Birth of a theorem: A mathematical adventure by Cedric Villani
Reviewed by Malcolm Pemberton

In 2009, the Wall Street Journal published the results of a survey designed to find out what is the best job to have based on a range of criteria including job satisfaction, stress level and salary. Perhaps just a little surprisingly the job of mathematician came top. Since then, the survey has been carried out regularly and although the job of mathematician has not completely monopolised first place, it has always been in the top handful and occasionally first. So what is it about mathematics that makes the job of mathematician so attractive? Cédric Villani makes a fascinating attempt to answer this question.

Cédric Villani won a Fields Medal in 2010 for his work on the partial differential equation governing the behaviour of plasmas. He was the Director of the Henri Poincaré Institute at the Sorbonne from 2009 to 2017. More recently, he was elected to the National Assembly of France in 2017 and is rumoured to have the ear of President Macron.

The book is arranged in the form of a diary covering the three years of his collaboration with his former student Clément Mouhot on the problem of Landau damping for the Boltzmann equation. Emails with detailed mathematics which will test the understanding even of professional mathematicians are included. But the reader should not worry because these emails simply play the role of pictures to illustrate the struggle, the frustrations and finally the success and happiness which come from the culmination of the mathematical adventure in the final solution of the problem.

Villani explains that mathematicians use the concept of a norm to measure things in complicated spaces and he gives the examples of using maximum values and of using integrated quantities. He exploits this idea in much of the rest of the adventure a recurrent theme of which is the hunt for an appropriate norm. By the night of 8-9 April 2009, he is close to despair but he wakes up the next morning with a voice in his head saying “You've got to bring over the second term from the other side, take the Fourier transform and invert in”. This turns out to be the key that unlocks the proof.

There is much in Villani’s book in addition to mathematics. He paints a vivid picture of life at the Institute of Advanced Studies at Princeton waxing lyrical about the good food but pointing out that bread and cheese are weak areas. He introduces the reader to the literature and music he likes but also makes it clear that he is a family man with a wife and children.

What does this tell us about what mathematicians do? They try to prove statements by logical argument, they have ideas and hunches, they make connections between their hunches, they make many false starts but when their hunches lead to success, they experience enormous satisfaction. Above all, it tells us that mathematicians search for the truth and mathematics can even be fun to do. Surely this means that those who make a living from doing mathematics are very lucky people indeed.
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