Charles Fefferman Interview - Transcript

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Andrea	Charles
What sparked your early interest in mathmatics?	
	Oh, when I was a little kid I was interested in 'kiddy science'. How rocket works, things like that. And I quickly became less than fully contented with the usual 'kiddy answers' and so I started checking books out of the library. One of which was a college physics textbook and I couldn't understand a single word. My father told me, of course you don't understand this book, it has math in it. You need to know more math. Oh well, so can I study some math? Uh, okay Charlie what grade are you in? I'm in the fourth grade (Andrea laughs). Okay, why don't I get you a fourth grade math book. And we'll see what progress you make in it and we'll take it from there. So, um, that started it. I made rapid progress, very rapid progress, and uh, I've never looked back and while 'kiddy science' wasn't as fun I found quickly that math is so fascinating that it was what I needed to do. So that's how I got into math
And did that experience inform the research decisions that you made early in your career as a mathematician?	
	Early in my career, um, no I don't think so. It had maybe a little more influence on the research decisions that I made later in my career, but in the beginning I think I was, uh, I was most strongly influenced by the personality and research interests of my advisor, Eli Stein. So I was very lucky to have as an advisor maybe the best teacher of advanced mathematics in the world. Um, and so that was my big early influence.
And, related to that your academic grandfather is Antoni Zygmund. How would you say the Chicago School of Analysis has evolved since the time of Zygmund?	

Andrea	Charles
	Well, so, um. Let me answer that first by saying what it was, uh uh, when I got involved, or even maybe just before and then come to what it's evolved into. So it started being, uh, a group of specialists in some arcane subject, which was of, uh, a great and passionate interest to a few people, uh and of um, of little interest to uh, to the mathematical world, uh, let alone to the scientific world. Uh, and what has happened, was that geographically, the the uh, Chicago School has spread over the globe and the, but the, intellectually, now the thing is completely different. The idea is that were being developed in the Chicago School in those days have become meat and potatoes for, uh I don't know, one-third of the mathematicians in the world. And have found very significant applications outside math. Uh, so I think that's the, uh, maybe the simplest most, uh, directly answer to your question about the changes of the Chicago School.
And what sort of applications?	
	Um, o, okay, so let's see. Um, well there's a subject called Littlewood-Paley Theory which takes a signal, let's say, and tries to break it up into pieces, uh, which are as elementary and simple as possible, both in terms of their frequencies and in terms of where they are in time. And that has turned out to become a tremendously useful tool in many different, uh, in many different, uh, fields. So the keyword is wavelets. It's used for example in the study of the flow of turbulent fluids and it's being used in current attempts to reconstruct a nice audible sound from an old Edison cylinder or Brahms playing Brahms, and and, I don't know a thousand other things. Um, uh, if if it isn't used right now in the uh, in the encoding standard for HDTV it soon will be. Um, uh, so this is one immensely important idea but it's simply a point of view which turned out to be fundamentally important.
And, is there a way to anticipate the development of mathematical ideas over time?	

Andrea	Charles
	Uh, not that I know of, um, so, uh, uh the particular ideas that I was just talking about, uh, seemed very arcane I think right up until the moment that they first got applied. I would have sworn in blood that there was no chance that they would be applicable during my lifetime. On the other hand, every so often, uh, one hears, uh, one promoter or another say that something, something or other is going to change the world. And uh, that's, I think that one should view that with skepticism. One never knows, that, its. If it is possible to tell, I think, no one has found out how.
There are various paths that a mathematican can take in their career. What motivates you to continue studying pure mathematics?	
	Oh, um, I couldn't put it down, it's so fascinating and so wonderful. Uh, I think I could not stop doing mathematics without becoming very sad. Simple as that.
And how do you choose your research directions?	
	Oh, okay, I don't choose the research direction, it chooses me. Every so often I hear about a problem and, uh, and the problem seizes me and I cannot stop thinking about it. Well I, sleep a few hours a night, but uh, it obsesses me. I cannot stop, during many moments of discouragement, I would love to just give up, but I can't because the problem has got hold of me. And, uh, and that can continue over decades.
And where do you find that inspiration? Where do you?	
	Um, I try to look for it everywhere and every so often at random it strikes. Uh, I try to look for it within pure mathematics, I try to look for it in the world outside mathematics and, um, it can come from anywhere.
Is there one specific example that really stands out to you when you look back on your career as a mathematician?	

Andrea	Charles
	Uh, well, let's see, so I mentioned wavelets. Here's something that I've been obsessed with uh, for the last 10 years or so. I happened to have heard a lecture, about 10 years ago by Ed Bierstone a Canadian mathematician, who as a matter of fact, right now is the director of the Fields Institute on some problem that had been posed by um, Hassler Whitney, a great American mathematician in 1934. And um, Ed explained some wonderful ideas that seemed relevant and the problem which, uh, which I had not heard about before, immediately grabbed hold of me and hasn't let go since. It appears now to be closely related to questions of how to draw conclusions from data. I guess the fundamental question of statistics. Um, I'm frustrated there is one particular reason, one constant in one lemma why it does not have practical applications right now. And if I could just, if I could just manage to uh, wrangle a better constant out of one lemma, then I think it will have very big applications in the outside world. That's one of the motivations that drives me to continue studying this problem. But that took me by surprise, the connection with, uh with data. And uh, for the first, I don't know, uh for the first half of the time that I was studying this question it never occured to me that the connection might arise. But it did, it was driven by uh, logical uh, mathematical uh, imperatives.
And, does your research ever find connections in industry?	

Andrea	Charles
	Um, the, the most significant connections by far come from wavelets. So, um, wavelets were developed, not exclusively but in a large part thanks to the reerach efforts of a few people working in the Chicago School, I was one of them. Um, so, the work that we were doing back then in the, that I was doing in the 70s and that they were doing in the 50s and 60s contributed greatly to uh, something that turned out to be important for industry. I think that's by far the biggest example in my own work. If the current stuff that I'm doing happens to pan out and of course I have no way to know whether it will or not. Then the applications to the outside world would, I would guess, and it's always dangerous to guess. But I would guess that it would be either well, so zero if it doesn't pan out or large compared to the applications of wavelets if it does pan out. The world is full of data, one needs good ways to analyze data. Anything that really makes a fundamental advance in that will be very important for science and for everything.
You have many academic descendents, three of whom are at the University of Toronto right now.	
	I am very proud of them
For young students today, do you think there should be changes to the incentives that drive the research topics that they choose?	
	Um, no I think it would be very very hard to make a systematic change that makes sense. Um, when a student picks a research topic, uh, the decision is influenced by the research interests of the advisor, the state of the field with which, in which the problem lives, the um, the personality of the advisor, the chemistry between them, uh who else is working on which other problem. It's immensely complicated and asking, asking for, for a sort of simple prescription for uh, how to assign research problems. It it reminds me a little of the question of how to decide who should marry whom. Uh, I would hesitate to pass laws about who should marry whom. It's, uh a sensitive process. And this is not so different.

Andrea	Charles
And, what is the relevance of mathematical research to society?	

Andrea	Charles
	Well, so I think there are, uh, I would say there are several respects in which it's relevant. Uh, the first, the first simply has to do with the training of people. Uh, training in pure math is, or more generally training, training in math um, is um, it gives a very special way of thinking which has been found to be useful in dealing with many problems in a changing world. So, so simply, uh, the fact that a lot of uh, well a lot, a certain number of people are trained in the mathematical way of thinking then go out into the world and bring that way of thinking to bear on a tremendous variety of problems. That's one already that's a significant impact of mathematics on the world. Uh, then, then I would, uh consider also the subset of math which is uh, concerned specifically with applied problems and there's a wide variety of problems in a world of uh, in which science and technology are important. There's a wide variety of problems to which mathematics applies and lots of mathematicians specifically study applied problems and some of that work, a lot of it is, quite important. For the health of that it is very important not to make artificial distinctions between pure, pure math and applied. So on the one hand I think it is, uh, what one hears sometimes uh, um, that that uh, that pure, pure math is so beautiful and so pure and wonderful that it should distance itself from applied math and on the other hand one hears that applied math is so useful and important that one should distinguish itself from pure math and that's a mistake there. I think there are interesting problems and not so interesting problems and that's the important distinction much more than pure versus applied. Uh, but then the, the uh, the last respect in which I'd say that math impacts on the world is that every so often there is, there is some huge discovery that changes everything uh, and math uh, has contributed its share of those insights.

Andrea	Charles
	The most obvious example is the discovery of the electronic computer and the various things that go with it. So the idea that, the idea that let's say, well so, once upon a time philosophers were interested in understanding uh, uh how to make axioms for the truth or at least let's say for all of mathematics, and well, uh, there may be infintely many axioms that how do you tell what is an axiom? Well it's alright to have infinitely many axioms if there is a completely mechanical procedure to decide what is an axiom and what is not. What is a completely mechanical procedure? Well there were several different definitions which all lead to the same idea and one of these way the idea of a computer and there was a mathematical theorem that among all possible computers there was a universal computer that could do anything that, uh that any computer could do, it simply had to be programmed. So this was the idea of a programmable machine. Um, and that changed everything and if mathematics had contributed nothing else to the world that justifies the enterprise many times over. So, so again I would say there are the three, there are the three things. There's the training of people with uh, with uh a powerful intellectual apparatus to go out and confront many problems. There are the questions, uh, the research topics specifically connected to applications and then there is the random, uh, infrequent immensely important uh, idea that comes from God knows where and that cannot be predicted. My own prejudice is that of these three, uh, impacts of math, the last one is most important. But none of them should be ignored.