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Remembering Jean Bourgain

by Alex Kontorovich

Jean had an immeasurable effect on my life and career, and our relationship went from postdoc advisor, to collaborator, to friend. We wrote a dozen papers together over the past decade.

Many have reminisced about the challenges faced when embarking on their first reading of a paper of Jean's; my initiation was not by choice, but by fire. In the fall of 2008, a year out of grad school, I applied to IAS for the 2009-2010 special program in Analytic Number Theory. I'd proposed to inject bilinear forms techniques into the affine sieve. Apparently Jean read my application, because the next time I visited Peter Sarnak, I was told that Jean wanted to see me. Until that point, we had exchanged pleasantries at conferences, but never talked math.

After working for a few hours with Peter (itself an exhausting event), I went to afternoon tea, and soon thereafter, Jean appeared. He saw me and said, "ah good, you're here; come," and turned and left for Simonyi Hall. I felt as if summoned to the principal's office.

As I arrived, Jean launched into a three hour lecture at his blackboard; I didn't understand a word he said, but dutifully wrote everything down in my notebook. I left in a complete daze and spent the next three weeks trying to work out from my chicken scratch what he was getting at. Eventually I realized that Jean had just explained to me the solution of the problem I'd planned to work on for the next year. Since this comprised the bulk of my proposal, I was sure my membership application would be denied. Instead it turned out that Jean, in his generosity, wanted to collaborate!

At first I had a hard time working with him. At the blackboard, I would have an idea, then think it's stupid and keep my mouth shut, only to have Jean suggest it five minutes later. I'm usually lighthearted/easygoing, so was surprised to be clamming up in front of Jean. I confided in Peter, who instantly diagnosed the issue:

"You're worried that you're not as good as him. Let me alleviate your concerns. You're NOT! **Nobody** is!" Hearing that seemed to do the trick, and henceforth ideas flowed freely and truly collaboratively.

Fortunately for me, the solution required a stubbornly technical result from the spectral theory of automorphic forms, and this was one of the very few areas Jean didn't have instantly at his fingertips. So these became our first two papers, the main theorem, and technical companion (the latter joint also with Peter).

When these were finished, I'd assumed that would be it, but as luck would have it, the ideas developed in those papers turned out to be useful in attacking a number

of unrelated problems, from Zaremba's conjecture, to the Local-Global Conjecture for Apollonian circle packings, to our "Beyond Expansion" program.

As our collaboration flourished, our *modus operandi* standardized. Once every few weeks, on the prescribed day, we met around tea time, 3:30 or so, and worked until 8:57 pm. We then drove to Blue Point Grill on Nassau St, which closed at 9:30, arriving by 9:05pm. You could see the depressed expressions as the staff saw us coming, realizing they'd be working late. (If we arrived any later than 9:05, they would gleefully tell us the kitchen was already closed, and we would be relegated to Tiger Noodles next door.) We would finish a bottle of Medoc as tables all around us saw their chairs inverted. By 10:30, we would be back in Jean's office, working until 1:30 am, when he would drive me to Princeton Junction to catch the last train back to NYC. I would arrive home at 3 am, and on I checking my email, discover a message from Jean. Attached would be a scan of a handwritten note solving what mere hours ago was a detrimental impasse.

Many people spoke of receiving such miraculous notes out of the blue in their email. But I had just spent 8 hours struggling with the guy. We were totally stuck! What black magic or animal sacrifice he did in those wee hours I will never know. His wife, Mei, and son, Eric, were unable recently to find in his office his Fields Medal; perhaps they should have been searching for this oracle!

The craziest part was that the solution was never of the form: "Here is how you plow through this massive wall." It was always much more creative: "Yes, this wall may be impenetrable, but if you take three steps to the right and start digging, you'll find a hidden tunnel across." It just didn't seem fair.

On one fateful such dinner in 2014, Jean told me the biopsy came back positive. He looked me in the eyes and said that the five year survival rate was absolute zero. I was devastated but also incredulous; here was a man full of vitality telling me his days were numbered. Jean fought valiantly and courageously, with much credit due to his extraordinary sister, Claire, a doctor in Belgium. As many have described, his mathematical output continued if not increased (if that's even possible) through all the surgeries and chemo until the end.

I am so blessed and fortunate to have been afforded the privilege of knowing and working with one of the greatest and most generous minds in the history of mathematics. I miss my friend dearly.