Building a Better Black Hole

Listening to Louis Crane might convince you that little black holes could someday power starships, or that the laws of our universe were fine-tuned by intelligent beings long ago. Just leave the math to him.

by SCOTT DODD

FQXi Awardee: Louis Crane, Kansas State University October 12, 2007

It's not easy to follow a conversation about theoretical physics with Louis Crane – and he knows it.

"I really have gotten to a place where I'm out there by myself," Crane says while discussing his latest work on a model of quantum gravity that bears his name. "It's sort of like crossing Alaska by dogsled. The view is wonderful, but there really aren't that many people to share it with."

Not that he doesn't try. I recently spent a long evening on the phone with Crane, an FQXi Awardee and professor of mathematics at Kansas State University in Manhattan, Kansas. Crane was trying to elaborate on the implications of the Barrett-Crane Model of loop quantum gravity, developed with fellow physicist John Barrett.

To do that, he had to explain some innovative ways of doing math that I had barely even heard of. "I wish you could see my hands," Crane told me at one point. "I think you could understand it better if you could see my hands."

I doubt it, especially after receiving an e-mail from one of Crane's early collaborators, Lee Smolin of the Perimeter Institute for Theoretical Physics. I had asked Smolin for his impressions of Crane's recent work. Smolin replied that he had found "lots in (Crane's) last few papers that I don't understand technically."

So at least I'm in good company.

Defying Categorification

"Louis Crane is a mathematician by training," says Christopher Isham, a fellow FQXi Member whose work overlaps with Crane's, "and he tends to think and present his ideas in a very mathematical way. Only a tiny fraction of theoretical physicists are familiar at all with the branches of mathematics that he uses."

It's been that way for Crane all of his life. A mathematical prodigy who took graduate-level courses at age 14, Crane studied at the University of Chicago under Saunders Mac Lane, one of the most influential American mathematicians of the 20th century. Mac Lane co-founded of a branch of math called "category theory."

Crane would later add his own term to the mathematical lexicon, "categorification." Like Mac Lane, Crane incorporates advanced mathematical models known as sheaves and topos theory into his calculations.

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Learning category theory from one of its originators sent the young Crane off on some very unusual directions. While in high school, he set out to reconcile Mac Lane's new mathematical concepts with theoretical physics.

"I decided that I wanted to stop thinking about spacetime as a continuum," he says, then adds – and I can't quite tell if he's joking – "Everyone just assumed I'd get over it."

Crane was determined, though, to bridge the gap that he perceived between math and physics, so he has taken courses in both throughout his career. "Right now, I'm spending half of my time reading astrophysics and the other half thinking about category theory," he says. "Some people think I'm crazy."

A Desire for Collabor-ification

Crane's need to find people that he can share his ideas with is one of the reasons that he applied for a grant from The Foundational Questions Institute. He said the $135,247 award will help him travel and collaborate in person with other physicists – something that Crane thinks is vital to his work.

When he and Barrett were working on their quantum gravity model, for instance, they sent each other frustrating e-mail after e-mail. But when they got in a room together for five minutes, they figured it out quickly, Crane says.

"I went to England this summer because there were two people I thought I could explain this to," he says, talking about his latest work. One was Barrett, and the other is Isham, whose work Crane cites in a new paper submitted in June.

Isham, the Dean of Natural Sciences at Imperial College in London, said he's one of the few theoretical physicists familiar with some of the advanced mathematics that Crane uses in his work. "The physical concepts are not very difficult," Isham says, "but the math is."

Isham acknowledges that it's hard to judge the long-term significance of the work that he and Crane do. "If successful, (we) would have a major impact on the progression of quantum gravity studies," Isham says. "But to be honest, (we) are very much shooting in the dark. It is high-risk research!"

Despite that, Crane says he keeps pursuing his work because "it's beautiful, and most other things are ugly."

Besides, he adds, "We're going to have to know the quantum theory of gravity if we're ever going to build little black holes."

Sure, but … wait a minute. What was that?

Black Hole-ification

Of course, Crane continues, to do so, we'll need armies of self-replicating space robots and focusing lasers the size of an asteroid. "I haven't spent a lot of time on the engineering," Crane concedes. "It would be very tricky."

This time, his line of thinking actually isn't so hard to follow. If we can fully understand – and ultimately control – gravity, then building tiny black holes to power starships could make sense. They would generate enormous amounts of power.

"I think it's the only thing imaginable that would actually get us to the stars," Crane says. "It's extremely difficult to make, but I don't think it's impossible."

And if it is possible, the recent cosmological theory that our universe is just one in an infinite series of multiverses suggests that a custom-built black hole might have already happened somewhere – and our own cosmos could be the result.

That's because, if we can one day produce black holes, we're probably going to make an awful lot of them. "We're going to go all over the universe," Crane says, "so there are going to be a lot of black holes." Long ago, intelligent beings might have littered their universe with spaceship-generated black holes, too.

A lot of black holes could mean a lot of daughter universes produced as a result. As long as we're making them, we might as well fine-tune them to support life as we know it – just as those previous space-farers probably would have done. "They would have the same physics that we do," Crane says.

If all of this is true – and we're piling up a lot of "ifs" here -- then maybe, Crane says, he's a link in the long chain that moves humanity toward fulfilling our purpose of creating more universes.

"Maybe that's why I do it," he says. "Maybe that's why I don't quit."

Now that's a concept that I have no problem understanding.

COSMIC DOGSLEDDER Louis Crane. Illustration Credit: Catherine Closet-Crane