3. Chemistry in Relation to Physics in the XXth Century

Introduction by Ana Simões

The relations of chemistry to physics have been the concern of many practicing chemists throughout time and place. Especially with the emergence and development of physical chemistry in the late 19th century, the advent of chemical physics which transformed the landscape of 20th century chemistry by consolidating theoretical chemistry as a core component of a discipline traditionally considered as a laboratory science, and the introduction of physical instruments, techniques and methods into several domains of chemistry, the relations of chemistry to physics have been an implicit component of the daily practice of some 20th century chemists as well as an explicit part of their oral and written reflections on chemical culture.

Such was the case of the American physical chemist Gilbert Newton Lewis. Excelling in the application of thermodynamics to chemistry, Lewis's scientific interests also included valence theory, theory of radiation and relativity. In the last stage of his career, Lewis tried to devise a new chemistry of deuterium compounds, a field he abandoned for research on photochemistry. In 1926, in the context of a broader reflection on the structure and methods of science offered in a popularisation book called *The Anatomy of Science*,[1] and later on, in 1933, in a paper titled "The chemical bond" published in the first volume of the *Journal of Chemical* Physics,[2] Lewis assessed the relations of chemistry to physics and contrasted the different features of theories in chemistry and physics. He compared the analytical characteristics of chemical theories to the synthetic features of physical theories. Chemical theories are grounded on a large body of experimental material from which the chemist attempts to deduce a body of simple laws which are consistent with the known phenomena. Contrariwise, physical theories postulate laws governing the mutual behavior of particles and then attempt "to synthesise an atom or a molecule."[3] Furthermore, Lewis contrasted the convergent method of chemists and the divergent method of physicists, thereby implicitly acknowledging the theoretical and methodological irreducibility of chemistry to physics.

In this session, Steven J. Weininger, a practicing chemist and historian of chemistry, and three historians of science representing successive generations of schol-

ars, the Sarton medallist Mary Jo Nye, Carsten Reinhardt, the author of the recent book *Shifting and Rearranging*, and the young scholar Néstor Herran, focused on 20th century chemistry in its relation to physics addressing the hypothetical reduction of chemistry to physics by looking at different case studies which, in all instances except for one,[4] were associated with the role of isotopes, be it stable deuterium, or the unstable isotopes which made up the new world of radioactivity.[5]

Pointing to the neglect by historians of the chemistry of deuterium and other stable isotopes, Weininger showed how chemists' and physicists' embrace of deuterium depended on its accommodation within different experimental cultures and accessibility to various physical and chemical techniques. Initially the appropriation of deuterium reinforced the distinction between the two disciplines, while later on its use within biochemistry melded together the two distinct analytical traditions.

Mary Jo Nye chose to analyse the scientific trajectories of two physical chemists, Fritz Paneth and Michael Polanyi, both émigrés from Germany to England in the early 1930s, and to discuss their philosophical reflections at the interface of chemistry and physics. Polanyi and Paneth became good friends in the 1920s, and Polanyi was involved in a debate on the nature of isotopes, and specifically on their chemical identity, between Paneth and Georg Hevesy in Vienna and Kasimir Fajans in Karlsruhe. Both Paneth and Polanyi insisted on the distinctive characterisation of chemistry as depending on the inexactness of its ideas, on the importance of exceptions to its rules, on the vagueness of its methods, and on its emergent properties.

By pointing to the hybrid character of radioactivity, a discipline depending on theories, practices and instruments coming from both physics and chemistry, Néstor Herran called attention to the role played by two factors –disciplinary ambiguity and high public profile– in shaping the appropriation of radioactivity in Spain. By stressing both the lack of consideration given so far to the interrelationship between radioactive research and its public representation, enhanced by its potential industrial and medical applications, he discussed the specificities of the appropriation of radioactivity in the context of a European periphery. He argued that its appropriation in Spain depended on overcoming tensions between radioactivity and former chemical ways of thought and doing, and on institutional and individual support by politically conservative scientists able to counteract the image of radioactivity as a subversive science conveyed by the socialist press and other popularisation of science outlets. In this way, historians of science were

invited to consider how much case studies such as this one encourage the revision of received views on the history of radioactivity.

Carsten Reinhardt looked at the leading role of physical instruments as carriers of novel techniques and principal actors in a novel method-making oriented chemistry. He addressed the ambivalent attitudes of chemists who used and appropriated physical instruments and methods into their own culture, in such a way that they could be more readily embraced by the chemical community. Such a process revealed varying degrees of acceptance, went hand in hand with manifestations of resistances from different sectors dependent on the specificities of the receiving chemical cultures, and contributed in the end to build a community of method makers able to cross boundaries not only inside the physical sciences but also of the life sciences and medicine as well.

By extending Lewis's considerations from theory to practice and to instrumentation, by taking into account specific local contexts and public representations of science, the participants in this session enlarged and enriched the discussion of the dynamic relations of chemistry to physics in the 20th century, in innovative ways, open for scrutiny.

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Notes

[1] G.N. Lewis, *The Anatomy of Science* (Yale University Press: New Haven, 1926).
[2] G.N. Lewis, "The Chemical Bond," *Journal of Chemical Physics*, 1933, 1, 17-28.

[3] Lewis, "Chemical Bond," op. cit. (2), 17.
[4] Carsten Reinhardt, "Applied Neighborship. Physical Methods and their Perception in Chemistry".
[5] Stephen J. Weininger, "Deuterium as a probe of the boundaries between physics, chemistry and biochemistry;" Mary Jo Nye, "Philosopher-Scientists at the Interface of Physics and Chemistry: Paneth and Polanyi on Chemistry as an Exact Science;" Néstor Herran, "A 'subversive element': publics, disciplines and the rise of Madrid's laboratory of radioactivity".