Quantum treatment

Changing medicine one tiny bit at a time

World War I soldier, journalist and inspirational writer Claude Bristol said you have to think big to be big. Another writer, George Herman, said, "I like to live as big as I can."

Thankfully, Dr. Chitra Rangan doesn't subscribe to this school of thought. When she set out to make a difference, she was thinking very, very small.

The PhD in physics has an interest in the interaction of radiation with matter at the nano scale—that's a thousand times smaller than the width of a human hair. It's within the realm of physical science but, at the scale of a few atoms or one molecule, it is the laws of quantum mechanics that govern the behaviour of matter.

"My interest is in how to manipulate the quantum behaviour of matter by designing appropriate pulses of light," she says. "It's fascinating. At the small scale, quantum behaviour is very non-intuitive."

Think of a ball, a round, bouncing ball. If you look at it, you can say with certainty that it is there. You can see how fast it will move and if you know what is pushing it, you can predict where it will be in the future.

Not so with teeny, tiny particles.

"At very small distance scales, you can't make these statements anymore," Rangan says. "Where is an electron in an atom at any given moment? It's here—and there—simultaneously. Fundamentally, matter behaves differently. You can't make statements with certainty. There's inherent uncertainty in both speed and location of an object at that scale. All that I can predict for a large scale, I can't do with a small scale."

The challenge, she said, is to take what you do know at a large scale and translate it into what you don't know at a smaller scale. It's not guesswork; it's different mathematical behaviour. It's quantum mechanics.

Growing up in India, Rangan always knew she would be either a teacher or a scientist. She was fascinated with physics and maths. After getting her MSc from India, she moved to the US and earned her PhD in 2000 at Louisiana State University in Baton Rouge. She now works at the University of Windsor in Windsor, Ontario.

Her small thoughts have huge consequences. By applying her technology, she expects to decrease the time necessary to plan treatment for cancer patients, thereby reducing waiting times. Her point is that by having the radiation plan done by computer then checked by humans, rather than being done entirely by humans, it will cut that time by several hours.

One of her former students heard about this project and made exactly the kind of comment that Rangan hoped for. The student emailed Rangan saying she was so happy that Rangan was doing this project, now that she herself was a patient at a cancer centre. She said her own treatment plan took so long and the nervousness and tension were difficult because of the wait time.

Rangan's technology doesn't so much address a problem as it does a need, she said. Right now, with cancer radiation treatment patients, healthcare professionals have to find out where the cancer is and what it looks like using CT scans. Depending on its location, radiation can be straightforward or very tricky.

"If it is prostate cancer, the CT scan is not the most time-consuming," she says, meaning that the radiation plan takes up most of the treatment planning time. "We work where the treatment planning is bottlenecked; where we have a tumour in a tricky place near other important organs that must not be damaged by radiation."

The bulk of time is spent trying to make a computer model of the effect of the radiation on the target area. The medical or clinical physicists involved are very experienced and knowledgeable about how cancers behave; what angles radiation should be delivered; and how to best plan a computer model or treatment on a phantom (a dummy human model). This entire process could take an hour or could take a few days.

"In the meantime they're not doing anything else," says Rangan. Using her computer model, you can input the prescribed dose of radiation and all coordinates then go home. "In the morning, the clinical physicist says yes, this makes sense, or not. It reduces the time the physicist spends on the computer rather than the time spent on the patient."

Although the technology isn't yet being used, Rangan says she and Jeff Richer, lead clinical physicist at the Windsor Regional Cancer Centre, have proof-of-principle. Phantom tests should start in April and after this, she will be in a position to say if the code can be implemented or not.

Dr. Chitra Rangan (right) consulting with a student.

"There's already software commercially available," she says. "We have to interface our software with commercially available software. We're still getting permission for its use on patients. That'll be in about a year."

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