

# Spirit of Math

By Anthony Reinhart

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Young as he still is at 34, Professor Nima Arkani-Hamed was far younger when he walked into a high-school classroom and found proof that the universe was, indeed, expanding. He was in Grade 8 at Zion Heights Junior High School in northern Toronto, and the classroom belonged to Charles Ledger, a teacher who had developed his own brand of supercharged math instruction for high-performing students ready to go beyond their textbooks.

Of course, Dr. Arkani-Hamed could not have predicted the precise sequence that would land him where he is today: at the utter limit of humanity's understanding of the universe, as one of the world's top particle theorists, with a fully tenured teaching post at Harvard to boot.

Instead, he focused on what was in front of him – interesting problems and drills, drills, drills – and suddenly, his world got bigger.

"It was an amazing atmosphere that wasn't replicated for me until well into my college years," Dr. Arkani-Hamed said this week, seated beside his former teacher, now 74, after they reunited in a high-school classroom in Waterloo, Ont. "At a very truly fundamental level, it started me off in the sort of frame of mind that I keep and carry with me today."

Moments later, that frame of mind opened up for a crowd in the Waterloo Collegiate auditorium when the long-haired physicist, in his black pants and black untucked shirt, took the stage to deliver a mind-bending public lecture called *The Future of Fundamental Physics*.

"I realize this is a rather modest title," Dr. Arkani-Hamed said to laughs from an audience dotted with scientists from Waterloo's Perimeter Institute for Theoretical Physics, which played host to the event and arranged to bring Mr. Ledger and his family to it from the Toronto area.

Mr. Ledger began to develop his unique teaching method in the mid-1970s in response to difficulties students at Zion Heights were having with algebra. He came up with a series of drills, and then backed them up with a process of teaching to support them. All of it was more complex than what was contained in the math textbooks of the day.

As he fine-tuned his methods, "we started to work away from the texts," Mr. Ledger said, and "eventually we were teaching without using the texts at all." Before long, Zion Heights teams were cleaning up at regional, provincial and national math competitions, and Mr. Ledger's program, eventually dubbed *Spirit of Math*, began to attract notice. Still, education officials deemed it impractical to adapt for widespread use, mainly because of the retraining teachers would require to deliver it.

So, after he left teaching at the school in 1993, Mr. Ledger took the program private. His daughter, Kim Langen, now oversees Spirit of Math, in which parents can enroll children who are already adept at math for weekly, 90-minute classes to hone their creative problem-solving skills. The approach aims to equip students (900 are enrolled in Greater Toronto and Winnipeg) to discover answers on their own, rather than by rote. Ms. Langen said teachers are also encouraged to challenge students, and to teach to the top third of the class, rather than to the weakest.

"Our whole methodology was so different, and because of that, people were really hesitant to accept it," Ms. Langen said, recalling the public-school system's refusal to embrace the program despite its clearly positive results. "And like any place, there's some jealousy happening," she said, perhaps since it arose organically, out of a single teacher's simple desire to find a better way.

Back at the Perimeter Institute after his talk, relaxing in the Black Hole Bistro, Dr. Arkani-Hamed used the same kind of language to describe the forces that push scientists to the frontiers of understanding. "What really drives them is a deep sort of curiosity," he said. "It doesn't feel like playing a game; it doesn't feel like chess; it doesn't feel like solving a puzzle; puzzles are invented by humans." In physics, there's a sense of discovery, and what it contains is far beyond what we imagined we could have imagined."

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