G I Taylor – An Amateur Scientist

Geoffrey Ingram Taylor made outstanding contributions to the mechanics of fluids and solids spread over about 60 years starting in 1909. He was both an experimenter and theoritician of distinction.

Born on 7 March, 1886 in London to Margaret and Edward I Taylor, Geoffrey had a quiet and contented childhood. His father, an artist, worked at home and could devote time to Geoffrey and his brother, and often took them to the countryside and river. Taylor seems to have inherited his extraordinary talents from his mother's side which constisted of many members 'showing a clear disposition to independence and originality'. His grandfather George Boole originated Boolean algebra; George Boole's father, though a common cobbler, was interested in mathematics and in making optical instruments; aunt Alice, an amateur mathematician, worked on four dimensional geometry.

The Christmas lectures at the Royal Institution (an annual event initiated by Faraday) given by Sir Oliver Lodge on wireless telegraphy in 1897 that Taylor attended had a decisive influence. Years later Taylor commented, "I wish I could again capture the exquisite thrill those lectures gave me. From that time I knew I wanted to be a scientist.". There were early signs of his capabilities. At the University College School where Taylor studied the perceptive Headmaster noted in a testimonial that " I have had no boy of whom I would say with more confidence that he was likely to excel in original research". As a boy of 18 he built a boat at home and developed a life long passion in sailing, which led to, in adult life, the invention of the CQR anchor (see articles on p. 10, p.88) and the winning of the Club Cup of the Royal Cruising Club in 1927.

In 1905, with the help of a scholarship and supplementary funds from the local county council, Taylor joined Trinity college and completed his BA in mathematics and physics. A major scholarship enabled him to stay in Cambridge for research. He worked under J J Thomson on light quanta and interference. It is remarkable, however, that Taylor was not sucked into the then exciting field of quantum physics, but instead chose an independent path in mechanics. An appointment as Reader in Dynamical Meteorology at Cambridge University initiated him into research in turbulence. It was an inspired and bold decision by the committee in choosing a young man of 27 who had no knowledge of meteorology. He initiated some experiments to measure the fluctuating velocities in the atmosphere, but it was the Scotia expedition that saw Taylor bloom. The Scotia expedition, on a wooden whaling boat, was meant to study icebergs in the aftermath of the Titanic disaster. Showing characteristic ingenuity, Taylor launched balloons and kites to measure the vertical distributions of temperature and humidity up to a height of 2000 m. From these experiments Taylor came up with fundamental ideas and theories on the transfer of momentum and heat due to turbulence.

The exciting developments of powered flight and World War I inevitably drew Taylor to aeronautics. He learnt to fly, made the first measurements of the pressure distribution on a wing in flight, and a study of the failure of propeller shafts led to the famous 'Taylor dislocation theory'. During the war, he was commissioned as a meteorologist by the British Air Force.

In 1919, after World War I, Taylor returned to Cambridge, as a lecturer of mathematics at Trinity College. Taylor did not like teaching or administration. Therefore the appointment in 1923 as Yarrow Research Professor, which relieved him of teaching and other duties, suited him just fine. At this time he developed a long friendship with Rutherford. In 1925 he married Stephanie Ravenhill, a teacher of modern languages, who was to become his life long companion and accompanied him on many of his sailing expeditions. A person who greatly contributed to Taylor's success as an experimentalist was Walter Thompson, a technician who remained with Taylor for 40 years. Thompson made all Taylor's apparatus usually just from rough sketches.

Taylor started a new phase of extremely productive research in, among other things, dissipation of tidal energy, rotating flows and stability of what is now known as Taylor–Couette flow. However his major contributions were in plasticity and turbulence. During World War II, because of his profound understanding of mechanics and physics, he was a much sought after consultant on a variety of problems. He was involved in the Manhattan Project. Noteworthy here is a similarity solution that Taylor obtained for the propagation of a blast wave, and using which he obtained a surprisingly accurate estimate of the yield (16.8 kilotons of TNT as against the actual value of 20 kilotons) of the first atomic explosion based on the (unclassified) pictures released.

The post war period saw Taylor guide several students, G K Batchelor, A A Townsend, P G Safmann among them. These are well-known names to the fluid mechanics community. Taylor continued to work on many interesting problems, including swimming of microscopic organisms, using characteristically simple and ingenious experiments. Swimming of microorganisms is at low Reynolds numbers and dominated by viscous forces, and is quite different from swimming of larger bodies, like fish, which is dominated by inertia forces. The ubiquitous airfoil sections found in the high Reynolds number world of birds and fish do not make efficient propulsion elements at the micron scale. A fluid mechanics student usually sees first hand Taylor's ingenuity in his film, 'Low Reynolds Number Flow'.

The gamut of problems that Taylor studied is remarkable. He along with L Prandtl dominated the fluid mechanics scene during the first half of the 20 th century. Taylor had high regard for Prandtl and pushed the case for Prandtl getting the Nobel Prize. Taylor felt that the bias was too strongly in favour of atomic physics. Taylor was a happy, simple man. He considered himself an amateur much like "his grandfather, George Boole, and others like B. Franklin and Ramanujam". It was simple curiosity and the fun of unravelling the working of nature, which guided his research. To a scientist today it will seem remarkable that Taylor never had a secretary, applied for a research grant or felt a need to take sabattical leave. The final years were not so happy. Taylor suffered a stroke in 1972 that left his left side paralysed, and the intervening years till his death in 1975 were frustrating ones.

Suggested Reading

[1] George Batchelor, *The Life and Legacy of G I Taylor*, Cambridge University Press, 1996

[2] *The Scientific Papers of Sir Geoffrey Ingram Taylor*, (Vols. I-IV), Ed G KBatchelor, Cambridge Universities Press, 1971.

[3] G K Batchelor, An unfinished dialogue with G I Taylor, *J. Fluid Mech.*, Vol.70, pp.625-638, 1975.

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