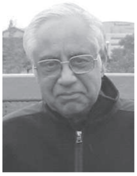
Editorial

Anil Kumar and S V Bhat, Editors



Email:
anilnmr@physics.iisc.ernet.in

Email: svbhat@physics.iisc.ernet.in

The phenomenon of electron paramagnetic resonance (EPR), also known as electron spin resonance (ESR) was discovered by the Soviet physicist E K Zavoisky in 1944 at the Kazan State University. It appears that Zavoisky looked for and may also have observed nuclear magnetic resonance (NMR) as early as in 1942 but the signal was not very reproducible due to the inhomogeneity of the magnetic field he used. Then, the Second World War interrupted his work and when he came back to the laboratory after the war, he focussed on and succeeded in observing EPR, where the homogeneity was less crucial. It is interesting to note how the war affected and also aided the discovery of both NMR and EPR: the teams of Edward Purcell and Felix Bloch who independently discovered NMR in 1945 participated in the war effort and this experience is known to have played an important role in their success in observing the first NMR signal. Purcell and Bloch went on to share the Nobel Prize in Physics in 1952 for this work.

Thus historically, EPR was discovered earlier than NMR, and is the older of the two sister disciplines. But as often happens in other fields of human activity (e.g., Venus and Serena Williams in tennis, Karishma and Kareena Kapoor of Bollywood), the younger NMR has overtaken the elder EPR in technological innovations and applications in different fields such as physics, chemistry, biology and medicine. The reasons for this are not far to seek: while the basic concepts of the two phenomena are analogous, more-than-three-orders of magnitude larger magnetic moment of the electron compared to that of the proton has two crucial implications: one technological and the other fundamental. Typical resonance frequencies for EPR are three orders of magnitude higher (in the microwave range versus the RF range) and the relaxation times orders of magnitude shorter (nanoseconds versus microseconds) compared to the ones encountered in NMR. This makes it so much more difficult to perform EPR experiments corresponding to similar experiments in NMR. Thus in the first few decades after their discovery, while NMR developed in leaps and bounds, EPR was struggling to keep pace. However, with the latest technological advances, EPR is catching up with NMR, be it in distance determination in biological molecules or imaging. In fact, one of the latest trends currently is the combination of the two phenomena in experiments such as dynamic nuclear polarization, as if NMR and EPR were partnering in a ‘doubles match’!

NMR originated in an attempt to determine nuclear magnetic moments accurately. However, there was obviously much more to the phenomenon: in his Nobel Lecture, Purcell remarked: "...I remember in the winter of our first experiments, just seven years ago, looking on snow with new eyes. There the snow lay around my door step – great heaps of protons quietly precessing in the earth's magnetic field. To see the world for a moment as something rich and strange is the private reward of many a discovery...." In the words of Harald Cramér, member of the Royal Swedish Academy of Sciences, Bloch and Purcell "..opened the road to new insight into the micro-world of nuclear physics. Each atom is like a subtle and refined instrument, playing its own faint, magnetic melody, inaudible to human ears. By their methods, this music has been made perceptible, and the characteristic melody of an atom can be used as an identification signal. This is not only an achievement of high intellectual beauty – it also places an analytic method of the highest value in the hands of scientists." Romanticism apart and true to the spirit of the previous sentence, in the seven decades subsequent to their discoveries, NMR, and to a lesser extent EPR, have developed into enormously powerful experimental techniques, indispensible in the fields of physics, chemistry, biology and medicine. The development of MRI in the 1970's proved to be an extraordinary boon to common man and is a glowing example of non-directed research and is now hailed as "one of the major contributions of 20th century science to humanity". The two experiments also provide convenient platforms to visualize and study quantum behaviour of spins. It is not surprising therefore that applications of both NMR and EPR to quantum computing and quantum information processing are being vigorously pursued.

This journal has earlier carried a few articles on NMR[1]. Expanding on the topics covered in these articles, this theme issue on 'Magnetic Resonance' is being brought out to mark the notional 70th year of the discovery of the phenomena as well as to give a bird's eye view of the current status of the two fields. We have tried to put together articles written by experts in various specialized applications of the two techniques along with articles on early history and future prospects of NMR along with the biographical sketches of the three persons featured on the back-cover. However, we are aware that 'Magnetic Resonance' is very much a 'Work in Progress' and we believe that in the not too distant a future there will be occasions to publish more articles on the topic.

[1] Siddhartha P Sarma, Determination of structures of proteins in solution using nuclear magnetic resonance, *Resonance,* Vol.8, No.8, 2003.

Susanta Das, Nuclear magnetic resonance spectroscopy, *Resonance,* Vol.9, No.1, 2004.

Kavita Dorai, Magnetic resonance imaging: window to a watery world, *Resonance,* Vol.9, No.5, 2004.