

## Edward Raymond Andrew

Raymond Andrew was one of the first physicists in the UK to get involved with the technique of nuclear magnetic resonance (nmr), developed just after the second world war in the USA. His career in this subject spanned the years from 1948 until his death. His contributions included the development of the technique as a structural tool in organic solids, the invention of the magic-angle method of narrowing the resonance lines in solids, an understanding of the effects of the nuclear quadrupole moment on both the static and dynamic aspects of nmr, and an early recognition and development of the application of the technique to biological studies. This later work included a contribution to the massive success of Magnetic Resonance Imaging (MRI), now widely used in most hospitals as an imaging technique for the human body. He held chairs in the universities of Wales in Bangor, Nottingham and Florida, Gainesville, during his career and wrote the first textbook for nmr, published in 1955, with a Russian translation following shortly after.

Born in Boston, Lincolnshire, the only child of English parents, but with some Scottish blood in the lineage of both parents, he was educated at Wellingborough School, where he was head boy, before going up to Christ's College, Cambridge in 1939, obtaining first class honours in both Part I and Part II of the Natural Sciences Tripos, and taking a BA in 1942. His college tutor here was the novelist and two cultures polemicist C P Snow. Sir Lawrence Bragg FRS was the Cavendish Professor at this time and other supervisors included David Shoenberg FRS and Norman Feather FRS. Thereafter followed three war years as a Scientific Officer at the Air Defence Research and Development Establishment in Malvern, where his project involved the effects of gunflashes on X-band radar.

1945-48 were years as a research student at Pembroke College and the Cavendish, working with David Shoenberg on problems of the penetration of magnetic fields into Type I superconductors and a PhD ensued in 1948; Kapitza having been Shoenberg's PhD supervisor, Andrew later won a USA-wide competition for the most distinguished academic 'parentage'. A Commonwealth Fund Fellowship then took him off to Harvard for a year's 'post-doc' appointment, where he rubbed shoulders with the nmr pioneers around Ed Purcell. He collaborated closely with Bersohn on a paper concerned with the nmr lineshape of an interacting triangular array of nuclei, the next step up in complication from the famous Pake doublet due to a pair of interacting nuclei. He returned in 1949 to join former Cavendish and low temperature physics colleague Jack Allen F.R.S , recently appointed to the chair at St Andrews, where he set about building up an nmr presence. Early experiments with students and colleagues Bob Eades, Dan Hyndman and Alwyn Rushworth focused on dynamic effects on nmr linewidths in organic solids such as cyclohexane and benzene. The broadening of the linewidths due to modulation in these continuous wave experiments was quantified.

His appointment to the chair at the University College of North Wales, Bangor, in 1954, was followed rapidly by the publication of his nmr book (the first monograph on the subject) and to the development of the magic angle spinning technique. Andrew and Eades developed the idea, that if a solid sample is spun fast enough in the main nmr magnetic field, and at the magic angle, the resonance line will narrow markedly in a way that mimicked the sharp narrowing in resonance that occurs when solid samples are melted into liquids. The importance of this advance is difficult to overstate, although it took a while, maybe twenty years, before its true significance for the chemistry of materials was realized. Having solved all the technical problems of rapid spinning, the group even toyed for a while with the radical idea of generating the same effective narrowing by leaving the sample static but rotating the main magnetic field. About this time, in the late 50's, funding became available for a state-of-the-art 60MHz commercial nmr machine, with AEI winning the contract. There followed many experiments exploring the effects of the nuclear quadrupole moment on resonance lineshapes and on relaxation; 30 years on, in the late 80's, the high temperature superconductors needed these relaxation ideas to explain their relaxation curves. Whilst at Bangor he also became the founder Chairman of a UK group, the British Radio-frequency Spectroscopy Group, B R S G, which flourishes to this day.

1964 saw him move to the Lancashire-Spencer Chair of Physics in Nottingham, succeeding the magneticist L F Bates; nmr flourished there under Raymond's leadership for the next nineteen years, and he appointed several others who became prominent team leaders. He continued to forge ahead with his own experiments. It was in the early 70's that he began using nmr as an application to biological topics, such as amino acids and proteins. A short step here took him into the then new field of nmr imaging, the now common-place imaging method used in hospitals known as M R I . Nottingham became an important centre for this application of nmr, and is a world centre to this day. His early colloquia on this topic used to feature a slice through a lemon, where the pip could be clearly distinguished. His lecturing method was admirable; he always seemed able to gauge the audience's abilities and adapt his exposition accordingly.

An offer of a research chair in Florida with no retirement stipulations tempted Raymond to move in 1983 and he continued there as the Graduate Professor of Radiology, Physics and Nuclear Engineering until his death. The themes of his work in Florida continued those of his later years in Nottingham. He published in all *circa* 300 papers in his working lifetime.

He was a great traveller throughout his career and this led on to many honours and participation in the upper echelons of the magnetic resonance world. He was the President of the Groupement Ampere from 1974-80, and presided over a very successful Ampere Congress in Nottingham in 1974. From 1976-79 he was the UK chairman of the Standing Conference of Professors of Physics, and from 1983-86 he presided over the International Society of Magnetic Resonance. Journal editorships included Magnetic Resonance in Medicine, Physics Reports, Journal of Magnetic Resonance, Chemical Physics Letters and the Bulletin of Magnetic Resonance. Honorary Degrees were awarded by Leipzig, Poznan, Turku and Wales, and he won the Wellcome Foundation Medal and Prize in 1984. The Distinguished Service Medal of the Society of Magnetic Resonance in Medicine was awarded in 1991. Elected to the Fellowship of the Royal Society of Edinburgh in 1952, he became a Fellow of the Royal Society in 1984.

He first married Mary, with whom he had twin daughters; Mary died in 1965 and Raymond married Eunice in 1972. He is survived by her and by his daughters, Patricia and Charmian.

**David Tunstall**

**Edward Raymond Andrew: born 27 June 1921; Elected FRSE 3 March 1952; died 27 May 2001.**