that the Earth's speed of rotation was slowing down. He explains the problems of the dissipation energy budget which has intrigued astronomers since Laplace. Light was shed on all this by the study of the particular case of the Irish Sea model (1919). But a final estimate for the equilibrium energy budget had to await data obtained later by artificial satellites and lunar laser-ranging measurements.

Until the dawn of the twentieth century, tidal research was carried out almost exclusively by two European countries that maintained large navies and regularly observed the effects of huge oceanic tides on their coasts: the United Kingdom and France ("the continental writers", as Cartwright refers to them). At first astronomers played a fundamental role: in Britain several Astronomers Royal, including Harold Spencer Jones, were involved, while Laplace dominated the French scene (assisted by the astronomer Alexis Bouvard, as Cartwright subtly notes).

The development of celestial mechanics and "*théories de la Lune*" led to the theory of the tides and the Laplace tidal equations, which represented the first mathematical mastery of oceanic phenomena. Lord Kelvin and George Darwin extended these equations to describe the harmonic expansion of the tides. And even at that time, it was possible to use the amplitude of tidal waves to make a preliminary evaluation of the mass of the Moon.

New horizons opened with the advent of the American Rollin Harris's *Manual of Tides* in 1901 and his construction of 'cotidal lines' which covered the world's oceans. Although George Darwin was harshly critical of this work, the great mathematician Henri Poincaré gave it generous support. Again Cartwright reminds us how Harris's intuitiveness led him to propose the existence of an underwater ridge in the Arctic Ocean; this major oceanic feature was originally called the Harris ridge, but is now known as the Lomonosov ridge.

In subsequent chapters covering the twentieth century, we find oceanographers and geophysicists taking the lead from the astronomers in the field of tidal discovery. We hear about the famous Liverpool Tidal Institute, which was important, both observationally and theoretically, in providing tidal analysis and predictions so well perfected by Arthur Doodson that they delayed the use of computers in this area. In these same chapters, Cartwright approaches the difficult aspects of pure mathematics with clarity, describing, for example, the theory developed by Joseph Proudman, George Goldsbrough and Doodson to describe tides in basins and oceans as represented by simple geometrical shapes.

The last three chapters see tidal research extended over the entire world, and describe events known to most readers, and during which Cartwright himself had a key role. This was the time when, with the introduction of computers, the first global model of ocean tides was calculated by Chaim Pekeris in 1960, when ocean tidal loading was introduced in the Laplace equations, while in 1979 the models of Ernst Schwiderski described 11-diurnal, semi-diurnal and long-period tides. During this time also, George Platzman calculated the normal modes of oscillation of the ocean, and a method for analysing and predicting tides, known as the 'response method', was developed by Cartwright and Walter Munk.

The book ends with the more recent years (one of the last references is from 1996), which see technological advances — bottom pressure recorders and superconducting gravimeters, for example, but in particular satellite altimetry, which, with the US/French TOPEX/Poseidon satellite, has attained the incredible accuracy of ±3 centimetres in measuring the distance between the satellite antenna and the sea surface.

I really enjoyed this book, and consider it a masterpiece. I was delighted to find, among its many high-quality illustrations, George Darwin's ingenious drawing of the evolution of the Earth–Moon system, as I used to set this as an exercise for my students.

Obviously, the book is primarily written for astronomers, geophysicists and all those known as 'tidalists', who will surely enjoy it. But I also recommend it to physicists and pure mathematicians. □

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My Brain is Open: The Mathematical Journeys of Paul Erdös
by Bruce Schechter
Oxford University Press/Simon & Schuster: 1998. 224 pp. £22.50/$25

Alexander Masters

When Paul Erdös "left" (as he called it) in 1996, even *The New York Times* took notice, and printed a front-page obituary calling him "a wayfarer in math's vanguard". Two years later, Paul Hoffman published an excellent biography about him called *The Man Who Loved Only Numbers* (Fourth Estate/Hyperion, 1998; reviewed in *Nature* **394,** 535–536; 1998), which reached number three in *The Sunday Times* best-seller list. Now Bruce Schechter has followed this up with a second biography, *My Brain is Open*. In his 83 energetic years, this peculiar, obsessive little mathematician has built up a substantial public following.

Erdös was born in 1913 in Hungary, and discovered negative numbers when he was four. He belonged to that extraordinary cluster of scientific geniuses — which included John von Neumann, inventor of the electronic computer and game theory, and the Nobel prizewinners Eugene Wigner, George de Hevesy and George Olah — who emerged from two or three schools in Budapest after the First World War.

During his life, Erdös wrote more than 1,500 papers, books and articles, more than any other mathematician ever. Some of these became the great classics of our century, opening up entirely new fields of study to which generations of mathematicians have devoted their lives. As the mathematician Paul Winkler said, "If I can see a bit farther it is because I stand on the shoulders of Hungarians".

Schechter is particularly concerned to clarify a few of the basic ideas underlying this astonishing production, such as the sieve of Eratosthenes, Cantor's infinities and Euler's curious problem (the foundation of graph theory) about whether a man could walk across all seven bridges of Königsberg without crossing the same bridge twice. It is inspiring reading, because Schechter, following in the spirit of Erdös, makes clear that much good mathematics can come from whimsical speculation and the clever use of simple ideas. If popular writing about mathematics remains of this quality, there is still enough unused material for a shelf-full of Erdös biographies.

In other respects, Hoffman's book is slightly longer and better on anecdotes, but Schechter's, while not so lively, is less inclined to get distracted from its subject. Although you would never guess it from the acknowledgements, both writers once worked for *Discover* magazine. Erdös's famous love of creative cooperation has apparently not spilt over into the world of mathematical biographies.

From his teenage years, when he could instantly square a four-digit number and knew 37 proofs of Pythagoras's theorem, Erdös called himself old and decrepit. A few years before his 60th birthday he appended the letters PGOM to his name, which stood for Poor Great Old Man, then added further initials every few years. By the time he was 75 he was PGOMLDADLDCD (Poor Great Old Man, Living Dead, Archaeological Discovery, Legally Dead, Counts Dead).

His output had slowed down a little by then. "One of my greatest regrets," remarked one of his last collaborators, "is that I didn't know him when he was a million times faster than most people. When I knew him he was only hundreds of times faster." □

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