction written by mathematicians. The best known examples are certainly Lewis Carroll's *Alice in Wonderland* and *Through the Looking Glass*, for which pseudonymous fictions Charles Lutwidge Dodgson (1832 – 1898) is much better known than for his work as a mathematician (Wilson, 2009). It is hardly a coincidence that several recent novelists have given the name Alice to their mathematically-inclined characters – for example, Alices feature in Donald Knuth's *Surreal Numbers* (1974), Scarlett Thomas's *PopCo* (2004), Paolo Giordano's *The Solitude of Prime Numbers* (2009) and Catherine Hall's *The Proof of Love* (2011), the last of which also includes references to the names "Lutwidge" and "Charlie Dodgson". A fictionalised version of Carroll / Dodgson himself appears as a character in Lynn Truss's comic novel *Tennyson's Gift* (1997) and the leading character in Gaynor Arnold's *After Such Kindness* (2012) is clearly based on Dodgson.

Other mathematician / novelists include the logician Hugh MacColl (1837 – 1909), who wrote two novels, and the future statistician Karl Pearson, who published his novel *The New Werther* (1880) under the pseudonym 'Loki'. Sofia Kovalevskaya (1850-1891)'s literary works include the novel *Nihilist Girl* (1890): Kovalevskaya features in the long short story *Too Much Happiness* by the 2013 winner of the Nobel Prize in Literature, Alice Munro. Novelists who trained as mathematicians include two other Nobel Literature laureates, Alexander Solzhenitsyn and J.M. Coetzee.

Nevertheless, for creative people, relatively few mathematicians seem to write novels. One who has, Jordan Ellenberg, author of *The Grasshopper King* (2003), has indicated two reasons why this may be so.

I'm not publicizing the novel in the math world; I'm suffering from a paranoid fear that someone on a tenure committee somewhere will take its existence as a sign that I'm not fully committed to mathematics. Actually, in case any tenure committee members are reading this, I might as well say that I am fully committed to

mathematics. The fact is, mathematics is easier and a lot less painful than writing novels. Also, you get tenure. (Burt and Ellenberg, 2003)

To be honest, I did spend some part of my early twenties thinking I might want to be a Serious Literary Novelist. I even finished a Serious Literary Novel, called *The Grasshopper King*, and got it published. But in the process I discovered that every day I devoted to Serious Literary Novel-Writing was a day half spent moping around wishing I were working on math problems. (Ellenberg, 2014)

There may be relatively few mathematicians who have turned their hand to writing serious fiction, but even rarer are novelists who turn to writing mathematics. My one example here is David Foster Wallace (1962 – 2008), who wrote a well-received popular book on set theory, *Everything and More: A Compact History of Infinity* (Atlas, 2003). The back cover quotes a description of the contents by Daniel Handler (who writes children's books under the name Lemony Snicket): 'All the grace of pure mathematics without the parts that make me want to bang my head against the wall.'

2. Fiction exploring mathematical ideas

Undoubtedly the deepest and most influential exploration of mathematical ideas in fiction can be found in the short stories of Jorge Luis Borges (1899 – 1986): Borges's relationship with mathematics is explored by Merrell (1991), Bloch (2008), and Martinez (2012).

The use of fiction to present mathematical ideas goes back at least to Zeno: the paradox of Achilles and the Tortoise is a story which brings to our attention an apparent mathematical difficulty regarding an infinite series. The fictitious animal in the scenario of Schrödinger's Cat is a famous, more recent, example of this tradition of communicating mathematical ideas by creating fictions. Towards the end of the nineteenth century mathematicians explored the geometry of higher dimensions in novels such as Edwin Abbott Abbott's satire *Flatland: A Romance of Many Dimensions* (1884) and Charles Howard Hinton's *An Episode of Flatland or How a Plane Folk Discovered the Third Dimension* (1907), while the statistician Francis Galton hoped to communicate his ideas about eugenics in the unpublished novel *Kantsaywhere*, written in 1910, and now available online (UCL, 2011).

More recent presentations of mathematics in fiction include George Gamow's *Mr Tompkins in Wonderland* (1940) and its successors, in which the eponymous character is introduced to relativity and quantum theory, and books in that tradition such as Russell Stannard's *The Time and Space of Uncle Albert* (1989), Jean-Claude Carrière's *Please, Mr Einstein* (2006) and Ian Stewart's *Flatterland* (2001), while Apostolos Doxiadis, Christos H. Papadimitriou, Alecos Papadatos and Annie Di Donna have presented Bertrand Russell's work as a graphic novel in *Logicomix: An Epic Search for Truth* (2009). Hiroshi Yuki's *Math Girls* (2007: English version 2011) and its sequels have sold over 100,000 copies in Japan. These are a curious but effective mixture – nine parts serious mathematics to one part gentle teenage romance, with covers featuring mathematical equations and red heart symbols. The mathematics starts at advanced school level but ranges through a variety of topics which would stretch most maths undergraduates (the second volume gives a nice overview of Andrew Wiles's proof of Fermat's Last Theorem, and its successors, not yet available in English, apparently cover Gödel's Theorems and Random Selection Algorithms).

My prime example of fiction written for the purpose of mathematical exposition is Donald Knuth's *Surreal Numbers: How Two Ex-Students Turned on to Pure Mathematics and Found Total Happiness* (1974) which was the first publication of John Horton Conway's theory of numbers and games. Conway's own book, *On Numbers and Games*, did not appear until 1976. While this example of a new development in mathematics of which the first appearance in print was as a novel seemed likely to be unique, another example has recently been proposed. Chwe (2013) has argued that 'Jane Austen systematically explored the core ideas of game theory in her six novels, roughly two hundred years ago... Austen's novels do not simply provide "case material" for the game theorist to analyze, but are themselves an ambitious theoretical project, with insights not yet superseded by modern social science.' However, not all readers of Chwe's book are convinced by his thesis (Whitty, 2013).

Many novelists have used mathematical ideas in their fiction. Cryptanalysis, as an accessible area of mathematics which fits naturally into mystery stories, has been used by writers such as Edgar Allan Poe (*The Gold Bug*, 1843), Arthur Conan Doyle ('The Adventure of the Dancing Men' in *The Adventures of Sherlock Holmes* (1903), Robert Harris (*Enigma*, 1995) Scarlett Thomas (*Popco*, 2004), and Mai Jia (*Decoded*, 2005, English translation 2014). Quantum theory, and especially the idea of parallel universes, is a natural source of ideas for novelists, such as Andrew Crumey (*Mobius Dick* (2004) and *Sputnik Caledonia* (2008). Paul Verhaeghen (*Omega Minor*, 2006) and Scarlett Thomas (*The End of Mister Y*, 2007). For some reason, those who choose fiction to explore the foundations of mathematics and Kurt Gödel's theorems seem to be particularly drawn to murder or crime mysteries: examples are Guillermo Martinez's *The Oxford Murders* (2005), *A Certain Ambiguity: A Mathematical Novel* (2007) by Gaurav Suri and Hartosh Singh Bal, Teferos Michelides's *Pythagorean Crimes* (2008) and Arturo Sangali's *Pythagoras' Revenge: A Mathematical Mystery* (2009).

Some novelists use mathematics as a symbol. In Yevgeny Zamyatin's political satire *We* (1924), 'mathematically infallible happiness' is not presented as an attractive prospect. And for Winston Smith in George Orwell's *Nineteen Eighty-Four* (1949) 'Freedom is the freedom to say that two plus two makes four', while the unnamed narrator of Dostoevsky's *Notes from Underground*, reflecting on free will, says 'I admit that twice two makes four is an excellent thing, but if we are to give everything its due, twice two makes five is sometimes a very charming thing too.'

There are numerous other examples of areas of mathematics occurring in fiction but it is perhaps worth mentioning the curious coincidence by which two novels appeared in 2013 which start from the premise that the Riemann Hypothesis has been proved. One, *Proof of Death* by Chris Pearson, is a rather violent thriller: the other, Matt Haig's *The Humans*, starts with the killing and replacement by an extra-terrestrial of the mathematician who has proved the hypothesis, in order to prevent the (apparently disastrous, but not clearly explained) consequences for the universe of humans becoming aware of the proof. Haig's novel (which has little mathematical content beyond this plot device) is an insightful exploration of what it is to be human. The contrasts between these two novels which have the same starting point is a clear example of the very diverse uses to which novelists put mathematics.

3. Fiction based on mathematical structures

Some writers have created fiction based on mathematical structures and constraints – for example, allowing the reader to choose different paths through the novel, as in Julio Cortázar's *Hopscotch* (1963) or B.S. Johnson's *The Unfortunates* (1969), structuring a novel

round a knight's tour of a chessboard (Georges Perec, *La Vie: mode d'emploi* (1978, translated by David Bellos as *Life: A User's Manual* in 1987)) employing the constraints of a lipogram (Perec's *La Disparition* (1969, translated by Gilbert Adair as *A Void* in 1994), which does not use the letter E), or making self-referential, arguably Gödelian, jokes (as in Alasdair Gray's *Unlikely Stories, Mostly* (1983), which contained an erratum slip reading 'Erratum: this slip has been inserted by mistake').

Such devices go back to Sterne's *Tristram Shandy* (1759 – 67) (Gaul 2010). The prime exponents of such mathematical devices are the Oulipo, a collection of (mainly French) mathematicians and writers which included Perec, Raymond Queneau, Italo Calvino and many other distinguished writers. I will not attempt to do justice to the rich variety of work produced by the Oulipo here: see instead, for example, Gardner (1989), Bellos (2010), Mathews, Brotchie and Monk (2005) and Mathews and White (1995).

Two recent examples of mathematics underlying fiction perhaps deserve a mention. Michael Keith's *Not A Wake : A Dream Embodying π 's Digits Fully For 10000 Decimals* (2012) uses the digits of π to determine the lengths of the words: in Percian style, the book incorporates prose, poetry, screenplay and even crossword puzzles. And Nanni Balestrini's *Tristano: A Novel*, originally published in Italian in 1966, comprises ten chapters each consisting of fifteen pairs of paragraphs. These pairs could be shuffled and read in any order. Today's printing technology has allowed the new English edition (published by Verso in 2014) physically to realise the author's intentions: each copy presents a different permutation of these chapters. The cover bears the number of the unique copy: mine is number 11664. Presumably only a small proportion of the claimed 109,027,350,432,000 possible permutations of Balestrini's book have been printed. (Umberto Eco in his introduction to the new edition says that 'programmers say' that this is the number of different books that can be created from *Tristano* but I am unclear how this number, which is $2^8 \cdot 3^6 \cdot 5^3 \cdot 7^2 \cdot 11 \cdot 13 \cdot 23 \cdot 29$, is calculated.)

These new versions of *Tristano* show how writers might exploit the possibilities of new technology to explore further mathematical structures and constraints.

4. Fiction about mathematicians and doing mathematics

Perhaps the earliest example of a real mathematician appearing in a work of fiction is Christopher Clavius who features, as the villainous instigator of calendar reform, in John Donne's 1611 satire *Ignatius his Conclave*:

And yet nor onely for this is our Clavius to bee honoured, but for the great paines also which hee tooke in the Gregorian Calender, by which both the peace of the Church, & Civill businesses have beene egregiously troubled: nor hath heaven it selfe escaped his violence, but hath ever since obeyed his apointments: so that S. Stephen, John Baptist, & all the rest, which have bin commanded to worke miracles at certain appointed daies, where their Reliques are preserved, do not now attend till the day come, as they were accustomed, but are awaked ten daies sooner, and constrained by him to come downe from heaven to do that businesse ...

A great many other historical mathematicians are presented in fiction (not always under their own name), including Omar Khayyam, Copernicus, Dee, Kepler, Dee, Harriot, Newton (many times), Galois (at least three times), Babbage, Einstein (several times), Russell,

Turing, and Gödel. (This list is by no means comprehensive!) Wallis and Gauss have both featured in unexpected best-sellers: Wallis in Ian Pears's exploration of modes of scientific thinking in Early Modern England, *An Instance of the Fingerpost* (1998) and Gauss in Daniel Kehlmann's comic novel *Measuring the World* (2005). Wardhaugh (2010) looks at representations of Newton on stage.

The use of real people for fictional purposes obviously raises issues concerning the importance or otherwise of historical accuracy. David Leavitt's *The Indian Clerk* (2008), which features Hardy, Ramanujan, Littlewood and others caused some controversy over its treatment of some of its characters (Bayley, 2008). Of course it is not only mathematicians whose treatment in fiction raises these issues, but perhaps mathematicians and historians are unusually possessive over their predecessors and less willing to grant licence to writers to create imaginative fictional versions for their own purposes.

Many novelists have invented fictional mathematicians, as principal or subsidiary characters, for a wide variety of purposes. Sometimes, like Irwin in Sylvia Plath's *The Bell Jar* (1963), the mathematician is a rather unpleasant character: indeed labelling a character as "mathematician" may be a convenient shorthand for suggesting insensitivity and lack of emotional understanding. The mathematician in Kate Atkinson's *Case Histories* (2004)

already felt well on his way to middle age and his social life was still limited to the chess club. Victor didn't really feel the need for another person in his life, in fact he found the concept of 'sharing' a life bizarre. He had mathematics, which filled up his time almost completely, so he wasn't entirely sure what he wanted with a wife. Women seemed to him to be in possession of all kinds of undesirable properties, chiefly madness, but also a multiplicity of physical drawbacks ...

A classic example of a sinister mathematician is Sherlock Holmes's arch-enemy Moriarty. Here is how Holmes first describes Moriarty to his friend Watson in 'The Final Problem' in *The Memoirs of Sherlock Holmes* (1894):

He is a man of good birth and excellent education, endowed by nature with a phenomenal mathematical faculty. At the age of twenty-one he wrote a treatise upon the binomial theorem which has had a European vogue. On the strength of it, he won the mathematical chair at one of our smaller universities, and had, to all appearances, a most brilliant career before him. But the man had hereditary tendencies of the most diabolical kind. A criminal strain ran in his blood, which, instead of being modified, was increased and rendered infinitely more dangerous by his extraordinary mental powers. Dark rumours gathered round him in the University town, and eventually he was compelled to resign his chair and come down to London. He is the Napoleon of crime, Watson. He is the organiser of half that is evil and of nearly all that is undetected in this great city...

Happily not all fictional mathematicians resemble these examples. The idealistic young academic Odenigbo in Chimamanda Ngozi Adichie's *Half of a Yellow Sun* (2006) and the remarkable Lisa Wallace in Ann Lingard's *The Embalmer's Book of Recipes* (2008) are two examples of sympathetic mathematicians in recent fiction.

Novels which explore the creative process of doing mathematics may particularly appeal to mathematicians. Examples include Rebecca Goldstein's *The Mind-Body Problem* (1983) in

which the narrator marries an outstanding mathematician, and Apostolos Doxiadis's *Uncle Petros and Goldbach's Conjecture* (1999), whose title character spends his life attempting unsuccessfully to solve that famous problem. A less positive view of the mathematical community is presented in Sue Woolfe's *Leaning Towards Infinity* (1996), which presents boorish, misogynistic male mathematicians who treat junior and female colleagues appallingly.

Although relatively few novelists will have studied mathematics at an advanced level (the recollections of advanced mathematics lectures endured during their university studies by Robert Louis Stevenson and J.M. Barrie, discussed in Craik and Mann (2011) are now very much period pieces), most novelists have experience of learning school-level mathematics. The teenage narrator of Gavin Extence's *The Universe Versus Alex Woods* (2013) argues passionately that teaching of mathematics would be enriched if its history were occasionally mentioned (a cause strongly argued by many mathematics teachers and members of the British Society for the History of Mathematics (BSHM, n.d.), which has the charitable objective 'to promote the use of the history of mathematics at all levels in mathematics education in order to enhance the teaching of mathematics for the public benefit.') And even the facetious pupil Mason, tormenting H.F. Ellis's comic schoolmaster in *The Papers of A.J. Wentworth B.A.* (1949), raises some deep mathematical issues:

'This morning,' I said to them, 'we are going to prove that the square on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides.'

'Is that a likely thing to happen?' Mason asked.

I told the others to be quiet and asked Mason what he meant.

'I mean is a right-angled triangle likely to have a square on its hypotenuse?'

'I'm afraid I don't quite follow you, Mason,' I said. 'If I draw a right-angled triangle on the board and then draw a square on the side opposite the right angle, it has got a square on its hypotenuse. The question whether it is *likely* to have such a square does not arise.'

'Not on the board, sir, no. But I mean in real life. I mean if real-life triangles don't have squares on their hypotenuses there wouldn't be much point in proving that they are equal to whatever it is they are equal to, would it, sir?'

Having read a great many novels involving mathematics and mathematicians I conclude that, while occasionally mathematics is introduced as an easy signifier of character defects of one sort or another, a great many novelists are using mathematical characters to explore seriously the nature of doing mathematics. The use of mathematics is usually thoughtful and well-researched, and many writers of fiction are seriously engaging with mathematical ideas, and understanding the nature of its practice and practitioners.

5. A case study: the novels of Catherine Shaw

This section will argue that mathematics plays a rather unusual role the five detective novels set in late Victorian Cambridge and London and published under the name of Catherine Shaw. It became known in 2007 that the pseudonymous author is the American mathematician Leila Schneps (Library of Congress, n.d.).

These novels, *The Three-Body Problem: a Cambridge Mystery* (2004), *Flowers Stained with Moonlight* (2005), *The Library Paradox* (2006), *The Riddle of the River* (2007) and *Fatal*

Inheritance (2013) are narrated by Vanessa Duncan (later Vanessa Weatherburn), who initially is a young teacher in a private educational establishment in Cambridge and who during the course of the novels marries a mathematician and combines motherhood with detective work. In each of the novels Vanessa investigates murder mysteries: the novels also bring her into touch with contemporary social issues such as the education of girls, Lesbianism, anti-Semitism, prostitution and insanity. She comes across leading mathematicians and scientists (and, in the fifth volume) and is introduced to new technological advances, such as telegraphy, and new ideas in heredity, eugenics, the paranormal, and psychology as well as mathematics.

The first book is very neatly constructed, with a title which alludes to the mathematical Three-Body Problem – a topic of much interest to the mathematicians Vanessa meets - as well as to the triple murders which she has to investigate. Vanessa's desire to stimulate her young female pupils leads her to introduce them to some of Lewis Carroll's entertaining mathematical puzzles. As a result of one of her charges telling her family about this, Vanessa is introduced to several Cambridge mathematicians. She attends a lecture by Cayley and learns about the current controversy over the teaching of Euclid. As the plot develops her detective work takes her to Europe, where she meets Mittag-Leffler and the King of Sweden. The resolution is ingenious and mathematicians will enjoy the views of the mathematical topics of the time.

The subsequent novels involve more mathematics and mathematicians. In *The Library Paradox* it is in conversation with Vanessa, to whom Burali-Forti is trying to explain his paradox, that Bertrand Russell comes up with the idea of the set of all sets which are not members of themselves. Such in-jokes, and the gentle humour with which mathematicians are presented, are, for this reader, a large part of the appeal of these novels.

Although mathematics is so important to the plot of *The Three-Body Problem* that it might seem doubtful that the book would have any appeal to a non-mathematical reader, in fact online discussion shows that the books have acquired a following amongst those interested in the period rather than the mathematics.

The first two novels are told through letters to Vanessa's twin sister, a conceit which quickly becomes irritating: thankfully, the later novels use other narrative devices such as the narrator's case diary. It has to be said that, for me at least, the narrator is not entirely likeable. She has excessive self-confidence, betrays confidences, takes enormous personal risks and puts others at considerable risk, and interferes drastically with the lives of acquaintances.

Shaw uses mathematics extensively: the plots echo mathematical ideas, especially in *The Three-Body Problem* and *The Library Paradox*. The detailed accounts of mathematics and mathematicians in Cambridge and London at the time give pleasure to those of us who know a little of the background. But the mathematics serves another purpose.

For this reader at least, Vanessa's adventures are implausible. A teenage assistant in a small girl's school at the beginning of the series, she is quickly mixing with leading Cambridge mathematicians and then travelling around Europe, gaining a personal audience with the King of Sweden. She writes letters of thousands of words to her sister at the end of exhausting, eventful days which she describes in great detail. In later volumes she travels freely around the East End of London, making devoted friends amongst the Jewish community. She poses

as a prostitute in investigating *The Riddle of the River*. Her outrageous interference in others' lives always works out well. As the series continues, she becomes the mother of twin babies, who she adores but is able to abandon whenever and for however long the plot requires. In *Fatal Inheritance*, what is purportedly her case diary records her deliberations over whether or not to have an extra-marital affair with an attractive visiting European scientist. All of this reads more like the vivid fantasies of a teenage girl than a record of real life.

So as a twenty-first-century reader familiar with unreliable narrators, one naturally questions whether any of the events recorded have really taken place. Is Vanessa simply an imaginary teenage girl filling her time creating a fictitious, romantic future life for herself, with imaginary love interest and idealised, perfect children?

But the maths militates against this interpretation. Vanessa describes, in some detail, state-of-the-art mathematics. She tells us about the Three-Body Problem and the King of Sweden's prize for its solution, and about Poincaré's work on the problem. She doesn't fully understand them, but she describes accurately the Burali-Forti and Russell paradoxes. Our presumed fantasist might conceivably have heard of the debate in Cambridge over the position of Euclid in the curriculum, but she could hardly have invented the details of the most advanced research mathematics of the time. The hypothesis that Vanessa's adventures are her fantasy cannot stand up in view of the mathematics she describes.

So in Shaw's books the mathematics has a special role. It serves as guarantor, if not of the truth of what we are reading, at least that we can take seriously what the narrator is saying. These are more than a teenage fantasy. We can enjoy the novels without worrying about whether the whole story exists only in the narrator's vivid imagination. Of course, as Pierre Bayard has demonstrated in other cases of detective fiction (Bayard, 2000) we must remember that, like all narrators Vanessa has her own motives in writing her accounts and may be selecting her material and adjusting the facts for her own purposes. But just as the mathematical entries in Wikipedia are more likely to be reliable than the celebrity entries, because only those with some mathematical competence are able to write about mathematics, and just as Hardy could conclude that Ramanujan's amazing results 'must be true, because, if they were not true, no one would have the imagination to invent them' (Kanigel, 1991), so, in Shaw's Vanessa Duncan books the mathematics persuades us that our narrator's experiences are not entirely her own concoction.

6. Conclusion

This brief account has given some examples of the diverse uses to which writers of fiction have put mathematics. As we see also from Heather Mendick's analysis of mathematics in popular culture, the presentation of mathematics in fiction is nuanced and varied.

There are a great many more mathematical novels than have been mentioned in this paper. Alex Kasmana maintains a list of fiction involving mathematics at <http://kasmana.people.cofc.edu/MATHFICT/> and I have a less comprehensive, and less frequently updated, list at <http://staffweb.cms.gre.ac.uk/~A.Mann/Fiction>

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