

## **My Caltech Experience and Some Advice**

### **Lars Bildsten, February 23, 2015**

My career greatly benefited from the time I spent at Caltech as the Lee Dubridge Fellow from Fall 1991 to Winter 1995. The science directions I initiated at that time, the realization of a different research style and the enduring collaborations kept me productive and in constant exploration of new research paths. Even though some of the personnel have changed here twenty years later, the spirit remains the same: One of delight in discovery.

I have continued a strong scientific relation beyond just my time here as a Prize Fellow, but felt it was best today to stay focused on just the first three years of what has become nearly a quarter of a century of interaction.

#### **Graduate Student Experience at Cornell**

I was trained at Cornell under the diverse tutelage of Ed Salpeter and Ira Wasserman. Ed was full of new ideas, constantly, and liked to openly muse about entirely new problems for me at times when I felt I needed to actually be calculating and finishing a piece of work. Indeed, there were times with him when I thought he must have imagined I was a different student!! Ira, thankfully, both kept me on the path to completion, but also focused the open dialog about new projects to work on, making some of them real. Cornell was a wonderful place to be a graduate student, and I continue to recommend its splendid isolation as an excellent way to start a scientific career. However, I was unprepared for the next adventure. .

Ed Salpeter had spent the summer of 1951 at Caltech, leading to this reminiscence in 2008 that, to me, is telling:

“Pasadena and Caltech at the beginning of July 1951 were a great revelation for me, both scientifically (I had never learnt any astronomy before that) and socially. Socially, Cornell was a friendly place but somewhat subdued, so I was not prepared for Caltech’s exuberance. In our first week Willy and Ardie Fowler invited us to a 5:30 p.m. Cocktail Party. We knew that such parties do not last longer than two hours, so we put a roast in the oven before we left. Needless to say, the party went on all night and we all spent the early morning skinny-dipping in someone else’s pool (I can’t remember whose). We were almost arrested but Willy and Ardie (she was quiet, but effectively forceful) placated the police and all ended happily except that our roast was burned.” (Publications of the Astronomical Society of Australia, Volume 25, Issue 1, pp. 1-6. 2008)

However, in 1991, he was sending his students to Princeton and IAS for postdocs, so I went to IAS and gave a talk. The IAS audience was confident, self-assured, confident (did I already say that?) and eager to interrupt. As the hazing process proceeded, a few people decided to intervene, most importantly Peter Goldreich; who proclaimed it might be best for ME to actually give MY talk. Both he and Bohdan Pacyznski graciously let me complete the talk, making a clear impression on me of how to best treat a young person. I spoke with Peter at length and he said: "I hope you will apply to Caltech". I had earlier 'interviewed' with Roger at the Texas Meeting in Birmingham while sitting next to him at a dinner and trying to keep up with his rapid-fire style of questioning. The rest is history.. . with me starting at Caltech in Fall 1991 at the then stunning salary of \$36,000.

## **Arrival**

Caltech was tremendously generous upon arrival, allowing us to stay in a house while we did our apartment search; somewhere down San Pasqual. This was a large relief, as we had a few-month old Erika, and my wife Ellen was just starting to look for work as an Architect. This is also where we got introduced to the concept of a car. Indeed, one of the Caltech admins called me and said: "We have the house arranged, do you also want the car?". . . Of course, arriving in Southern California requires the acquisition of a car, since "you can sleep in your car, but you can't drive your apartment". That 1991 Honda was only sold a few years back.

## **Contrasts and Growth**

I immediately noticed a few items in contrast between Cornell and Caltech.

One thing was very different about Cornell and Caltech at that time.

The length of papers.

Maybe the long winters and few distractions forced the issue, but papers written at Cornell were notoriously long and full of many different ideas. Indeed, I have a vivid memory of placing a paper derived from my thesis on Roger Blandford's desk. It hit with a thud and Roger said: "Another Cornell Product!"

This was the beginning of three years of wonderful mentoring in Tapir and beyond. There was a great group of postdocs around at this time. Roger, Sterl and Peter were always available. Most impactful was the near daily lunches with Roger, Sterl and sometimes Peter. They would sweep up the postdocs and go to the Greasy. We would all openly muse about what we were doing, and Roger would create more new problems than any of us could track. Indeed, he was giving out ideas so fast that I learned it was best to wait a few days before launching into anything to see if Roger remained enthusiastic. He did, and would become a great critic for me, as would Peter and Sterl. I never wrote any papers with these three when at Caltech, but my interactions with them shaped much of my research style today.

Shri was, at that time, running Shri lunch in Tapir and this is where I also began interacting with him. However, we did not collaborate while I was a postdoc. Indeed, he gave me explicit career advice: “Lars, you should work on gamma-ray bursts!” that I did not follow. However, I did get to witness his research style and we had many excellent discussions about millisecond pulsars. One so animated that Tom Prince kicked me under the table to remind me of my place in life. Thanks, Tom! Shri and I, as many of you know, have been deeply collaborating on the Palomar Transient Factory, a very productive scientific project that will soon become the Zwicky Transient Facility due to a \$9M grant from the NSF and strong support from collaborating institutions.

### **Distractions and Very New Directions**

My officemate was Curt Cutler, a relativist who was interacting primarily with Kip Thorne’s group. Curt and I had a very productive scientific collaboration over the years, writing a total of five papers. Most critically, sharing the office with Curt allowed me to learn many new pieces of physics, especially GR, and, as we worked together, stellar pulsations. We did a lot of really fun calculations of possible oscillations of neutron stars. Though it remains unclear that such oscillations have ever been observed in neutron stars, much of the work on modifications of pulsations under rapid rotation is broadly applicable in other contexts and led to recent applications in wonderful data from Kepler that I will mention tomorrow.

An exciting aspect of engaging with Curt was the exposure to Kip’s group. One evening Curt told me: “You should come to Kip’s group meeting tonite, as he is laying out directions for his research group for the next five years”. So, I went, and indeed, Kip gave a many hour lecture on aspects of double neutron star binaries that would be relevant to LIGO. Keep in mind that this was 1992 or so, over twenty years ago!!!! At the end of his presentation, he, more or less said: “So, if any of you want to work on these problems, let’s get together tomorrow night and discuss” . . . Scientific line in the sand! I was very curious about the possible tidal interactions of the two neutron stars as they merge and so Curt and I took off to write that paper. One of my most highly cited and one of the fastest ones from start to finish. Oh, to be young!

I also began to interact with Tom Prince on his observational project to use the BATSE instrument on CGRO to study accreting X-ray pulsars. These are highly magnetic neutron stars that accrete matter onto their polar caps and emit pulsed x-ray radiation. My LONG Cornell papers had focused on how an accreting neutron star may emit gamma-ray lines that would be characteristically red-shifted, allowing for a constraint on the nuclear EOS. However, all of my predictions were far below what any instrument on GRO could see. . . , and, ahem, proved true. Not detected.

But, I knew about the telescope, but had no idea what else it could do. Here is where I got exposed to scientific opportunity writ-large. Tom, working with then postdoc John Grunsfeld (later NASA Astronaut and administrator) and graduate student Deepto Chakrabarty (later MIT Professor), had realized that the BATSE all-sky monitors could detect pulsing x-ray sources easily in the Fourier domain. Hence was launched a very successful program of monitoring dozens of pulsars. These objects are so compact that you can, in real time, measure the change in their rotation rate from the accretion of fresh material. Stunning, and the work we did led to many new insights on how these objects spin-up, spin-down and modulate accretion. All observational work, and my first serious foray into collaborating with observers, including an exciting trip to the Palomar 200 inch, where I was happily calculating that they would not detect anything while we were looking! As punishment, I was the one sent up to Prime Focus with the night assistant to diagnose an issue in the middle of the night.

### **Caltech Environment**

The intimate nature of Caltech provides for rather unique experiences with legendary scientists. This is not to be under-rated. I was the DuBridge Fellow, and Tom Everhart hosted a dinner very early in my tenure that allowed for us to meet Lee and Arrola Dubridge. We visited them at their home a number of times, and they accepted an invitation to come to our humble apartment for dinner one blustery Santa Ana windy evening. I called Lee and told him I would come and pick him up, but he insisted on driving the ½ mile to our place. I still remember him pulling up in some huge old car. Great evening, with Arrola bouncing baby Erika on her knee.

Jesse Greenstein explained to me why he hated neutron stars: “Can’t observe them from Palomar!”, and I enjoyed learning about galaxies from taking Maarten Schmidt’s class.

### **Summary**

I would summarize the impact of Caltech on my career in three ways.

- Broadening my research perspective, especially a dramatically increased awareness of what is happening in observational Astronomy
- Expansion of style to a willingness to ‘do the quick things’ when it made sense, though preserving the Cornell right for long papers when appropriate.
- Openness to moving into very new directions (e.g. LIGO and BATSE) when the opportunity is in front of you

### **Some Advice**

Astrophysics remains a vibrant field full of discovery and is fertile territory to a theorist who is aware of what is happening. So, let me close by doing my best to generalize to a few key elements from my personal experience.

Your mission statement is:

“The Burke Institute promotes research in theoretical physics by providing outstanding educational and research opportunities for graduate students and postdoctoral fellows, by bringing distinguished visiting scholars to Caltech, by hosting workshops to accelerate the exchange of ideas, and by encouraging cross-disciplinary collaborations.”

An excellent, clear mission. I will do what I can to give some specific initial advice.

**Environment and Atmosphere:**

I benefited from a diverse set of interactions. So, job one, is for the Burke Institute to do all it can to create, maintain and enhance that environment, certainly within each discipline, and where plausible, across areas of physics. That’s not easy, but I hopefully made a strong case for that value. You could consider bringing in senior experimentalists and observers to explicitly present emerging puzzles from their work.

**Mentoring:**

The faculty need to be engaged in mentoring Prize Fellows and push/nudge/cajole them in new directions. That means the faculty need the time to do that. . . . a large challenge today.

**Collaboration, Added Value and Leveraging:**

No one place can 'do it all'. Not even Caltech. Collaboration is a much larger piece of how science is done today. It also provides exposure for Prize Fellows to different ways of doing science and broadens their letter base in the never-ending search for the next position.

Much progress now occurs through exchange of ideas, and my advice here is to try different modalities for a while to see what really works. What works best may also be different in each sub-discipline, so flexibility is key. Let me mention a few possibilities for your consideration:

- Think about new ways to 'mix things up'. Postdocs and grad students remain the most flexible and can easily be the glue to new collaborations as they emerge, both within an institution and across institutions. Indeed, KITP and Caltech cooperate this way, informally, already.
- Short workshops with real time for discussion and small numbers of people may be appropriate responses when breakthroughs occur or to explore new research directions. Maybe letting your Prize Fellows lead these. Again, keep the focus on domains where Caltech faculty, postdocs or grads can take advantage of the event. Avoid becoming the 'goto' place for few day workshop proposals from others!! The proposals will drive you crazy.

- Potentially use resources for long-term collaborative efforts where faculty, postdocs and graduate students are engaged with a number of institutions to achieve a broader science goal. Could be inexpensive, as most resources could simply be for local expenses, not expensive travel. Namely, you want the other institutions to have 'skin in the game. If they really want to gather they will make the investment of their own time and resources.

In closing, leadership matters. Someone needs to 'own it', make things happen, take risks and make mistakes. This requires focus, breadth of awareness and an open-ness to the emergence of new contexts where theoretical physicists can have lasting impact. Good Luck Hiroshi!