Joe McGonegal: This is a slice of MIT "Alumni Books Podcast." I'm Joe McGonegal, writer for the MIT Alumni Association.

The sun is not really yellow, it's white. The retina of a murder victim, unfortunately, cannot be dissected to reveal images of the murder. And try as he might, you simply cannot concoct an edible laser. These and other counterintuitive phenomenon are the cognitive playground for students of optics.

Our guest, Stephen Wilk, class of '77, has been a student of optics for decades. His book, *How the Ray Gun Got Its Zap-- Odd Excursions Into Optics,* was published by Oxford University Press in October. In it, you'll find 45 optical mysteries of the world decoded and dissected. This collection will leave you with a better appreciation for the magnificent tool we've got in the human eye. Stephen Wilk, what is this book exploring that no other book before it had done?

Stephen Wilk: Well, I'm not sure that I could say it's something that has never been done, although my concentration is on optics. I've been a great admirer of science popularizers like Stephen Jay Gould, Willy Ley, L. Sprague de Camp, Isaac Asimov, Carl Sagan. And I wanted to write the same sort of thing that I enjoyed reading but with the emphasis on my own particular background, which was optics. I inherited the column the Light Touch at *Optics & Photonics News,* and it seemed to be more devoted towards the optics experiment of the week. And I wanted to change it over into somewhat quirky, humorous essays with an eye to education by stealth.

McGonegal: I'd love to have you just read a portion of it. In it specifically, why the ray gun got its zap, if you don't mind.

Wilk: The use of a sound fills a visceral need. We like to think that something is happening to verify that titanic ideas are in play when a ray gun is fired. Robert Sheckley made a point of this his 1958 short story, a *Gun Without a Bang.* Animals didn't associate the destructive power of a ray gun with the gun itself when it made no noise. It's not clear to me that animals associate the destructive power of a noisy gun with its noise either, but people do certainly. And a proper powerful weapon ought to indicate its potency with a sound.

So when Goldfinger threatens James Bond with the latest weaponry, an industrial laser in the

movie *Goldfinger* (it was actually a circular saw in the book) the fiendish device starts with an ominous whipcrack, followed by a high pitched trilling whine as it cuts. When the TV show, *The Avengers,* in the episode "From Venus With Love," showed a powerful, possibly extraterrestrial ray, it was accompanied by a revving up whine, which proved its undoing as a scientist later identifies the sound as that of a laser. Although this is certainly the only characteristic in that particular television reality.

I'd like to point out that besides a *Gun Without a Bang,* I'd learned since I wrote the book that there is a role playing game called Rifts, in which there are some ray guns manufactured by a company called Wilk Lasers. No relation. I was astonished when it existed. And one of the perks they had for their ray guns is that you can incorporate into them this characteristic zap sound so people will have that visceral feel that you're doing something.

There is one thing I'd like to comment on.

Mcgonegal: Good.

Wilk: In your intro, you said that it's not possible to make an edible laser, but the point of that was that people had in fact built edible lasers but they weren't really very practical. It's sort of an exercise in can we do this? The quinine laser has been built, but there's never been a paper published about it. And I've looked. Not even anything quite close to it. You have to go quite a bit of chemical iterations away from the quinine molecule to find something people have made [INAUDIBLE] and published a paper about.

So they have built the gin and tonic laser. They have built a Jell-O laser, although they had to fudge it. They couldn't use off the shelf Jell-O the way they intended, and they had to mix rhodamine 6g laser dye into Knox unflavored gelatin. But it still was a--

McGonegal: I stand corrected. Yeah, they are very entertaining essays. There's some good stories in there. You certainly know your history it seems. Plenty of pop culture to be had. And we can tell you're a great reader yourself. Has made you a great writer, I'm sure. Did you learn writing at MIT?

Wilk: I did some writing at MIT. I never took a formal course of it there, but I did playwriting, for instance, when I was there and they put on one of my plays. And I took a number of literature courses. I had some very good professors for that over there.

McGonegal: Talk about some of the challenges of putting this collection together. Were there some assays you had to strike or others that you wish you had more time to edit and revise in high press?

Wilk: Actually, this was my reason to revise them and to publish things that I blacked the space to do before. When I put this together, I had 10 years worth of essays drawn not only from *Optics & Photonics News* but also from MIT's own *The Spectrograph,* which was put out by the Harrison Spectroscopy Laboratory. And I only had a limited amount of space in both places, and there's been 10 years of development. Up to 10 years of development since then.

So I went back through and updated them, and in some places greatly expanded what had been written. The titular [INAUDIBLE] ray gun got an enormous amount added to it. As for challenges, it's actually the sort of thing that I love.

I love researching things. I used to love researching things back when I had to do it with the Science Citation Index and the Physics Abstracts. But nowadays, you have all these databases you can search so it becomes an interesting thing to sit down at the computer and see how much you can dig out.

McGonegal: I saw a lot of references to Google in here.

Wilk: Yeah.

McGonegal: And what about challenges from the publishing and marketing perspective in this changing industry?

Wilk: Well, I was fortunate to have published a book from Oxford University Press earlier, about 10 years ago. *Medusa-- Solving the Mystery of the Gorgon* was a very unlikely book to come out of a physicist. That's what happens when you turn a physicist loose on mythology. So they already knew about me, although in a different department and I already knew how to pitch a book to them. So that was not too difficult to do, and I'm very gratified that it didn't take an awful lot to persuade them to publish it.

But this time I didn't try to commit too much into marketing, and I'm glad that I didn't interfere too much in that because it was their idea to give it the title *How the Ray Gun Got Its Zap.* I had suggested *Light Work,* but I think this has got much more oomph to it and probably will attract more people.

McGonegal: How is your MIT education put to good use in this book?

Wilk: It started on the road to optics at MIT. I got my bachelor's in physics working with Professor Mike Feld from the MIT Spec Lab, and I took courses in optics there. So that was the initial thing. As I said, I'd had a lot of experience in researching things for all of my courses, and I always found it interesting the challenge to see what you could ferret out.

So my MIT education came in very useful. After that, I went onto the Institute of Optics, where I learned an awful lot more optics and got my doctorate out of Utah. But it was always MIT that I looked back towards when I was trying remember how to look something up.

McGonegal: What are you reading right now that's inspirational to you?

Wilk: Oh, I read a broad variety of books. If you'd asked me the other day, I would have said that I was reading a book about the Norse Sagas because I'm still interested in mythology. But I've just started reading *Free Radicals-- The Secret Anarchy of Science* by Michael Brooks, who's a physicist. And it's an interesting take on physics and where it goes and how it's, in some ways, not as disciplined as a lot of people think it is.

I hadn't realized that Michael Faraday, for instance, was a member of a relatively obscure Protestant sect and that it colored the way he viewed the world and the way he pursued his research. That's exactly the kind of thing I'm fascinated by, and it's the weird things in the background that don't always get told about that make for some of the most interesting stories.

McGonegal: You make a few comments in this book about science education. I remember something in the preface about the way we teach science these days to students. There's the canonical science that we learned for decades. Are you happy with the changes you see in science education today?

Wilk: I'm very happy with where my daughter is being taught. She's in high school, and I'm very impressed with the way they're teaching her. My disappointment is there's not enough hands on, I think. Laboratories and things. When I was a kid it was very easy to do a lot of chemical experimentation and electrical experimentation in the basement. And now, I think the opportunities for that are somewhat reduced.

I could easily build a device for pouring electrolysis on water out of old batteries that I found and a few chemicals that was easy to come by. Nowadays you couldn't do that.

McGonegal: You also expressed some frustration, I remember, in how even with all of these amazing

modern indices, which are so different from the way we went to college, there's still so much wasted effort or wasted time, it seems, in concurrent research projects headed towards the same goal or repetitive science.

Wilk: Well, that's people. That's not the databases. That's just that people seem to keep reinventing the wheel. It's surprising to see how many times there will be a topic that was very well covered already but people weren't aware of it. I've stumbled across examples in the books that I've just been reading-- the ones I just mentioned-- which bring up exactly the same sort of thing.

But in my own experience, the probability distribution of nearest neighbors is something that had been treated many times over. The development of color centralizers as a possible laser source had been rediscovered and re-proposed many times. In my book on Medusa, one of the theories about the origins of Medusa had been proposed no less than a dozen times in the space of 100 years. So that's not a problem of the database. That's a problem with the people using the database, and I'm sure I'm guilty of it myself.

When I wrote about tractor beams, I was amazed how much literature there was that I had missed. And I'm sort of grateful that I was able to help bring some of it to the fore because my original article on the tractor beam was cited by the people down in Creole who were doing actual work on tractor beams right now as a history of its concept.

Mcgonegal: It's good flattery. There were a lot of people out there on soapboxes, and I'm sure you get feedback to your column and to this book from people saying, hey, did you know about this? It's not in your bibliography. Somebody already wrote about this or you're wrong. You've gotten some feedback like that.

Wilk: Not as much as I'd like, actually. And in fact, the feedback that says you're wrong is often some of the most useful. The very first column that I wrote for OPN, the ones entitled, "Wait, I was right. It is obvious," was about a distribution function that was another one of these ones that people had researched over and over again.

And I got letters from both sides saying, yes, you're absolutely right. I've been telling people this for years. And yes, you're absolutely wrong and here's exactly why. And I had letters on both sides from former directors of the Optical Society of America. One saying I was right and one saying that I was wrong.

Controversy is a good thing, of course. The folks at OPN loved the fact that people were talking it up. And it certainly teaches you an awful lot.

McGonegal: What about other authors out there and other books unwritten? What topic or book specifically would you like to see a fellow alum write?

Wilk: I think I'd like to see more popular science, really. I think that there's a decline in basic books on a lot of what is science in the bookstore. If you go to the bookstores you don't see as many things as you used to just telling you about basic electricity and magnetism, for instance, in entertaining or laymen form. You see an awful lot of study guides and things, like Schaum's Outline, which is still around.

But Asimov wrote a book that made this accessible and interesting to the laymen, and I think that book's out of print. I'd like to see more about current work that's being done because we are in a period in which work is just exploding. We're learning so many new things, an awful lot of things that contradict what we've known before or that explain things we've known before. Just

About planetary science, for instance, you could write a zillion books, and I don't see enough of them out there. There's the know-how at MIT, and certainly there's the quirkiness to make it interesting. I'd like to see somebody doing more popular science coming out of MIT.

McGonegal: And what about a next book?

Wilk: A next book. Oh, there's a bunch of them I want to write. I already have three chapters written on another book on mythology called *Sons of God,* which is another weird mix of physics and mythology. There's a book I want to write called, *Why Do Stars Have Five Points,* that would be devoted to the way we perceive the stars and the way we physically image the stars.

Because it's fascinating to me. There's is a whole optical science to the way the stars look that is very rarely covered, and I've heard misconceptions about even on optics people. One of the things that fascinates me is that it's easy to say, well, stars have points because of diffraction, but it shouldn't be possible to give yourself a diffraction image that has an odd number of points like that. If I had a five pointed aperture, a five edged aperture, I should have 10 points on my star. So why do stars have five points? And I think I've got an interesting answer to that one.

McGonegal: We'll put it out to our listeners too. See what they come up with. Well, thanks to Stephen Wilk,

the author of *How the Ray Gun Got its Zap-- Odd Excursions Into Optics.* It's available now through Oxford University Press on amazon.com or at your favorite local bookstore. Stephen Wilk, thanks for joining us.

Wilk: Thank you very much for having me here.