

UNIVERSITY OF TORONTO

Keith Brian Ranger
1935-2007



Keith Brian Ranger died on February 28, 2007 in Toronto. He joined the Department of Mathematics in 1961, two years after an assistant lecturer appointment in England which followed the completion of both his undergraduate and graduate training at University College, London, in 1959. He published throughout his career, and remained active after retirement with the last of his over 120 papers bearing the date 2007.

His thesis developed new solutions for the Stokes equations which govern slow flow in a viscous fluid, and almost all of his subsequent work revolved about that central focus. The approach he took belonged to the tradition of classical applied mathematics as developed in the nineteenth century by people such as Kelvin, Navier and Stokes, whereby a complicated physical problem is reduced to a simplified mathematical model, while still retaining the effects of the essential forces; when the resulting partial differential equation is solved, the results can be interpreted physically to gain new insights into the nature of the actual behaviour. His early work in Toronto had two main directions: first, there was the introduction of magnetic effects in a conducting fluid in the then burgeoning study of MHD flows in which he made many and varied contributions to an understanding of fluid flow at low Reynolds and Hartmann numbers. Second, in a more mathematical view, he developed new approaches for solving the governing fourth order equation for slow viscous flow through first breaking it down into two separate second order equations belonging to a class from the theory of generalized axisymmetric potentials developed by Weinstein; different integral representations, appropriate for distinct geometries, were then found through quite ingenious analytical techniques. (Parenthetically, it can be stated that this expertise in practical analytical methods was displayed in the two advanced courses he taught for many years on partial differential equations and asymptotic methods. Each year a number of physics and engineering graduate students were explicitly advised by their supervisors to take these courses, and more than one (now distinguished scientist) has been heard to say effectively that "it was Ranger who taught me all my mathematics".)

These mathematical results became the main tools when he turned to consider the phenomenon of separation for slow viscous flow. Separation at high velocities had been studied both analytically and experimentally from the early 1900s, but there was some belief when, in 1950, Dean indicated that the equations showed the possibility of this phenomenon at very low velocities; however, no examples were given and the doubts remained. It was Ranger who, in 1976, gave the first clear example when, using the techniques he had developed earlier, he solved the equation for the slow flow past a spherical cap . in closed form, remarkably and precisely gave a plot of the resulting streamlines; subsequent experiments showed as complete an agreement as can ever be expected in such a situation. The fact that the paper announcing the result was co-authored by his doctoral student and a colleague though both acknowledged the essential role of Ranger in its development, illustrates his generosity in incorporating others even in his most important work.

A flurry of other papers followed this breakthrough result, and further examples of separated flow were presented. Increasingly, however, a greater value was seen in the careful plotting of the streamlines for the different problems which the precision of his solutions made possible, with a consequent clearer understanding of the basic kinematics. These papers established his reputation amongst the fluid mechanics community, particularly with many chemical engineers

who had a wider catalogue of flows to boost their intuitive understandings, and with workers in computational fluid dynamics who had exact solutions on which to test their numerical schemes.

His election to the Royal Society of Canada in 1979 was based on the value of these contributions. His subsequent publications continued to expand on this earlier work with one new application.

There was a realization that the flow of blood near a branching in the arteries could separate, thereby forming eddies which would lead to (dangerous) deposits on the wall. Through a positive exchange of ideas with cardiologists, models were developed to help describe this process, and the solutions were able to indicate where on the wall the deposits are more likely to form. Other papers followed which considered the effects of stenosis; consequently, he became involved in the early stages of the now popular study of biofluidynamics.

In 2004 Ranger received the Arthur Beaumont Distinguished Service Award from the Canadian Applied and Industrial Mathematics Society, which recognized (as stated in the citation) his contributions to the early development of the Canadian Applied Mathematics Society, as well as having served for many years on the Editorial Board of the Canadian Applied Mathematics Quarterly, and as a founding member of the Canadian Symposium on Fluid Dynamics.

Credits to the University of Toronto