

The Scientific Life and Work of René Freymann (1909–1995)

Abstract. René Freymann was born in Paris (1909), where he was graduated up to the Doctorate of Science (1933). He was Lecturer (1945), then titular Professor (1950) at the Faculty of Science of Rennes. He came back to Paris as full Professor at the Sorbonne (1956–1968) and then at the University Pierre and Marie Curie – Paris 6 (1968–1979). He died in Paris on February 11, 1995. In the first part of his career (1929–1950), the research work of René Freymann was devoted to infrared and Raman spectra, and then to dielectric constant and absorption measurements at metric and decimetric wavelengths. A few years after the discovery of magnetic resonance, René Freymann founded the Groupement AMPERE in 1952, for mutual information of scientists and organization of Congresses in the field of magnetic resonance and related phenomena. René Freymann also engaged his laboratory in the field of nuclear magnetic resonance, while continuing his work on the previous fields of infrared and Raman spectra, dielectric measurements, etc. In 43 years (1952–1995), the Groupement AMPERE has organized 70 scientific meetings on magnetic resonance and related phenomena. In half a century, Freymann's group published more than 50 theses and 540 papers. Such a successful work is also due to the communicative enthusiasm of René Freymann and to his exceptional human qualities.

1. The Scientific Career of René Freymann

Born on February 6, 1909, in Paris, René Freymann successively obtained the following diplomas, titles and positions:

- Bachelor of Science (Paris, 1928), Master of Science (Paris, 1930),
- Laureate of the French Physical Society, Price Louis Ancel (1932),
- Doctor of Science (Paris, 1933),
- Holder of a Scholarship of the National Fund of Scientific Research (1934),
- Research Fellow of the French National Center of Scientific Research (1936),
- Laureate of the French Academy of Sciences, Price Clément Félix (1938),
- Master of Research at the National Center of Scientific Research (1945),
- Lecturer at the Faculty of Science of Rennes (1945),
- Member of the Council of the French Physical Society (1948),
- Titular Professor (at personal title) at the Faculty of Science of Rennes (1950),

- Member of the Council of the French Society of Radio-Electricians (1952),
- Titular Professor of the Chair of General Physics at the Faculty of Science of Rennes (1956),
- Nominated Member of the National Committee of Scientific Research (1956),
- Full Professor at the Sorbonne (1956–1968) and then at the University Pierre and Marie Curie – Paris 6 (1968–1979).

2. The Research Work of the First Period: 1929–1940

This work was carried out at the Laboratory of Physical Research at “La Sorbonne” (which was the name of the old University of Paris) under the supervision of Professor Aimé Cotton.

René Freymann’s first work (1930) was to study various luminous phenomena at electrodes during electrolysis. He namely observed that the luminescence spectrum which is produced during electrolysis of aluminium seemed to be continuous. After this first work on atomic spectroscopy, René Freymann devoted himself to spectral methods for examination of molecular structure. Before beginning the spectral study of molecular structure, it was important to develop new infrared spectrometers for this use. He was thus conducted to study photo-electrical phenomena and to apply them. Moreover, he and his coworkers have brought various improvements to infrared techniques. After having solved the technical problems, they developed the infrared spectral analysis of organic compounds. As a result, several practical applications were obtained for carburants, lubricants, etc. But the main part of the research was devoted to properties of the absorption bands in the near infrared and their application to the study of molecular structure. Freymann *et al.* proved that the determination of the shift or the variations of intensity of absorption bands permits one to bring new data on intramolecular and intermolecular forces. This is the “method of perturbations”, which was developed. In several cases, the examination of Raman spectra allowed Freymann’s group to confirm infrared data.

Finally, in order to extend infrared measurements towards longer wavelengths, Freymann’s group began, in 1936, the study of hertzian spectrum by dielectric constant and absorption measurements at metric and decimetric wavelengths.

3. The Research Work During the War: 1941–1945

In 1941, the Freymann’s group continued his work at the Faculty of Science of Grenoble. They installed their spectrometer for the region 0.8 to 1.2 μm . They built a spectrometer-recorder with a gem-salt prism, allowing them to explore the infrared spectrum from 6 to 15 μm . Finally, they also installed a Raman spectrograph and an X-ray apparatus.

They observed the effect of intra- and intermolecular hydrogen bonds on the infrared bands of OH, NH and CH (chelation, molecular associations, ...).

They observed relations between dipolar moments of organic groups and the shift of infrared bands of OH, NH and CH.

They observed the influence of double bonds on the infrared bands of OH, NH and CH.

4. The Research Work at Rennes: 1945–1956

During the same year (1945), René Freymann was nominated Master of Research at the French National Center of Scientific Research (for full-time research) and Lecturer at the Faculty of Science of Rennes (for teaching and research). He chose the second position, and he was teaching many branches of Physics, such as electrostatics and electrodynamics, mechanics of vibrations and acoustics, molecular physics, electronics, quantum mechanics and spectroscopy.

In 1945, the Physics Laboratory of the Faculty of Science of Rennes had been destroyed during the war. However, Freymann's group resumed research as soon as 1946. He introduced in hertzian spectroscopy (Debye dipolar absorption) the concept of lattice defect. He observed the hertzian Debye absorption of semi-conductors (zinc oxide, uranium oxides, etc.). He observed the effect of traces of impurities (copper) on hertzian Debye absorption of ZnO. He contributed to the study of light on hertzian Debye absorption of semiconductors. He observed the effect of adsorption of water or gas on hertzian Debye absorption of solids. He contributed to the study of phase changes by examination of the dielectric properties. He contributed to the study of visible and infrared absorption of uranium compounds.

5. René Freymann and the foundation of the Groupement AMPERE: 1952–1956

At the beginning of 1952, Yves Rocard and René Freymann organized in Paris the first Colloque A.M.P.E.R.E. (Atomes et Molécules Par Etudes Radio Electriques = atoms and molecules by radio electric studies), associating this scientific theme to the name of Ampère, the pioneer French Physicist of the 19th century in the field of electromagnetism. Simultaneously, they decided to start a permanent association under the name of "Groupement AMPERE", and to publish a quarterly "Bulletin AMPERE", for mutual information of the participants.

During the first period of four years (1952–1956), René Freymann was the animator of the Groupement AMPERE. He had the responsibility of composing and editing the Bulletin AMPERE. He published and sent out 17 issues of this Bulletin during this period.

After the first Colloque in Paris (1952), the next ones were organized in Grenoble (1953), Paris (1954 and 1955), and Geneva (1956). At the first Colloque AM-PERE, there were 30 participants, all French, from 15 laboratories. At the Geneva meeting of 1956, more than 150 physicists were present from 8 European countries, and also some Americans.

6. The Research Work in Paris. First period: 1957–1968

In 1957, René Freymann was nominated Professor at the University of Paris (Sorbonne). He used the first Nuclear Magnetic Resonance (NMR) spectrometer, which was industrially built in Europe (Trüb-Tauber, 25 MHz).

With his coworkers, he developed the first research work in France, in order to apply NMR to chemical analysis, and to the physico-chemical study of pure liquids and solutions.

So, from 1957 to about 1965, Freymann and coworkers have studied by NMR many protons of CH, OH, NH, PH and SH, whereas from 1930 to 1945, they had studied the CH, OH and NH groups by infrared absorption or Raman diffusion. They also compared the data provided by these two groups of techniques, and gave a summary of these comparisons at the Colloque of Cagliari-Sassari (1964).

In 1963, two Varian 60 MHz NMR spectrometers had succeeded to the Trüb-Tauber 25 MHz NMR spectrometer. These two spectrometers were used not only for physico-chemical research, but also for teaching NMR at various levels to technicians and research fellows.

In 1964, Freymann's laboratory moved from the old Sorbonne to the new Faculty of Science of the Quai Saint-Bernard and place Jussieu.

In 1965, Freymann *et al.* resumed studies on dielectric relaxation, consisting of Debye dipolar absorption of organic compounds. This research lead them again towards the domains of infrared absorption and Raman diffusion they had abandoned 20 years ago. First they resumed some old studies on intermolecular actions in liquids. But it is mainly by developing their research at low temperatures that they began cryospectroscopic research from 300 to 4 K, either in infrared and far infrared or by Raman effect with laser (1967).

7. The Research Work in Paris. Second period: 1968–1979

Freymann and coworkers applied cryospectroscopic techniques to the following subjects:

– cryospectroscopic chemical analysis: many “forbidden” bands appear, and their role is important in analytical chemistry,

- study of solid-state phase transitions by infrared or Raman: these data complete the dielectric measurements,
- study of fine structures, satellite bands, ...,
- study of quasi-isolated molecules, in rare gas matrices.

In 1970, four groups were constituted in Freymann's Laboratory of Molecular Experimental Physics:

- one group for experimental and theoretical studies by infrared and Raman effect on molecular dynamics of the solid state,
- one group for exploring the new way of molecular dynamics of dense fluids,
- one group for studying mesomorphous states,
- one group for studying many organic compounds, ferrocenes, carboranes, and sulphur or nitrogen compounds.

Finally, connections were established between the researches on electroluminescence phenomena (1930), adsorption (1945–1957), and infrared and Raman cryospectroscopy (1968–1979).

8. The development of the Groupement AMPERE: 1957–1995

We now come back to the History of the Groupement AMPERE. This History may be read in the successive issues of the Bulletin AMPERE. Georges Béné (Genève), who was among the first members of the Groupement AMPERE, succeeded to René Freymann in 1956, as the Editor of the Bulletin AMPERE from October, 1956 to the end of 1989. He was also Secretary General of the Groupement AMPERE from October, 1956 to September, 1990. Raymond Kind (Zürich) is now Editor of the Bulletin AMPERE (since January, 1990) and Secretary General of the Groupement AMPERE (since September, 1990).

The successive Presidents of the Groupement AMPERE were René Freymann (1965–1970), G.-J. Béné (1970–1972), A. Lösche (1972–1974), E. R. Andrew (1974–1980), K. H. Hausser (1980–1988), R. Blinc (1988–1994) and B. Maraviglia (since 1994).

After the Geneva meeting of 1956, René Freymann had organized the sixth Colloque AMPERE at Rennes and Saint-Malo (1957). The following AMPERE Congresses were organized in Paris (1958), London (1959), Pisa (1960), Leipzig (1961), Eindhoven (1962), Bordeaux (1963), Louvain (1964), Ljubljana (1966), Grenoble (1968), Bucarest (1970), Turku (1972), Nottingham (1974), Heidelberg (1976), Tallinn (1978), Delft (1980), Zürich (1984), Rome (1986), Poznan (1988), Stuttgart (1990), Athens (1992) and Kazan (1994). The 28th AMPERE Congress will be organized in Canterbury (1996).

Specialized Colloques AMPERE were organized in Krakow (1973), Budapest (1975), Dublin (1977), Leipzig (1979), Uppsala (1981), Crete (1983), Bucarest

(1985), Lisbon (1987), Prague (1989), Zürich (1991), Menton (1993), Santorini, Grèce (1995).

AMPERE Summer Schools were organized in Mangalie, Romania (1969), Basko Polje, Yugoslavia (1971), Varenna, Italy (1973), Pula, Yugoslavia (1976), Rhodes, Greece (1978), Graz, Austria (1981), Portoroz, Yugoslavia (1982), Crete, Greece (1986), Novosibirsk, USSR (1987), Portoroz, Yugoslavia (1988), Varenna, Italy (1992), Portoroz, Slovenia (1993) and Varenna, Italy (1995).

AMPERE Workshops and Forums were organized at Lipica (1990), Rome (1991) and Poznan (1994).

The Colloques of the AMPERE Sub-Group on **Hertzian Optics and Dielectrics (HOD)** were organized in Clermont-Ferrand (1968), Bordeaux (1970), Clermont-Ferrand (1975), Marseille (1977), Lille (1979), Toulouse (1981), Bordeaux (1983), Grenoble (1985), Pisa (1987), Rennes (1989), Hammamet, Tunisia (1991), Paris (1993), Zaragoza, Spain (1995).

Two Conferences of the AMPERE Division on **Spatially Resolved Magnetic Resonance (SRMR)** were organized at Heidelberg (1993) and Würzburg (1995).

So, in 43 years (1952–1995), the Groupement AMPERE, created by René Freymann, has organized 70 scientific meetings on Magnetic Resonance and Related Phenomena.

René Freymann attended most of the AMPERE Congresses, from the first one (Paris, 1952) up to the date of his retirement (1979). His last participation to an AMPERE event was for the AMPERE-HOD Colloque of Rennes (1989), ten years after his retirement.

9. Conclusion

The Scientific Work of Freymann and coworkers extended on half a century (1929–1979):

168 papers were published on infrared and Raman spectra,

149 papers were published on hertzian spectroscopies and NMR,

144 papers were published on dielectric hertzian spectroscopies,

80 papers were published during the last period (1968–1979) by the various groups of the Laboratory of Experimental Physics.

A total number of 52 theses were also published during the whole period (1929–1979).

One of the first coworkers of René Freymann was his wife Marie Freymann, who shared with him all his scientific life.

Last but not least, all who knew René Freymann were impressed by his exceptional human qualities, as well as his communicative enthusiasm towards scientific research.

In our opinion, this also contributes to explain the many successes of his scientific life and work.

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