



John Charles Polanyi



Date of Birth 23 January 1929

Place Berlin (Germany)

Nomination 9 June 1986

Field Chemistry

Title Professor, Nobel laureate in Chemistry, 1986

Professional address

University of Toronto

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Most important awards, prizes and academies

Awards: Marlow Medal of the Faraday Society, UK (1962); Steacie Prize for the Natural Sciences (1965); Henry Marshall Tory Medal of the Royal Society of Canada (1977); Wolf Prize in Chemistry, shared with G. Pimentel (1982); Nobel laureate in Chemistry (1986). **Academies:** Royal Society of Canada; Royal Society of London; American Academy of Arts and Sciences; National Academy of Sciences, USA; Companion of the Order of Canada; Pontifical Academy of Sciences; Russian Academy of Sciences.

Summary of scientific research

The past decades have seen the birth of a field of chemical physics termed 'reaction dynamics', the study of the atomic and molecular motions underlying chemical reaction. Starting in 1956, J.C. Polanyi's laboratory at the University of Toronto attempted to detect and measure the extent of vibration and rotation in reaction products from gaseous reaction by recording their emission in the infrared. Ultimately these experiments yielded quantitative data concerning the motions in molecules at the instant of their formation, and also the effect on these product motions of systematic alterations in the corresponding motions in the reagents. From these data it was possible, by means of Monte Carlo trajectory computations performed in this and other laboratories, to obtain some insight into the patterns of motion in the course of transition from reagents into products. More recently Polanyi's laboratory has been involved in an attempt to establish, through theory and experiment, a means of probing the subpicosecond 'transition state' directly, either by recording feeble emission or by laser absorption; this area of research (still in its infancy) constitutes 'transition state spectroscopy'. In a second recent departure this laboratory has turned its attention to the dynamics of simple reactions occurring at surfaces. Following adsorption of submonolayers on the surface, reaction is initiated by ultraviolet light. The present indication is that this procedure can result in reaction between coadsorbed species, both held at the surface, with preferred locations and orientations. Most recently his laboratory has been involved in studying photoreaction one molecule at a time, beneath the tip of a Scanning Tunneling Microscope. The hope, therefore, is to exploit this 'surface aligned photochemistry' as a means of improving our understanding, and therefore our control, over microscopic reaction pathways - the molecular choreography of the reactive process.

Main publications

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1439 (1969); Mok, M.H. and Polanyi, J.C., Location of Energy Barriers. II. Correlation with Barrier Height, *J. Chem. Phys.*, 51, p. 1451 (1969); Ding, A.M.G., Kirsch, L.J., Perry, D.S., Polanyi, J.C. and Schreiber, J.L., The Effect of Changing Reagent Energy on Reaction Probability, and Product Energy-Distribution, *Faraday Disc. Chem. Soc.*, 55, p. 252 (1973); Polanyi, J.C. and Schreiber, J.L., The Reaction $F+H_2 \rightarrow HF+H$: A Case Study in Reaction Dynamics, *Faraday Disc. Chem. Soc.*, 62, p. 267 (1977); Foth, H.-J., Polanyi, J.C. and Telle, H.H., Emission from Molecules and Reaction Intermediates in the Process of Falling Apart, *J. Phys. Chem.*, 86, p. 5027 (1982); Arrowsmith, P., Bly, S.H.P., Charters, P.E. and Polanyi, J.C., Spectroscopy of the Transition State. II. $F+Na_2 \rightarrow FNaNa^+ \rightarrow NaF+Na^+$, *J. Chem. Phys.*, 79, p. 283 (1983); Bourdon, E.B.D., Cowin, J.P., Harrison, I., Polanyi, J.C., *et al.*, UV Photodissociation and Photodesorption of Adsorbed Molecules. I: CH_2Br on $LiF(001)$, *J. Phys. Chem.*, 88, p. 6100 (1984); Bourdon, E.B.D., Das, P., Harrison, I., Polanyi, J.C., *et al.*, Photodissociation, Photoreaction and Photodesorption of Adsorbed Species. II. CH_2Br and H_2S on $LiF(001)$, *Faraday Disc. Chem. Soc.*, 82 (1986); Lu, P.H., Polanyi, J.C. and Rogers, D., Photoinduced Localized Atomic Reaction (LAR) of 1,2- and 1,4-dichlorobenzene with $Si(111)7 \times 7$, *J. Chem. Phys.*, 112, p. 11005 (2000); Jiang, G., Polanyi, J.C., Rogers, D., Electron and Photon Irradiation of Benzene and Chlorobenzene on $Si(111)7 \times 7$, *Surface Science*, 544, p. 147 (2003); I.D. Petsalakis, J.C. Polanyi and G. Theodorakopoulos, Theoretical Study of the Induced Attachment of Benzene to $Si(111)-7 \times 7$, *Surface Science* 544, 162 (2003); S. Dobrin, H. He, F.Y. Naumkin, J.C. Polanyi, and S.A. Raspopov, Photoinduced Charge-Transfer Reaction at Surfaces. Part II: $HBr \dots Nan/LiF(001) + hf(610 \text{ nm}) \rightarrow Br-Na+n/LiF(001) + H(g)$, *J. Chem. Phys.* 119, 9795 (2003); F.Y. Naumkin, J.C. Polanyi, *et al.*, Electron-Induced Attachment of Chlorinated Benzenes to $Si(100)-2 \times 1$, *Surface Science* 547, 324 (2003); C.F. Matta and J.C. Polanyi, Chemistry on a Peg-Board: The Effect of Adatom-to-Adatom Separation on the Reactivity of Dihalobenzenes at $Si(111)-7 \times 7$ Surfaces, *Phil. Trans. Royal Soc. London A*, 362, 1185 (2004); S. Dobrin, K. Rajamma Harikumar and J.C. Polanyi, An STM Study of the Localized Atomic Reaction of 1,2 and 1,4-diBrPh at $Si(111)-7 \times 7$, *Surface Science* 561, 11 (2004); K. Rajamma Harikumar, I.D. Petsalakis, J.C. Polanyi and G. Theodorakopoulos, Parent- and Daughter-Mediated Halogenation Reactions Modeled For 1,2- and 1,4-Dibromobenzene at $Si(111)-7 \times 7$, *Surface Science* 572, 162 (2004); S. Dobrin, X. Lu, F.Y. Naumkin, J.C. Polanyi and J. (S.Y.) Yang, Imprinting Br-Atoms at $Si(111)$ from a SAM of $CH_3Br(ad)$, with Pattern Retention, *Surf. Sci. Letters* 573, L363 (2004); S. Dobrin, J.B. Giorgi, F.Y. Naumkin and J.C. Polanyi, Photoinduced Charge Transfer Reaction at Surfaces. III. $(HF)_2 \dots Nan/LiF(001) + hf(640 \text{ nm}) \rightarrow HFF-Nan+/LiF(001) + H(g)$, *J. Chem. Phys.* 122, 14705 (2005); S. Dobrin, K. Rajamma Harikumar, C.F. Matta and J.C. Polanyi, An STM Study of the Localized Atomic Reaction of 1,2 and 1,4-Dibromoxylene at $Si(111)-7 \times 7$, *Surf. Sci.*, 580, 39 (2005); H.E. Ruda, J.C. Polanyi, *et al.*, Developing 1D Nanostructure Arrays for Future Nanophotonics, *Nanoscale Research Letters*, 1, 99 (2006); S. Dobrin, K. Rajamma Harikumar and J.C. Polanyi, STM Study of the Conformation and Reaction of Long-Chain Halo Alkanes at $Si(111)-7 \times 7$, *J. Phys. Chem. B*, 110, 8010 (2006); X. Lu, J.C. Polanyi and J. (S.Y.) Yang, A Reversible Molecular Switch Based on Pattern-Change in Chlorobenzene and Toluene on a $Si(111)-(7 \times 7)$ Surface, *Nano Lett.* 6, 809 (2006); S. Dobrin, K.R. Harikumar, R.V. Jones, I.R. McNab, J.C. Polanyi, *et al.*, Molecular Dynamics of Haloalkane Corral-Formation and Surface Halogenation at $Si(111)-7 \times 7$, *J. Chem. Phys.* 125, 133407 (2006); K.R. Harikumar, J.C. Polanyi, *et al.*, Electronic Switching of Single Silicon Atoms by Molecular Field Effects, *J. Am. Chem. Soc.*, 128, 16791 (2006); S. Dobrin, K.R. Harikumar, T.B. Lim, L. Leung, I.R. McNab, J.C. Polanyi, *et al.*, Maskless nanopatterning and formation of nano-corrals and switches, for haloalkanes at $Si(111)-7 \times 7$, *Nanotechnology*, 18, 044012 (2007).