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Hayes, Michael A

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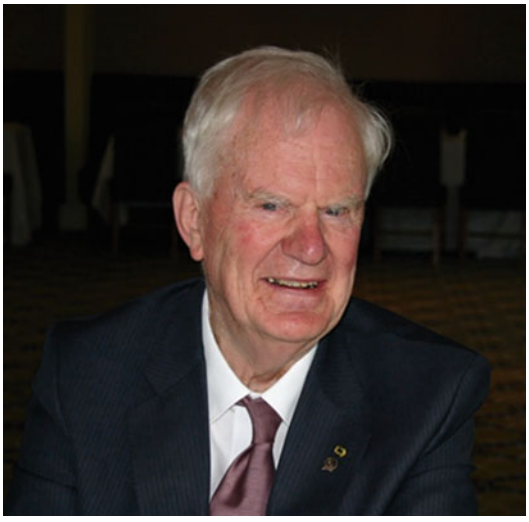

Michael A Hayes

Michael A. Hayes (*August 02, 1936 in Kilfinane, County Limerick, Ireland; †January 01, 2017 in Dublin, Ireland) was a mathematical physicist with special interests in finite elasticity, elastic wave propagation, and the use of ellipses in mechanics.

Early Life and Education

Michael Hayes was born in the small market town of Kilfinane, in County Limerick, Ireland, on August 02, 1936. He was the second of four sons. He first attended the local primary school and then moved with his family to the city of Limerick. There he attended the Christian Brothers secondary school of Sexton Street, where his facility with mathematics and science was quickly recognized.

In 1953 he was awarded an Open State Scholarship to study Mathematical Science at University College Galway (now NUI Galway) through the medium of the Irish language, gaining his BSc in 1956, followed by an MSc. While at Galway, he was awarded the Sir Joseph Larmor Prize and was an Assistant Lecturer in Mathematics and Mathematical Physics.

Having gained an NUI Travelling Studentship, he selected Brown University, Rhode Island, USA, for his doctoral studies, under the direction of Ronald S. Rivlin. There he worked on wave motion in elastic solids and the related concept of stability and was awarded his PhD degree in 1961.

H. Altenbach, A. Öchsner (eds.), *Encyclopedia of Continuum Mechanics*,
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Professional Career

After Brown, Mike Hayes spent a year at Johns Hopkins University, Maryland, USA, to work with the group of Jerry L. Ericksen and then joined Alfred E. Green's research group at Newcastle University, UK. In Newcastle upon Tyne, he met and married Colette who was to be his wife of more than 50 years. His successive professional positions were at King's College (Newcastle upon Tyne, UK), the University of Ife (Ibadan, Nigeria), and the University of East Anglia (Norwich, UK). Finally, in 1973 he was appointed Professor and Head of the Department of Mathematical Physics at University College Dublin, Ireland, where he eventually became Emeritus Professor of Mechanical Engineering.

Among several honors and accolades, Michael Hayes was elected a Member of the Royal Irish Academy in 1980, the Secretary General of the International Union of Theoretical and Applied Mechanics (IUTAM) from 1996 to 2000, and Member-at-Large of the IUTAM General Assembly from 2000 to 2004. A triple special issue of the journal *Mathematics and Mechanics of Solids* celebrated his scientific life and work in 2005.

Scientific Work

In more than 50 years of active research, Mike Hayes wrote over one hundred scientific papers in Applied Mathematics and Mechanics and a monograph with Philippe Boulanger on bivectors (complex vectors) in 1993. At first under the guidance of his advisor RS Rivlin and other actors of Continuum Mechanics such as JL Ericksen and AE Green, and then as an independent researcher, he wrote fundamental papers in the field of nonlinear elasticity and tackled classical problems of continuum mechanics, with particular interest in the theory of wave propagation in solids.

His most famous and cited papers were on waves in elastic materials. These papers have had a deep impact in the research activity on the characterization and stability of elastic materials and are, to this day, still used in the geophysical modeling of soil and in the theory of acousto-elasticity; see, for instance, the handbooks by Pao et al. (1984) or by Kim and Sachse (2001).

For example, Hayes and Rivlin (1961) were able to extend the formulas giving the speed of elastic waves propagating in an infinite media (body waves), or on a half-space (Rayleigh waves), or on a layered structure (Love waves) to include the effect of a pre-deformation, using the theory of small deformation superimposed on large (also known as the incremental theory of nonlinear elasticity). Mike Hayes also studied the implications of these formulas into stability theory (material and geometric stability, strong ellipticity, uniqueness, etc.) and into the propagation of waves of finite amplitude in the exact theory of nonlinear elasticity (Boulanger and Hayes 1992).

In a short and elegant paper (Hayes 1977), he was able to condense to three pages a previous result by Rayleigh that "the mean energy flux velocity vector for a single infinite train of elliptically polarized harmonic small amplitude plane waves propagating in a homogeneous conservative, dispersive system is equal to the group velocity."

He also used the language of ellipses to describe waves in a complete and systematic way. These geometrical objects are routinely used to characterize the planar polarization of a wave motion; Hayes showed that they can also be used to describe the (complex) propagation vector of inhomogeneous plane waves, for which the planes of constant phase are not parallel to the planes of constant amplitude (Hayes 1986). He dedicated a large body of work to this field, drawing parallels with the theory of quaternions instigated by Hamilton and studying in great depth the geometrical properties of complex vectors, the so-called bivectors. The results of this endeavor are collected in his monograph (Boulanger and Hayes 1993).

He was engaged with Millard Beatty in developing a deep understanding of internal constraints in finite elasticity. In a series of three long papers, best summarized in the book chapter by Beatty (2001), Beatty and Hayes provided a

general and rigorous theory of the so-called Bell constraint in nonlinear elasticity.

His papers were characterized by mathematical rigor, a firm grasp in applications, and a crisp and elegant writing style.

Over the years, he attracted several graduate and postgraduate students to work with him, NH Scott (University of East Anglia), PK Currie (University College Dublin), CA Horgan (University of Virginia), M Destrade (NUI Galway), and G Saccomandi (Università di Perugia), to name a few, and countless collaborators from all over the world, most notably MF Beatty (University of Nebraska), KR Rajagopal (Texas A&M University), and his closest collaborator, Philippe Boulanger (Université Libre de Bruxelles), with whom he wrote more than 40 papers.

Cross-References

- ▸ Carroll, Michael M
- ▸ Ericksen, Jerald Laverne
- ▸ Green, Albert Edward
- ▸ Love, Augustus Edward Hough
- ▸ Surface Waves
- ▸ Waves in Continuous Media: Classical Theory

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