

## Jean-Pierre Sauvage: The Lord of the Rings

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Jean-Pierre Sauvage

The history of science covers many events such as the one that occurred in Strasbourg last November. A great scientist who has dedicated his life to Chemistry reached the magic age of 65, and, as a consequence, his life has to change – it is the moment for retirement!

To celebrate this birthday, the Institut de Science et d'Ingénierie Supramoléculaires (ISIS) at the University of Strasbourg organized the *Journées Scientifiques en l'honneur de Jean-Pierre Sauvage*, which focussed on the topic of Supramolecular Chemistry. For this scientific event, which took place on November 26 and 27, about one hundred and fifty scientists from different continents gathered, although the majority were from European countries. Seventeen lectures were presented by leading scientists from Europe, America, and Asia, some by former collaborators and others by scientists from Strasbourg.

All the invited speakers showed their friendship and affection towards a great French, European, and world chemist, Jean-Pierre Sauvage, who just reached this magic number. This fantastic scientific party was celebrated in Strasbourg, the place where he began his studies in chemistry and where he has developed his research for the last three decades with significant contributions to chemistry. However, as is usually the case with those scientists who feel science is a personal challenge and whose creativity is the inspiration for many others, Jean-Pierre Sauvage is not totally leaving. For the benefit of the chemical community, he will continue to engage in his passion, that is, to work in chemistry for many more years, now from Northwestern University in Chicago. From there, he will continue to inspire those young students who will have the fortune of learning science and humanity under his expert guidance.

A clear sign of maturity in a community is when it is able to recognize those who are different and whose dedication and creativity has allowed the advance and progress of that

community. The chemical research developed in Sauvage's group at Strasbourg represents a wave of innovation in the design of new molecules, which has paved the way to a variety of new fields that are currently considered to be hot topics in chemical research (Figure 1). The chemical community has acknowledged these seminal achievements, and many important chemists wished to participate in celebrating this special occasion.

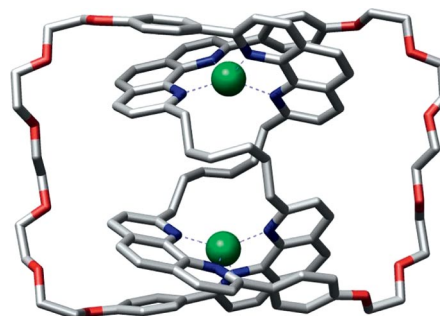


Figure 1. Molecular trefoil knot involving two transition-metal centers as templating species used as the logo in the JPS symposium.

As a singular contribution to this event, I would like to point out a beautiful article written by Professor Fraser Stoddart, perhaps the chemist who best considers the scope and significance of the achievements of his colleague and friend (Figure 2).<sup>[1]</sup> I strongly recommend the reading of this masterpiece to have a better understanding of the scientific impact of the work developed in Strasbourg over the last three decades in the search for the “Holy Grail” of Mechanically Interlocked Molecules (MIMs). With this in mind, it is worth mentioning the former and pioneering achievements that were reported in a seminal paper written in French in 1983.<sup>[2]</sup>

True to the gentlemanly style of Stoddart, he refers to his friend as “The Master of Chemical Topology” in the title of his article, which clearly reveals the importance of the scientific achievements and the mastery in which Jean-Pierre Sauvage conducted and exploited this new and important branch of chemistry.

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Figure 2. Fraser Stoddart addressing his friend and colleague Jean-Pierre Sauvage.

Since I frankly feel that it is not possible to improve on Professor Stoddart's laudatory article on Jean-Pierre Sauvage, I will simply and briefly remark on the importance of these achievements that are currently used in the chemical literature as "classical" concepts and whose existence results from the seminal contributions from the group in Strasbourg. In particular, I would like to bring to the attention of the readership the "discovery" of the *topological bond* or simply the *mechanical bond*. This has been the basis for the existence of different new families of chemical compounds such as the catenanes, rotaxanes, and knots, which, in turn, opened the way to other important areas in chemistry – as well as in nanoscience and nanotechnology – such as the structurally more complex molecular motors and machines; these fields are receiving the attention of an important part of the chemical community (see Figure 1).<sup>[3]</sup>

I would like to briefly give some details on the symposium in Strasbourg to commemorate this special occasion. At the heart of the organization of this emotive scientific meeting was Jean-François Nierengarten, a brilliant and very active professor in Strasbourg, who under the supervision of Dr. Sauvage obtained his doctorate degree (see Figure 3). Professor Nierengarten was able to put together one of the most-appealing scientific programs on *supramolecular chemistry*, with scientists from all parts of the world. The organization was simply perfect, and on behalf of all participants, I would like to take this opportunity to thank



Figure 3. A group photo of (from left) Nazario Martín, Jean-Pierre Sauvage, Haymo Ross, Jean-François Nierengarten.

Professor Nierengarten for his dedication and efforts towards such a successful and unforgettable scientific meeting.

To understand the high quality of the scientific presentations, and without going into many details, I will highlight the invited speakers that attended this meeting. A special comment is firstly dedicated to the opening of the conference by Professor Jean-Marie Lehn (Figure 4). With the title "A Journey in Chemistry – From Cryptates to Supramolecular and Adaptive Chemistry" Professor Lehn conducted with mastery the journey from the original cryptates – Jean-Pierre Sauvage worked as a young student during his Ph.D. studies under the supervision of Professor Lehn – to the development of a central area of fundamental importance in chemistry and chemical evolution, as is "Supramolecular Chemistry". This latter research eventually led to the Nobel Prize in Chemistry awarded to Jean-Marie Lehn together with Charles J. Pedersen and Donald J. Cram in 1987 for their pioneering work in the development and utilization of molecules with highly selective, structure-specific interactions. His talk concluded with the important applications of some of the supramolecular polymers presented.



Figure 4. Jean-Marie Lehn delivering his opening address to an enthusiastic audience. The background slide shows a young Jean-Pierre Sauvage as a student in the laboratory.

Professor Vincenzo Balzani from University of Bologna (Italy) gave a most encouraging lecture entitled "Energy for a Sustainable World: Challenges and Opportunities" and emphasized energy as the central problem that faces our society these days. Importantly, he indicated that finding a correct solution to the energy crisis could offer the opportunity to reduce disparity and create a more peaceful world. Our generation will ultimately be defined by how we lived up to the challenges presented by the energy crisis.

Professor David Amabilino from the Institute of Materials Science of Barcelona-CSIC (Spain), with a lecture on "Multifunctional Molecular Systems à la Carte", presented results from recent research conducted in his laboratory on multifunctional chromophoric systems, as homage to Jean-Pierre Sauvage's imaginative, stylish sorties into this terrain. The lecture by Lucia Flamigni from the Institute per la Sin-

tesi Organica e la Fotoreattività (ISOF)-CNR (Italy) entitled “Terpyridine Complexes as Functional Assembling Units in Arrays for the Conversion of Light Energy: The Story of a Collaboration” demonstrated the main achievements from the collaboration over many years established between the Strasbourg and Bologna groups.

Still on the first day of the “Jean-Pierre Sauvage Symposium”, Dr. Sandrine Chodorowski from L’Oréal (France) gave a lecture entitled “Supramolecular Materials in Cosmetics”. Dr. Chodorowski is a representative example of a former member of the Strasbourg group who have developed their scientific careers in industry. Actually, she was able to give beautiful examples on how supramolecular chemistry based on a straightforward chemical methodology found its way into cosmetics industry.

As an outstanding example of a foreign scientist who visited Jean-Pierre Sauvage’s group in Strasbourg for a scientific stay, Professor Makoto Fujita from Tokyo University (Japan) presented a talk entitled “Organo-Inorganic Chemistry”. Here, he revealed the story behind the first square molecule, the manner in which it was designed and the reasons for its design, as he wished to inspire the next generation of chemists to have fun mixing inorganic and organic chemistry.

The presentation “Supramolecular Chemistry of  $\pi$ -extended Tetrathiafulvalenes: Efficient Concave Receptors for Fullerenes” by Professor Nazario Martín from University Complutense of Madrid (Spain) encompassed the geometrical and electronic reciprocity between a new family of  $\pi$ -extended TTF derivatives (exTTF) as strong electron-donor systems and fullerenes as well-known electron acceptors. On the basis of this innovative supramolecular “concave–convex complementarity principle”, he presented the best purely organic receptors for fullerenes reported so far.

The second day of the symposium started with an unforgettable explanation by Professor Fraser Stoddart (Northwestern University, USA) of his article dedicated to Dr. Sauvage. In this talk, he showed his close friendship to and respect for Dr. Sauvage. This was followed by a brilliant presentation on “Radically Enhanced Molecular Recognition”. His recent observations of strongly associated  $\pi$ , $\pi$ -dimers, referred to as  $\pi$ imers in some of the early literature, of both viologen and tetrathiafulvalenes upon redox stimulation when incorporated into mechanically interlocked molecules was highlighted. It is still worth noting the great importance of the contribution from Stoddart’s group on the development of “topological chemistry”; some of the most beautiful examples of molecules based on the mechanical bond have come about from this research group.

Professor Nicola Armaroli from University of Bologna (Italy) presented an appealing lecture entitled “Supramolecular Photoactive Nanomaterials”, in which he gave an overview on his work dedicated to light-induced fundamental processes in nanomaterials based on H-bonding and  $\pi$ -stacking, to forming novel luminescent carbon nanotubes and nanovesicles or to promote the formation of photoactive grids on surfaces. Professor François Diederich from

ETH Zürich (Switzerland) also gave an outstanding presentation, entitled “Opto-electronic Organic Materials by Novel Acetylene Chemistry”. He presented a novel “click chemistry-type” reaction based on donor-substituted alkynes and electron-accepting olefins such as TCNE or TCNQ. On the basis of this reaction, a wide variety of novel chromophores can be made. He also highlighted novel chiral acetylene materials, including alleno–acetylenic macrocycles with exceptional Cotton effects.

A few sessions were devoted to presentations by scientists from Strasbourg. Conference attendees had the possibility of enjoying wonderful presentations on a variety of topics that involved both covalent and supramolecular chemistry. Professor Michel Rohmer (Institut de Chimie) presented his results on “The Biosynthesis of Bacterial C35 Triterpenoids of the Hopane Series: A Mine of New Enzyme Reactions”. Professor Pierre Braunstein (Laboratoire de Chimie de Coordination, Institut de Chimie) delivered an excellent talk on the synthesis of heterometallic complexes in which metal–metal bound complexes and clusters were discussed in detail. Professor Raymond Ziessel (Laboratoire de Chimie Moléculaire, LCOSA) presented a lecture entitled “An Adventure in Excited State Tuning using a Molecular Toolbox”. Professor Wais Hosseini from the Laboratoire de Chimie de Coordination Organique (University of Strasbourg) gave an overview of his results in supramolecular chemistry in a direct and appealing manner.

A talk entitled “Nanoscopic views of Ions and their Complexes in Solution and at Liquid Interfaces from MD Simulations” was given by Professor Georges Wipff (Laboratoire MSM, UMR CNRS, Institut de Chimie). Dr. Philippe Reutenauer from Cuisine Innovation (France) then captivated his audience with an amusing presentation on “Culinary Innovation Sustained by Chemical Knowledge: The



Figure 5. Professor Hosseini (left) demonstrating his culinary skills whilst assisting Dr. Philippe Reutenauer (right).

Case of Alginate”; Professor Hosseini was kind enough to show his skills as an expert kitchen assistant (see Figure 5).

The final presentation of the symposium was given by Dr. Jean-Paul Collin who works in the same laboratory (Laboratoire de Chimie Organo-Minérale) as and who is a close friend of Dr. Sauvage. He talked about “Le Périple du Laboratoire de Chimie Organo-Minérale”, and showed some aspects of life in the laboratory over the last three decades. Certainly it was very moving, and I would especially like to recall the moment when the name of the late Christiane Dietrich-Buchecker was mentioned – a profound silence echoed through the room...

At the end of the symposium, Dr. Jean-Pierre Sauvage thanked all the attendees for their participation in this auspicious event in honour of him. He emphasized his continued interest in cultivating a good atmosphere in his group, whilst remembering some special moments. His dedication to Professor Jean-Marie Lehn was moving – “thank you for your friendship, for your support and for (your) influence (on) me...” He also acknowledged Professor Jean-François Nierengarten, for the organizing of this unforgettable meeting for him. His last words were dedicated to “his favorite wife”, Carmen.

The symposium concluded with only one word written on the screen dedicated to Jean-Pierre Sauvage: Merci!

In addition to the important group of scientists who attended this symposium, many others representing both scientific institutions and industries also participated in this special occasion. The editors of some chemistry journals, such as Dr. Peter Göllitz (*Angewandte Chemie*), Haymo Ross (*European Journal of Organic Chemistry*), and Denise Parent (*New Journal of Chemistry*) were also present and contributed to the importance and success of the event.

As a final thought, which no doubt was in the mind of the many attendees of the symposium, I would like to remark on the significance and strong impact that the chemistry developed in Strasbourg on the conceptually innovative *mechanical bond* has had on the world of chemistry. This bond has been essential for the existence of a wide variety of new families of compounds, which have been further prepared efficiently and in a systematic way. Moreover, this new chemical bond has surpassed the limits of molecules used to explore the technological applications of molecular motors and machines. Such pioneering findings developed in Strasbourg – as well as in other laboratories – should be properly recognized on their own merits by the international chemical community as one of the most important and significant achievements in the chemical sciences produced in the last decades.

## Acknowledgments

Dr. Weiss is thanked for the photo contributions.

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- [2] C. O. Dietrich-Buchecker, J.-P. Sauvage, J.-P. Kintzinger, *Tetrahedron Lett.* **1983**, 24, 5095–5098.
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