# Perspectives on Science and Literature
## Interview with Roald Hoffmann: Poet, Playwrite, Scientist and Nobel Prize Winner

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## Resumen

Esta entrevista presenta diferentes aspectos sobre la vida y obra de Roald Hoffman, distinguido científico, poeta y dramaturgo polaco. El profesor Hoffmann ha recibido numerosos por sus aportes al conocimiento, incluyendo el Premio Nobel de Química en 1981.

## Summary

This interview introduces readers to the life and work of Roald Hoffman, a distinguished Polish scientist, poet and playwright. Professor Hoffmann has received numerous awards for his contributions to knowledge, including the 1981 Nobel Prize in Chemistry.

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# 1. Introduction

(Adapted from http://www.roaldhoffmann.com/short-biography)

Roald Hoffmann was born in 1937 in Zloczow, Poland. Having survived the war, he came to the U. S. in 1949, and studied chemistry at Columbia and Harvard Universities (Ph.D. 1962). Since 1965 he is at Cornell University, now as the Frank H. T. Rhodes Professor of Humane Letters Emeritus. He has received many of the honors of his profession, including the 1981 Nobel Prize in Chemistry (shared with Kenichi Fukui).

Notable at the same time is his reaching out to the general public; he participated, for example, in the production of a television course in introductory chemistry titled "The World of Chemistry," shown widely since 1990. And, as a writer, Hoffmann has carved out a land between science, poetry, and philosophy, through many essays and three books, "Chemistry Imagined" with artist Vivian Torrence, "The Same and Not the Same and Old Wine" (translated into six languages), "New Flasks: Reflections on Science and Jewish Tradition," with Shira Leibowitz Schmidt.

Hoffmann is also an accomplished poet and playwright. He began writing poetry in the mid-1970s, eventually publishing the first of a number of collections, "The Metamict State," in 1987, followed three years later by "Gaps and Verges," then "Memory Effects" (1999), "Soliton" (2002). A bilingual selection of his poems has appeared in Spanish. He has also co-written a play with fellow chemist Carl Djerassi, entitled "Oxygen," which has been performed worldwide, translated into ten languages. A second play by Roald Hoffmann, "Should've," has had several workshop productions since 2006; a new play, "We Have Something That Belongs to You," had its first workshop production in 2009.

# 2. Science and Literature

**How and when did you first realize that you were a poet besides a scientist?**

That's a complicated question. I first became interested in poetry at the university, so it is a tribute to the American system of general education that a person who was going to become a scientist was also taking a course in poetry. And you know, I think there's something very good about that. Here, you would get that in the liceo, but there is a difference in reading a novel at age 16 and reading it at age 21.

By age 21, you have been in love and out of love so the novels Anna Karenina or Madame Bovary mean more to you than they did at an earlier age. I had a poetry course, and I remember clearly the poem that the professor taught. It was a course in reading poetry, not in writing. It was a poem by Wallace Stevens, "Sunday morning," a beautiful poem. I think what made this poem was its magic and how what was said, was said beautifully and economically.

I didn't try to write a poem until I was 40 years old. The first poems were not successful. I should have taken a course, but I did not. I sent out the poems and they were rejected; there was no commentary on them, no feedback. It was only around age 45 or so that I came to a group of people who read poems to each other. In response to that, I was able to write a couple of poems that I felt were successful in some way. When I understood it and my friends understood it, I realized that I'd be writing. And from the time I started writing, that's 30 years now. I've published four books in English plus a book of translations of my poems into Spanish. I think the poems translate very well into Spanish.

So it was in that group, in midlife, that I realized I was a poet. I think this may have in it a lesson for other people. Actually, there's something interesting, poetry requires some maturity. There are no children who are great poets. It is not like math or music in terms of talent. It requires some maturity and making connections between things. I find that very encouraging. I think people can begin to write at various stages. Some people write from childhood and some people begin in midlife, like me.

**Has your experience and interest in literature (and the humanities in general) somehow improved your understanding of science? How?**

In general, science is written in a certain style, a style that has developed over 150 years and has not changed that much. This style aims to represent the facts and nothing but the facts. As if such a thing was possible. It is not. Expression in first person in general is dealt out of

scientific writing; a third person dialogue is encouraged. That is the theory. If one departs too much from the style of a scientific article, one will not get it by the gatekeepers: the editor and the reviewers who are inherently defending the status quo in a very critical and conservative mode. So I cannot write my articles departing too far from what the norm is. However, I am a strong believer in subverting the format of the scientific article.

Your question was really more about doing science and writing it, but I'd like to focus on the writing process first. I think making emotional contact with the reader in a scientific article is not easy because everything in the structure works against it. But if one makes that emotional contact, one has the reader. One has the reader interested, believing that you care about their understanding. So I try to inject a little personal style in the writing, even within the constraints of a scientific article, and I think I succeed.

I also think writing poetry has taught me the power of short and strong words and of expressing ideas compactly. And sometimes I can do it. Most of the time, it is not a direct influence. I think the perspective of two things from my writing has come into my scientific work. One is the idea of narrative, of telling a story; that is so fundamental, such a basic human quality. Good stories are more believable. [laughs]. I have structured my scientific articles and perhaps my research so as to explore a story, and I have not been afraid to talk about obstacles-- that I had to climb this mountain-- so I have tried to talk about what went wrong, for instance. I don't construct a sanitized narrative of just success; I find people are very interested in that.

**• They identify with you...**

Yes!

**• How do your scientific research interests influence your literary work?**

At the beginning, I thought it would be easy to write poems about science. And why not? Why not write about science? It proved difficult for many reasons. Eventually, I was able to write poems in which either the metaphors of science would work out naturally and I could use them to write poems or I would use scientific words or vignettes. Let me explain what I mean by metaphors. There is a very strange state of matter where crystals are formed from atoms. Some of the atoms are radioactive and the first crystals that form are beautiful, clear, transparent, like we imagine crystals to be. With time, some of the atoms inside the crystal fall apart, they are radioactive. And falling apart destroys the pristine beauty of the crystal. The crystal becomes cloudy and amorphous and doesn't look so pretty. Ok, there is a metaphor! There is a poem right there! The enemy is within.

I can find metaphors in science. I've written 3 plays. In 2 of the 3 plays, there is some science. But in the third play there is no science. I find it interesting to write plays with scientific ideas. In one of the plays, for instance, I want to have some

discussion of the social responsibility of scientists and artists. I could give a lecture about that! But it is much more interesting to take two extreme positions and put them within a family, in particular a father and a daughter. The characters are both scientists, but they are very different. To be specific, the father thinks everything that scientists do has consequences that should be examined; and the tragedy is his making of a molecule that is very toxic ---actually the neurotoxin that is responsible for something that is called red tide. He isolates and synthesizes that molecule and publishes an easy way to make it. One day, a group in the Middle East use that molecule to kill six hundred people. He blames himself, and the play opens right after his suicide. It turns out the suicide is much more complicated because there are other reasons. His daughter is a molecular biologist who is studying what is called the "Spanish Flu" in the United States of 1918, an epidemic that killed millions of people around the world. She is going to determine what the virus responsible for it is, and when asked what she will do with it, she says "I will publish it, of course." And someone says "And, what if somebody else uses that?" and she says "I don't care." So there are two opposing views on whether one should care about the consequences of one's research; to explore them in a theatrical scene is much more interesting than to write an essay.

Sometimes my theater comes from science but it doesn't really have to. My last play is about my mother and me; about survival in World War II, good and evil. It has no science at all. It has had two readings and no full production yet, and it's 2 years old. It is called Something that belongs to you. It has poems in it. It is set partially in the US and partially in an attic of the schoolhouse where we were hidden during World War II. And strangely enough, all the scenes set in World War II are poems. I would not have imagined before I wrote it that one could write poems about those terrible times, but that is how it came out.

**• That's what you do when words are not enough...**

That's right.

# 3. Teaching Science

**As a teacher, how do you manage to adapt to your students' learning styles and keep their attention when teaching complex material?**

I have thought a lot about what I have learned in 45 years of teaching. It is clear that anything that makes the students think through something helps in the teaching process. For instance, simple strategies like telling students to make rough notes in class and then to rewrite them in the evening demands a lot of self control on the part of the students. But, what that simple strategy is doing is using a number of things that psychologists have found about the learning process. First of all, the process of writing with your hands explores a tactile to visual link in cognition, and it seems to be important in fixing ideas in your mind. Second, the idea of making rough notes and then rewriting them makes use of the time range of short term memory. You can remember details for about 24 hours and then, you forget. Those are little strategies.

I think another strategy I've always believed in, is turning a problem around so it doesn't become a routine, solving a problem in a certain way. I always design a problem that goes the other way---so that one can see that it is the idea, not the actual formula of substitution that carries across. In an absolutely trivial way, if you have a formula that relates Fahrenheit to Celsius you want to do the conversion in both directions to get the idea across. I will do almost everything to try to get the students to learn by themselves. Mainly, what we do, and this is not an idea original to me, is that we wake up in the student capacities that had been there already. It is a wonderful feeling for both teacher and student when students become aware of that. They see they can do it. Something is enabled in them.

# 4. Science in Latin America

**What do you think Latin American countries like Colombia should do to develop more in terms of scientific research?**

Well, I think one part of the answer is that there has to be economic support from the government to do the research, to encourage young people, and to create the industries that employ them. There's a limit of how much education you can receive without a sound economic base that will employ those people. So, if the wealth of a country depends on natural resources, the government should really try to create research and industrial capabilities for adding value to those resources. I don't know enough about Colombian resources, but if we look at the Arab countries that live off petroleum income, their strategies appear short sighted. They should be structuring the education of chemists to transform that petroleum and not just sell it because it will eventually run out.

I think if one wants to enhance the level of science in Colombia or other countries, one should provide programs for young scientists to go abroad, which would benefit everybody. That means going to the United States largely, probably at the postdoctoral level. So one should create scholarships at the postdoctoral level. Now, the country will lose some of those people; they will stay abroad. They will come back if the economic situation at home improves and they can get jobs where they can be fulfilled in some way. We have seen waves of this, for instance from Taiwan and South Korea. In the beginning, nobody went back, now 90% go back. With China the situation is just in transition, again, nobody went back before, and now about one third of the PhDs are going back. So I think such postdoctoral or graduate fellowships would be an investment in the future. I think there should be also funds for the scientists; support for two trips a year to go to conferences and participate in research events.

In general, research experiences are the way to draw young people into science at the university level. I know from experience in my case, my courses in chemistry at the university were not very good, but I worked during the summers at national laboratories. The research was not in any area that I went to work on after that, but it was the research experience that was just wonderful. I think it creates a family structure in the scientific research group in what is, otherwise, a very cold environment. In a research group there are four, five, six people, and you can sense the intensity of your advisor and what the other people are doing, and that creates the sociological structure of a family.

# 5. Women in Science

**Why do you think the percentage of women participating in science programs is still low? What do you think we could do to change that?**

I have had a good number of women students, but not that many. They have done very well. My daughter has a PhD in physics so I have another sort of first hand input. The situation has changed tremendously in the last 30 years. The facts in the United States, in chemistry, are that the percentage of women with PhDs has gone from 12 % to 39%, now that is a really dramatic change, and I think it is irreversible. At the undergraduate level, more than half of the chemistry students are women. So the situation has changed. There are more women in science in South America, but at the highest levels, there are not enough women in any Latin American country.

There is a real problem in our system in the U.S. with the Assistant Professor stage, the beginning of a career, at the end of which there is an important decision: whether to be promoted to Associate Professor. That stage, which lasts for 5-6 years, has become a machine for innovation. Young professors have to get research money and find graduate students. Typically in the United States it would be around age 27-33 that this happens. It is a wonderful machine for getting new science, but it puts incredible personal stress on those people. And we have seen something interesting: the number of PhDs who are women has increased, but the number of applicants for Assistant Professorships has not. And I think the reason is that women are feeling that the stress of forming a family falls more on them than it does on men. So I think that, within a US context, you would have to change the culture of the Assistant Professorship, give women more time... I don't know the situation country by country. Clearly societal structures matter. If women are going to enter the scientific workforce, social structures have to be in place to make that possible.