Introduction, Another Nobel Prize in Fifty Years of Magnetic Resonance

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In this issue of the *Bulletin of Magnetic Resonance*, we celebrate the success of one of the leaders of modern magnetic resonance. In 1991, Richard R. Ernst received the Nobel Prize in Chemistry for his major contributions to the development of Fourier transform and multidimensional NMR. This year, 1994, represents the 50th anniversary of the discovery of electron paramagnetic resonance by Zavoisky (1) as reported in his 1944 Thesis (Figure 1). Next year, 1995, represents the 50th anniversary of the discovery of nuclear magnetic resonance and the subsequent publication of the results in 1946. These experiments of E. M. Purcell, H. G. Torrey and T. V. Pound at Harvard (2) and F. Bloch, W. Hansen and M. E. Packard (3) at Stanford ultimately led to the award of the first Nobel Prize in nuclear magnetic resonance to Bloch and Purcell in 1952. In fact 1994 also represents the 50th anniversary of the award of the Nobel Prize to another famous researcher in the field, Isidor I. Rabi for his groundbreaking molecular-beam experiments (4). A very lucid discussion of the early history of magnetic resonance can be found in a *Bulletin* article by Norman Ramsey (5).

In this special issue of the *Bulletin*, we have reproduced the Nobel Prize award lecture of Richard Ernst. In addition articles from some of his past coworkers and other eminent NMR spectroscopists have been included. As noted by Dr. Ernst, both in his article and in an ISMAR 1992 Special Plenary Lecture, his success rests on the many significant contributions of others in the field.

Unlike almost all other fields of science, the theory and application of magnetic resonance has been on an exponentially rising curve for the past 50 years. Normally in science we expect an exciting new field to draw initially many new participants to it (the "bandwagon" phenomenon) with a resulting explosion of new discoveries. However, once many of the major questions are answered, an equilibrium in the population of top scientists is established. The result is an S-shaped curve characterizing the vitality of a field with time. Ultimately as the field passes from favor (fewer grant funds!), many participants migrate to the next exciting development in science. This often leads to an actual decrease of scientists in the field. The vitality of the field is now better characterized by a bell-shaped curve.

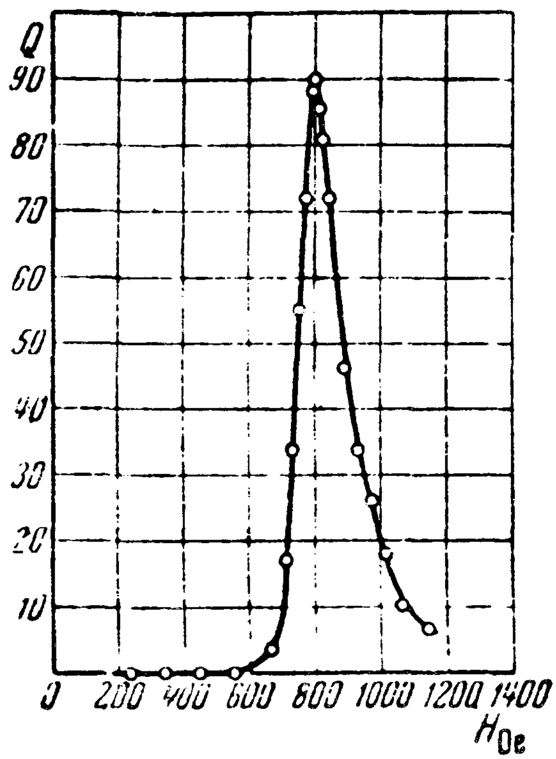

Figure 1: Electron paramagnetic resonance spectrum of $CrCl_3$, from Zavoisky (1).

The lifetime of a field in science is often disturbingly short, 15 to 25 years. However, this has not been the case with magnetic resonance, where we find that even after these past five decades we still are on the rising exponential portion of the curve. The reason for the difference of course is that there have been numerous ways of inventing new and exciting applications and understanding of magnetic resonance. As pointed out by R. Ernst (6), "I am not aware of any other field of science outside of magnetic resonance that offers so much freedom and opportunities for a creative mind to invent and explore new experimental schemes that can be fruitfully applied in a variety of disciplines."

In the first wave physicists discovered much basic magnetic resonance theory. This is still going on today as evidenced by the continued strong participation of physical scientists in the meetings of the International Society of Magnetic Resonance. Early on chemists began to recognize the importance of the chemical shift and coupling information as a way to identify the structure of molecules. A new wave of interest developed as commercial machines were built and that wave also continues to this day. Biochemists followed in turn as instruments became more sensitive and applications to biomolecular structure and function took off. That wave especially continues to expand exponentially today following the more recent introduction of Fourier transform, 2D and now multidimensional NMR spectroscopy – fields richly contributed by Richard Ernst.

I don't believe that any of the early visionaries of magnetic resonance would have thought that NMR, with such low sensitively, could ever be used for 3D imaging. Magnetic resonance imaging and spectroscopy now constitute a fourth phase of this explosion, and now we are also seeing new developments in solid state magnetic resonance and materials science that hold much promise as well for the future. Each of these waves has brought forth ever more diverse and creative scientists into our field.

In this issue Anil Kumar describes his journey through Richard Ernst's laboratory. Jean Jeener, the pioneer of the first 2D NMR pulse experiment, takes us on a journey through time in quantum dynamics. Alexander Wokaun and colleagues describe an algorithm that may help lead to automated assignment of multidimensional NMR spectra. Ole Sørensen describes some novel pulse sequences for multidimensional NMR. Mark Rance again returns to multidimensional NMR (clearly a popular field!) and methods for improving sensitivity. Alex Pines and colleagues describe some of their pioneering developments in dynamic-angle spinning. Slobadan Macura and colleagues take us back to 2D NMR and motional effects in cross-relaxation/exchange spectroscopy. Malcolm Levitt and colleague present a novel method for treating spin dynamics using the homogeneous master equation. Anil Kumar returns with his colleagues to discuss the importance of cross-correlations in 2D NOE experiments. Finally, one of the first pioneers of pulsed NMR spectroscopy, Erwin Hahn describes with his colleague some nuclear electric resonance detection.

Where is it all going? As pointed out by Richard Ernst, following the discovery of X-rays many Nobel Prizes have been awarded in that field, including medical and biomolecular structure applications. It is rather obvious that over the next 50 years we will also see many more major magnetic resonance discoveries and applications, with numerous other Nobel Prizes and awards to come.

REFERENCES

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P.S. The next meeting of ISMAR will be held in Sydney, Australia from July 16–21, 1995. The council is discussing several possible sites for the 1998 meeting in Europe. If you are interested in hosting the next ISMAR meeting in 2001, please contact the president of the society:

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Clearly the field of magnetic resonance will be thriving into the next century.