Political Science

It is not often that a scientist or engineer attains high public office. Herbert Hoover, a mining engineer; John Sununu, a nuclear engineer; Margaret Thatcher, a chemist turned lawyer...all are highly unconventional in their careers. More often, we find scientists and near-scientists engaging in political activity: the priorities of those such as Noam Chomsky are common enough not to occasion surprise today. Margaret Thatcher does not often need to consult chemical principle to guide her political decisions (environmental matters apart); Chomsky, when fulminating against Vietnam policy, could hardly have been moved by philological passion.

A real danger appears, however, when an active professional scientist gains political power as well, and uses that to proselytize, or even impose a particular scientific theory. One such person was Marcelin Berthelot (1827-1907), an eminent French chemist who did not believe in atoms. Berthelot remained active in research almost to the end of his days—he was a man of demonic energy—but he also became, for a while, Inspector of Higher Education and even Foreign Minister in the French government. He was regularly elected president of the French Chemical Society as well.

His skepticism concerning atoms arose, to simplify the matter, from a conviction that the "atomic hypothesis" required all gaseous molecules to be diatomic, and since this led to contradictions, the entire hypothesis must be erroneous. Because of the highly centralized nature of French education (university professors still, nominally, require ministerial approval for a change in course structure and content), and because of the excessive power of a "grand patron" in those days, Berthelot apparently succeeded in indoctrinating generations of French chemistry students with his obsession.

If there were no atoms, then stereochemistry had to be a fantasy (in spite of Pasteur's towering achievements!) and without that intellectual tool, organic chemistry could not develop properly. This recognition led the French chemist Haller in 1900, the year when Berthelot was elected to the French Academy, to declaim furiously that Berthelot's piece of "pure doctrine" had disastrously held back the production of organic chemicals in France, while it roared ahead in Germany. Organic chemistry, Haller declared, is "directly inspired by theory" and a false theory meant mis-inspiration. One recent commentator has gone so far as to claim that young French chemists continued to be taught atomic skepticism until the eve of the atomic bomb!

The only safe vaccine against episodes of this sort is a multiplicity of centers of initiative...free and entirely independent universities, multiple independent professional bodies (preferably in competition), and multiple journals in the same field. Today, of course, science is international to a degree that protects against national extravagance...unless, of course, frontiers are closed; then the Lysenkos of this world seize their chance. The most important protection, perhaps, is a multiplicity of journals: in a country where there is only one official journal in each field and the international mails are restricted, both standards and liberty are apt to slide and error can take long to resolve (as happened in the polywater episode). MRS has done well to create *Journal of Materials Research*, and should not be fazed by possible criticisms that it has diluted the literature!

If a scientist can misuse political influence, political dogma can, on occasion, mislead a scientist (as it did Lysenko). The most amusing example of this (of which I have personal experience) refers to Le Chatelier's Principle. This was enunciated by another very eminent French scholar, a metallurgical chemist this time: he invented the Pt/Pt-Rh thermocouple which is still in use a century later. We all learn his Principle in school: a skater glides over an ice sheet at 0°C, the pressure he exerts lowers the freezing point and the skate sinks a little deeper into the locally melting ice. The system has "accommodated" the applied constraint...that's how Le Chatelier worded his thermodynamically based Principle.

During the Second World War, the supply of natural quartz crystals from Brazil almost dried up. They were needed for oscillators, and so large crystals were artificially grown by the hydrothermal route. The crystal thus produced contained "Dauphine twins," regions in which the lattice is rotated by 180° about the trigonal symmetry axis. Such crystals were useless unless the twinned regions could somehow be rotated back into the surrounding orientation, restoring a true monocrystal.

An eminent Cambridge crystal physicist, W.A. Wooster, found out how to do this: quartz is elastically highly anisotropic and so, if a stress is applied to a twinned quartz crystal, the differently oriented inclusion will store a greater or lesser amount of elastic energy (per unit volume) than the main orientation. The trick, as Wooster recognized, is to arrange the stress system so that the desired orientation (the main crystal) is elastically "softer" in response to that constraint, and at the same time to raise the temperature so that atoms can shift through short distances. That orientation which gives way more compliantly—which "accommodates the constraint"—will prosper; the other orientation will shrink and disappear. By applying carefully calculated torques and bending moments to crystal plates that were to be used in oscillators, Wooster and his colleague L.A. Thomas were able to remove the troublesome imperfections. They published their findings later, in 1951.

At about the same time, a Soviet crystallographer, A.V. Stepanov, treated the same problem in a series of theoretical papers. Unfortunately, he stood Le Chatelier's Principal on its head. He asserted that the crystal must modify its local orientation in such a way that the system maximizes its *resistance* to the constraint—clearly, a distinctly communist worldview!

The final irony in this little history is that Wooster himself was a dedicated communist, quite open about his predilections and always ready to defend the Soviet position. But for this excellent crystal physicist, scientific rigor quite unconsciously outweighed the communist way of looking at the world.

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https://doi.org/10.1557/S0883769400058012 Published online by Cambridge University Press