21 October 2018

When and how I heard about the Dannie Heineman prize

As I remember, Veronica (my wife) and I were sitting outside in the sun having lunch, when my good friend Sriram Shastry called me from the Bangalore airport to tell me I had been awarded the Dannie Heineman prize. I was then grateful that Sriram had done the work needed for me to be considered, and pleased for Sriram's sake that he was right — I certainly never expected his application to succeed.

My research interests

I have largely been interested in statistical mechanics and quantum mechanics, and the connections between the two. I began with my PhD thesis on the two-dimensional 6-vertex model. This was a statistical mechanics problem, and like most such models, consisted of simply counting different configurations of a physical system. In this case, it was a model for ferroelectrics, as well as many other situations, including even ice. I was able to solve a very general class of these problems exactly, greatly surprising my thesis advisor Professor CN Yang. Yang had earlier won a Noble prize, had spent many years at The Institute for Advanced Study in Princeton, and had just come to Stony Brook. I was his first graduate student, ever. With Yang, and his brother Professor CP Yang visiting from Ohio, we extended and investigated these solutions. This work showed an amazing connection with the one-dimensional quantum Heisenberg-Ising model of a magnetic chain. In fact, CN Yang had done very important work solving this problem years earlier, and so was 'the expert'.

Soon after this, I found an interesting paper of Calogero presenting an exact wave function for a one-dimensional quantum system of N particles interacting by a repulsive inverse-square potential. However, his solution was an unbound scattering state, so I figured out how to 'put it in a box' and so do the thermodynamics of particles at a finite density – the so-called Calogero-Sutherland model. Continuing, I was able to greatly expand the work, and even make a close connection of these physics problems, with the mathematical topic of random matrices.

In the course of my research, I have often been able to collaborate with my good friend and colleague Sriram Shastry. It first began in 1980, when he visited the University of Utah with his family, and has continued to this day, even in India and Japan. A look at my publications will discover these joint 'S&S' papers, often in pairs, with each of us as a principal author of one or the other.

In this way, I have proceeded throughout my career. If one would like more, please take a look at my book: *Beautiful Models: 70 years of exactly solved quantum many-body systems*, (World Scientific, Singapore, 2004).

21 October 2018

My beginnings

Since I was the first in my family to go to college, I think that makes me a sort of 'minority' student. My mother Nora Hopkins was a nurse, and gave me her nursing chemistry book, while my father had many different professions, and gave me a table of logarithms from when he taught navigation in the Merchant Marine. I grew up for the most part in the small farming community of Marshall, Missouri; I would agree that I have many Missouri character traits, for better or for worse. My local teachers were very good, especially 'Granny' Crutcher who taught me math, and asked me to evaluate new math textbooks the salesmen had given her. Soon after the Sputnik was launched, the National Science Foundation tried to recruit young scientists. When I was a junior in high school, they offered a summer program in physics at the Missouri School of Mines in Rolla. (No one seemed to notice that it was only for boys!) I was selected, and enjoyed it so much that I decided to skip my senior year of high school and go directly to college. Every one agreed, and so that's what I did.

I began at a small college, William Jewell, in Liberty outside Kansas City; after a year there, my teachers advised me to go to a bigger school. My high school science teacher back in Marshall had also attended a NSF course, for teachers, at Washington University in St Louis. It seemed very good, so I transferred there, and was accepted. I had outstanding teachers at 'Wash U' but the most influential in so many ways was Professor TA 'Alec' Pond, who taught a sophomore modern physics course from a book by Max Born. A year before I graduated, Pond was hired to start a Physics Department at the State University of New York in Stony Brook. The next year I followed him there with a National Science Fellowship, and it was Alec Pond who hired CN Yang two years later.

My life at Utah

Of course it's not really just my life at Utah, because I'm part of a family. Let's go back to Washington University when I was an undergraduate. I was short on money, so TA Pond graciously hired me to help his graduate students, including Chris Hohenemser. Chris' wife was my German teacher Anne, and his father Kurt was in the School of Engineering. I got to know Chris and Anne through physics and German, but also by political activity. They invited me and others camping with them in Colorado the summer of 1963 when I graduated. It was a group of family and friends, including me, and my brother. There in Colorado I met Chris' sister Veronica Hohenemser, two years older than me, and then living in an apartment in Manhattan. Over the next two years we got to know each other, visiting back and forth between NY City and Long Island, and every summer again camping in Colorado. On July 30, 1965 we were married; the certificate says Gothic, Colorado but it was actually on a mountainside. I should explain this summer camping; we

rented a house in Stony Brook from teachers who taught in NY City during the school year, but in the summer lived in their house on Long Island. So we had to go elsewhere in the summer. In 1967 and 1968 we built a cabin, by hand, on Forest Service land (legally at the time, like at Brighton) at about 9,500 feet elevation. In October 1968 our daughter Cori was born in Port Jefferson, NY. I graduated in 1968, spent a year with CN Yang at his Institute for Theoretical Physics, then two years at Berkeley as an Oppenheimer Fellow. Our son Jason was born in February 1970 at the Kaiser Hospital in Oakland, California. Thus, our family was now all together.

Unfortunately, it was not so easy to find jobs in physics at this time; I wanted to stay in the west. But, in the spring of 1971 I had two faculty offers: Stanford University, Palo Alto, California and University of Utah, Salt Lake City, Utah. That wasn't so hard to choose; as you know, we chose Utah. I should make it clear that we are not Latter Day Saints. But this was not a problem at all – for us, or for anyone else – the whole 33 years we lived in Salt Lake City. In 1971, there were a variety of people living in Salt Lake, going to the University, and raising children. We lived in the (red-lined) Avenues, an old neighborhood of Salt Lake City, just a 15 minute walk west to town or east to the U. Our children went to an Open classroom, which was absorbed into the public school system. Veronica and I co-opted as teachers in the school: batteries & bulbs, and cross-country skiing. By the time I retired, I had taught some of my former grade-schoolers at the U.

How do I view the Heineman prize?

This is a hard question for me to answer; I am shy and modest. First, I see it as the Heineman Award, rather than 'prize'; this just makes me feel more comfortable. I have always seen theoretical physics as a very cooperative endeavor, rather than 'competitive'. I have been warmly mentored by my older colleagues, collaborated productively with my associates, and fondly taught the upcoming students. This is, of course, overlooking the immense historical supporting structure established by the great scientists and mathematicians of the past; everyone depends on this.

So I see the award as recognition by my colleagues, that I have done my part over the years, of a collaborative venture. It is even more satisfying that the award is shared with Gaudin and Calogero, since we three have different but related interests, and have always gratefully shared our individual approaches with each other. Yet throughout my career I certainly have not worked toward a 'prize'.

Let me tell a story that I feel explains my motivation throughout my career. As I explained, I came from a small farming community in Missouri. I started college when I was 17, and all boys had to register for military service at 18. This was 1960 and the Vietnam war was on, but the draft board gave me a student deferment. However, by 1967 I was still in college (working on my PhD thesis) and so my draft

board reclassified me IIA, since after 8 years I had still not left college. In their experience, I was a very slow student. But they gave me two years more. However, in 1969 I was still at Stony Brook (now as a post doc in Yang's Institute for Theoretical Physic) and they were really upset, and again reclassified me. Professor CN Yang graciously wrote for me a very kind and detailed letter to the draft board, explaining how good my work had been and would continue to be, and how valuable it would be for the country. He also sent me a copy, and this has been an inspiration throughout my entire professional career. (Also, I was not drafted!)