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Editorial

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Creating a Borderless Platform for Scientific Research in Canadian Chemical Transactions

Mohammad A. Halim[1*], Mohammed G. Sarwar[2], Ian D. Hosein[3], Xuan-feng Yue[4]

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[1]Department of Chemistry, The University of Western Ontario, London, Ontario, Canada

[2]The Scripps Research Institute, La Jolla, California 92037, USA

[3]Department of Chemistry and Chemical Biology, McMaster University, Hamilton, Ontario, Canada

[4]College of Chemistry and Chemical Engineering, Shaanxi Normal University, Xi'an, China

**Corresponding Author, Email: mhalim4@uwo.ca, phone: +1-226-663-8026*

Everything in this expanding universe and massive biological world inside of flora and fauna are composed of atoms [1]. That is why Professor Geoffrey Ozin from the University of Toronto mentioned chemistry as *"the central science" which pervades the physical, life and applied sciences* [2]. Interestingly, these powerful themes were also echoed by renowned and influential physicist Richard P. Feynman (1918-1988), winner of the 1965 Nobel Prize in Physics. He stated "*If we were to name the most powerful assumption of all, which leads one on and on in an attempt to understand life, it is that all things are made of atoms, and that everything that living things do can be understood in terms of the jigglings and wigglings of atoms".* In this editorial, we explore how a borderless philosophy shaped scientific research in near past and will shape the future endeavors in science and technology.

An aspiration for borderless knowledge is a repeated theme in the annals of history. It was common practice among the great Greek philosophers, Muslim scientists of the Middle Ages, and even among the 'renaissance men' in Europe. Notably, Watson and Crick, two key figures who unveiled the secret of life through the double helix in DNA, as well as numerous molecular biologists of that era were inspired by Schrödinger's *"What is life?"*, a small but powerful book in which this prominent physicist of the twentieth century advocated "unified, all–embracing

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knowledge" [3–5]. In his book, he envisaged how mutations in a gene are governed by the rules of quantum mechanics, and assumed the gene may be a type of irregular "aperiodic crystal" that plays a pivotal role in transferring information through a *"hereditary code-script"* [6]. In an earlier event in 1932, Niels Bohr, a distinguished scientist in atomic physics, lectured on "light and life" which inspired Max Delbrück, a 26 year old young physicist, to change his field from physics to biology. Later in 1969 Delbrück won the Nobel Prize for molecular genetics [7]. This was one of the major turning points of the twentieth century, when biochemical research interfaced with new insights exploring the very physical world in the womb of biology.

Many researchers around the world believe that quantum chemistry changed the 20th century's world by introducing experimental instrumentation, such as NMR, X–ray crystallography, optical spectroscopy, electron microscopy, and ultrafast lasers, thereby advancing our communication through optical fibres, developing solar cells for generating efficient energy, performing computer–aided drug design, and uncovering unknown genomic sequences through computational biology. Interestingly, the foundation and basic postulates of quantum chemistry was developed by two renowned German physicists, Walter Heitler and Fritz London. In the late ninety twenties, serious debates had been provoked among the physicists on the formulation of quantum physics which divided them into two blocks. In 1925, Heisenberg, together with Max Born (1882–1970) and Pascual Jordan (1902–1980), applied mathematical tools to represent the quantum phenomena in an atom, known as matrix mechanics, [8–10]; however, because of the intricate mathematical formulation, this matrix mechanics was unpopular with the physicists. On the other hand, Schrödinger applied a wave mechanical approach employing de Broglie's 'wave–particle duality' (1924) to explain the electronic interactions in an atom, and he further developed his epoch-breaking 'wave equation', which was easy to understand and model [11]. However, very few physicists and chemists of that era were interested in applying quantum formulations for treating chemical phenomena. In 1927, Walter Heitler and Fritz London received the prestigious Rockefeller scholarship and they decided to go Zürich to work with Schrödinger. Heitler described his memories with Schrödinger "*I joined Schrödinger's department in Zürich. F. London was also there. It was a very pleasant summer and, of course, Schrödinger was in excellent spirits. Each Sunday a small excursion was arranged by Mrs. Schrödinger which invariably ended in some nice country inn with a glass of wine (or may be two)"* [12]. For nearly six months, they continued their research with Schrödinger in Zürich.

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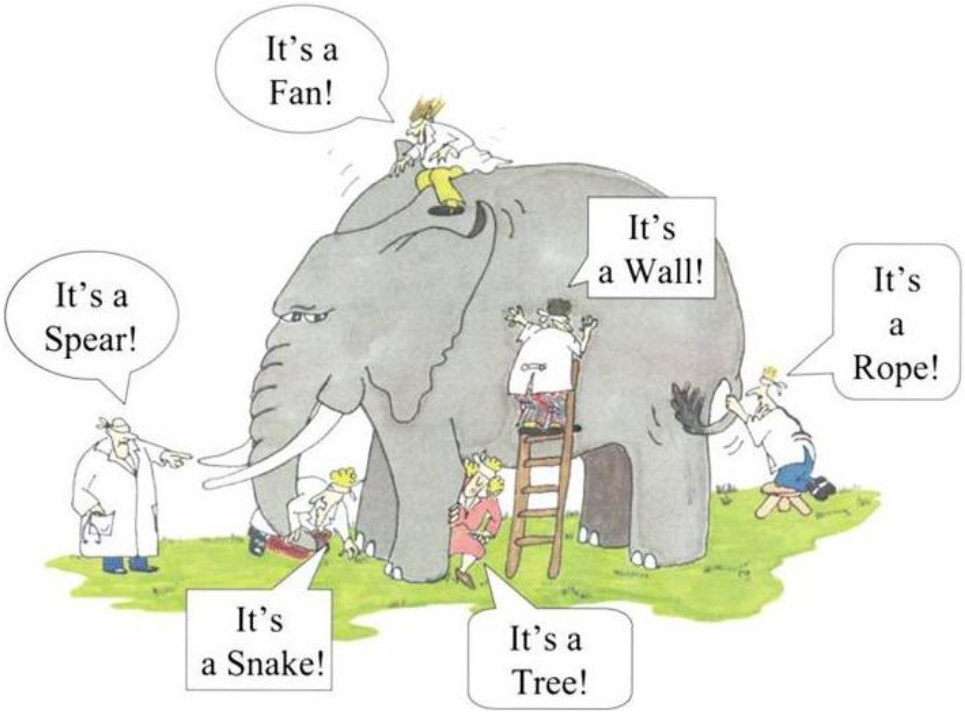

Figure 1. Blind Men's Research on an Elephant. Adapted by Permission from Macmillan Publishers Ltd: Kidney International [13], (Artist: G. Renee Guzlas) Copyright (2002).

In 1927, after the retirement of Max Planck (1858-1947), winner of 1918 Nobel Prize in Physics, from Friedrich Wilhelm University in Berlin, Schrödinger was appointed as his successor and he moved to Berlin [12]. In this circumstance, Heitler and London together tried to explain the bonding in the hydrogen molecule by applying the quantum–mechanical formulations. In 1927, they summarized their work in an article entitled *"Interaction of neutral atoms and homo polar bonding, according to quantum mechanics"* published in Z. Physik [14]. The date of this publication is recognized as the birth of quantum chemistry.

The concept of borderless knowledge is also reverberated in a recent article entitled "The future of chemical physics" by Ahmed H. Zewail, who won the 1999 Nobel Prize in chemistry for his contributions to femtochemistry. He pointed out that the 21st century sciences are returning to 'Greek science' where the borders of knowledge were less defined [15]. Because of the universal aspect of knowledge in Greece, Aristotle is known as *'The Father of Political Science'*, and at the same time he is also regarded as *'The Father of Biology'*. Despite today's diverse and compartmentalized knowledge in numerous disciplines, scientists are progressively learning from one another and trying to overcome the *"The Tower of Babel Syndrome"* [16] in sciences.

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Figure 2. Raphael's School of Athens (1510). Adapted from Wikipedia Commons.

As Ahmed Zewail described: "*physicists are exploring the world of (macro)molecules and novel materials, from polymers to potentially superconducting organic and inorganic substances, and biologists are increasingly invoking the concepts of molecular bonding and the techniques of kinetics and dynamics*"[15]. Interdisplinary research around the globe is advancing, and in order to see the real *Elephant* [17], the story of blind men's research on an elephant in which one said this is a pillar, a second said it is a wall, and so on (**Figure 1**), in our research, we should 'flow' [18] with the theme of borderless science by writing, sharing, and discussing with one another so the gap between the diverse scientific communities can be closed. More importantly, without arts, we can neither articulate nor decorate our sciences, nor attract our future generations to basic sciences as Einstein stated *"all of science is nothing more than the refinement of everyday thinking"*. In Canadian Chemical Transactions, we aim to create a borderless platform (through open access publishing), inspired by *'Raphael's school of Athens (1510)'* in which philosophers from east and west sat together to share knowledge, with the common purpose of achieving a sustainable world (see **Figure 2**).

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References and Notes

[1] "Two Worlds" from Mohammad Halim's unpublished poem: "*The mysteries of the two universes are still not unfolded / The expending little one is around us / And the massive one, the world of very far, is inside us"*. He has a different view for the world of very small and very far.

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[16] According to Genesis, Chapter 11 "*the whole earth was of one language and of one speech*." The people of Babylon planned to build a great tower to reach heaven, to show their greatness and power; some sources mentioned they planned to kill God. Their plan displeased God. He destroyed their high–rise tower, and Genesis described the event as "*Come, let us go down, and there confound their language, that they may not understand one another's speech*."

[17] "Elephant and Blind Men" http://www.jainworld.com/education/stories25.asp (Last accessed January 6, 2013).

[18] *'Saras'* means 'flow' which is derived from *'Saraswati'* a Hindu goddess of knowledge, and 'flow' is a basic requirement for generating knowledge, for making things flourish, stable and connected

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