Haaretz

My Part in Finding the 'God Particle': Meet the Mick Jagger of Physics

Eilam Gross, professor of particle physics, opens up to Ayelett Shani at his Weizmann Institute office.

Ayelett Shani

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I want you to describe for me the moment when you understood you had found what you've been looking for over the past three decades.

It was at the end of last year. I was sitting with two friends who are very senior members of the project: Marumi from Japan, and Alex from Norway. This was in Marumi's home in Paris, and we were eating, drinking and getting drunk. I will never forget it. Marumi said he had brought terrific grappa from some dump in Italy and that I had to try it. I drank some and said, "Wow, that's really good." And then I crashed: I fell asleep for a few hours. And suddenly, in the middle, at 3-4 in the morning, Marumi and Alex shake me and say, "Eilam, do you want to see the Higgs?" I sort of wake up and they show me the image on the screen.

And what do you see?

It's not a picture of something, not a creature. It's a sort of statistical fluctuation for which we had searched and waited, but had never happened.

Did you faint?

I was in shock; my heart jumped. But what we saw did not have sufficiently high statistical significance. It was

what we call three standard deviations.

And you need five.

Five is our golden number. But it was like, Wow, it's happening but I don't believe it. And now, in 2012, I am telling you that our discovery is, without a doubt ... if it doesn't turn out to be the greatest of the 21st century, then one of the greatest. Without a doubt.

Why? What does it mean?

It closed a crazy intellectual circle of understanding the structure of matter. Think of it as there having been a puzzle for which we had a model that was somewhat imaginary. But the whole model is predicated on this particle. If we had not found it, the whole model would have collapsed and we would have had to find a new model. In that case, we might have been stuck for hundreds of years. Hundreds. We had plenty of circumstantial evidence for its existence, but we didn't have the Higgs.

Okay, for you this model was critical but for most of humanity it was less so. What is its direct relation to our lives? Now that you have discovered it, what will happen?

The alternative was not not to discover it, but to discover that it doesn't exist. We've been there before.

Would that have broken your heart or made you rejoice?

There would be a feeling of: "I tried but it didn't work; I did what I could, but crap." And you know what? This is an awful thing to say and people will kill me, but, if I die now, that's fine, all right. Professionally, I did it. Really.

That's great for you. Probably few people in the world feel that way.

I always wanted to do something that had an impact.

But you're not explaining to me what the impact is.

We wrote a textbook in physics, we turned a page in Newton's book of nature. Okay?

But what can be done with it?

That doesn't interest me.

It doesn't interest you?!

No. You know, I'm sorry to repeat this cliché time and again, but when [J.J.] Thomson discovered the electron, in 1895, he raised a glass of champagne "to the useless electron."

Yes, because he thought it was useless.

And at the party, when I stood there across from my guys and we celebrated, I raised a glass of champagne and said to everyone, "To the useless Higgs." Because, what do you think, that in 1895, when the electron was discovered, they said to Thomson: Why are you bothering to look for something that no one sees? I don't know today what Higgs will bring us.

We can't grasp the implications of the discovery?

It involves understanding the universe, understanding God's grand plans. To understand how the world was created, beginning from one ten-billionth of a second after the Big Bang until today. I think that is huge. Do you know the biggest cliché? In connection with Higgs? That thanks to Higgs we have the Internet?

Yes, I knew that.

I was present at that, too. As a student, in 1989, I met Tim Berners-Lee, who invented the World Wide Web. Why? They needed something that would make it possible for a thousand physicists to sign off on an article. So indirectly, Higgs brought us the Internet. What the future will bring I don't know. But it really

makes no difference, because we have just written the textbook. I don't know if it will have any application. What difference does it make whether it will have an application or not?

I was hoping you would give me some sort of futuristic reply. Something out of science fiction.

Then write that you had hoped we would talk about something futuristic, and Prof. Gross sat across from you and said, "I couldn't care less what they do with it, because it doesn't interest me." That is the essence of basic science. We are now reconstructing in miniature what we will call the Big Bang. What does that mean? That we are reconstructing in a collision the energy that existed in the universe between protons immediately after the Big Bang. To reconstruct the Big Bang, all you have to do is gather the whole universe into a point and start from the beginning. The universe will disappear if we reconstruct the Big Bang.

More philosophically, in what way does your understanding and apprehension of matter influence your worldview?

In the past two years I lost both my mother and my brother. At the end of their lives, in my final conversation with them, which was also their last-ever conversation with anyone, I confessed to them both that my occupation with science has led me to understand that science can be so bizarre that nothing can be ruled out.

I am sorry for your loss. Do you think you grasp death differently than you would have otherwise?

You know, on the day of the declaration, Alex, Marumi and I were in a car. And suddenly Alex and I found ourselves saying to each other ... do you know what it's like when two people say the same thing at the exact same moment?

Yes, of course.

We said something like, "Wow, look at how the world looks different." Everything is suddenly clearer to us. Even the flowers look different. Even the air, as though you are seeing it. It felt as though it was no longer theory, but that we truly understand matter. A feeling that everything is talking to us, that nothing here is hidden – everything is suddenly clear. Suddenly there is no mystery behind the beautiful butterfly, no mystery behind the clothes, no mystery under a flower, no mystery behind a clod of soil. Everything is clear. Nothing is a miracle. That's what it does to us, this discovery.

That is very beautiful and very sad.

The amazing thing is that Alex and I uttered it at the exact same instant. I remember that afterward I picked up a grain of sand from the ground and said that now the words of William Blake take on a double meaning: "To see a world in a grain of sand." Suddenly there really was a sense of exaltation, of seeing the whole universe in a grain of sand. I don't know how to explain it to you, it made us feel like...

Like everything connects.

Yes. Everything connects. There is this sudden click.

Like spiritual enlightenment.

Now I ask myself whether what I felt was the equivalent of that. I think the feeling I shared with Alex during the drive was actually very similar: a type of enlightenment, a type of revelation.

People who have experienced enlightenment describe it very much like that: all is one. And what has physics been struggling with for the past hundred years? To find the mathematical equation that describes the universe simply, with one simple equation and a

minimum of terms, maybe one term. The force that contains all forces. Unity. Physics, too, is searching – believes – that everything stems from one source. We have no evidence of that. But this brings us closer to that.

You live on the Geneva-Tel Aviv line, right? Tell me about your life in Geneva. What do you do there the whole time?

Work my butt off, don't sleep.

What does that involve?

I see to it that the research progresses on all fronts, because searching for the particle and measuring its features is a saga of epic proportions. I organize meetings, attend meetings, make comments at meetings, and I show people a path if they don't already know it. I read articles, write articles – there is no shortage of work. Hundreds of physicists are working on it. My job is to coordinate all those hundreds so they do something coherent and avoid chaos.

What does CERN – the European Organization for Nuclear Research – look like? I imagine it like a gathering of "Star Trek" fans. Lots and lots of gimmicks in one place. Is there any sense of community there?

Yes. There is a certain similarity to a science fiction conference, except that the people in CERN are a little more sane. They are physicists, they know what they are doing; some of them are obsessed with the work and talk only physics, even during coffee breaks or at meals. I am not like that. But I don't have time to eat, so I only eat sandwiches.

It sounds lonely, alienated, like in a factory.

There are times of loneliness. So you call your girlfriend in Israel. People work very hard and often work alone. But it is not a factory. It's not an 8 to 5 thing. You come to CERN and live the physics. There are

no set hours. There are meetings at 7 in the morning and at 9 in the evening. There is no time. Time has no meaning.

Which is very ironic.

Yes. And anyway, when people work in an international environment, or on both sides of the Atlantic, when will you hold a meeting that involves people from Japan, the United States and Geneva? You have a real problem.

So you make a wrinkle in the universe and invite everyone. What did it feel like, before the discovery, to know that you were devoting your life to a search for something that might not exist?

I have two replies to that. One is that maybe this is the ethos of a true scientist. The second, which is more poetic, is that I have felt my whole life that I was searching, whether for the woman of my life or for the particle. Two things that aren't to be found. In the end I found both – in 2012, as it happens. Both the divine feminine particle and the God particle.

I need to understand what it means to find it, in terms of the professional hierarchies. How extreme is it? Is it like proving Fermat's theorem?

If I say that this project in Geneva is as stupendous as the moon landing, then I would say that finding the particle ranks slightly below the discovery of the electron.

When you were studying physics, was this even a goal?

Of course not. It wasn't even known, or was barely known. Just imagine – in high-school physics we were taught that the structure of the atom is a proton and that electron rings revolve around it, which is arrant nonsense.

You mean it isn't like that?

Of course not. And when I was a university student, in the 1980s, the God particle was like something theoretical. In other words, it has to be there, but no one has seen it. I first became occupied with it in 1987, as a student.

So this is the realization of the greatest professional dream?

Without a doubt. Not only the discovery, but the very fact that I was in charge of the search for the Higgs boson in Geneva, as the Higgs convener. My whole life I dreamt of being the convener. I fought for the position for 10 years. It's one of the most coveted in the ATLAS experiment. I never got it; someone else always got it. Two years ago, I gave up. Yallah, I said, I guess I am not the intended one. And then I switched to a different field: the search for dark matter. As soon as I did that, as soon as I let go, I got the phone call from Geneva. It's absolutely incredible. I learned a great deal from that, and also, I tell everyone as a joke: You didn't want me as a minister, you got me as prime minister. All those years I didn't get the job, didn't get it, didn't get it, and then suddenly the forces of nature convened, not only to bring the Higgs but also to bring me as the person at the top of the pyramid.

I still can't figure out the hierarchy. What are you, exactly? Are you the Mick Jagger of physics?

Nice – the Mick Jagger of physics. But it's like, let's say, the minister in charge of the search for the Higgs particle in the accelerator government. Okay?

Yes, now it all makes sense. Are you one of those people who never despair?

I don't despair. I am obsessive. Every scientist is like that. You have to be.

Have you been like that your whole life? Orderly, precise?

Precise, but definitely not orderly. I haven't opened my mail for a year, for example.

That doesn't impress me, I never open mail.

This whole mess that you see here on the floor is photos of my family. My mother died two and a half years ago, as I said, and I will finally scan all the family photos so I will know who is in my family. In the meantime, my brother also died, unfortunately, and the photos are still here – I don't have time. This work stole my life. But I don't treat it as work, I treat it as my life. My life is the search for the Higgs.

What is your motivation?

To leave something after me.

Really?

Yes. It always was. I can't stand the thought that I am living for no purpose. That I am purposeless. I've always had that notion.

What turns you off? Mediocrity? The purposelessness of existence?

Mereness. Mereness of existence disturbs me. I can't bear the idea of a life of mereness, it depresses me. There has to be a goal and a meaning to all of this. I think that what drives me is the attempt to inject content into my life, in order to leave something behind. It was very important for me to leave a mark.

What's splendid about your story is that the search has an aim. Most people are searching but don't know for what. They are coping with the mereness of existence.

Yes, that's exactly it, I tried to fill the emptiness of existence.

But you did it with great precision, in a kind of abstraction of the metaphorical search.

I did it in the most natural way: to fill the emptiness of existence by investigating existence. But I think a lot about the fact that I was leading the search when it happened and that it didn't have to be like that. About why I found myself in the right place at the right time. Whether it was by chance or not.

What's your take on that?

My feeling ranges between two extreme points. One of them is that it was totally by chance, and the other, which is the exact opposite, is that maybe, despite everything, it was meant to be.

That was helpful, because I didn't really want to say it. Either I was just lucky or not. But it makes no difference – the result is the same. I was there in the right place at the right time and I also realized a personal life dream. Very few people can say that they realized a dream they worked on for 25 years. Lovely.

Now is the time to talk about the anticlimax.

It was all followed by a severe anticlimax. Very severe. After it all happened I experienced emptiness. Something suddenly collapsed inside me, because I did not set the next goal.

Did you shut yourself up in the house and say: "I want my 25 years back"?

No, but I became very irritable. Suddenly I wasn't as happy as I had thought I would be. The event took place on a Wednesday, and until Friday evening I fell into a depression of: Well, what's next? And: So what? But I came out of it very fast, and today I feel I have fulfilled something very, very big. I hope I will be able to appreciate it all my life, that instant. In 1987, everyone here was searching for the Higgs. My two supervisors were searching, and somehow, 25 years later, a student of theirs is poised at the top of the pyramid. But the

journey is not over, the search is not done. We are certain that there are more particles.

Oy.

But I don't care anymore.

Like, "All the particles can die for all I care"?

It no longer interests me. I have done my part, I have found my particle.

So there is no more "What now"?

There is. But I also feel that I don't have enough years left to bring off anything so spectacular again.

You once wrote, "In certain circumstances a particle is capable of influencing its own past." I find that a very exciting thought, though I'm not sure I completely grasp its meaning.

There was a pair of physicists who said that we will never in our life find the Higgs, because there is some scheme from the future that is preventing us from discovering the Higgs in the past. That's a very complicated idea in physics. It says, basically, that every given moment in our situation is the result of history; and, we think today – because of the quantums – also of the future. A combination of the future and the past produces the present. In a certain constellation, you can change that fabric and effectively create different starting conditions. And then you have actually changed the past. But over and above the fact that it's science fiction, all of that can occur only in particles of particle seconds, so they are not really relevant in the big picture. I admit that what first drew me to physics was these mystical elements within the profession. My whole involvement in physics actually began with a book called "The Tao of Physics" that I happened to pick up in a mystic bookstore in New York. But nowadays physics is fantastical enough that you don't

need to spice it up like that. The fact is that we are now able to see 14 billion years into the past and to reconstruct instants and generate collisions. You see a pipe 27 kilometers long, you press a button and suddenly you get an image of inside the atom. A collision with the energy of the Big Bang. That's science fiction, isn't it? So, why spice it up with more fantasies?

Do you want prizes? Recognition? I think you really like to get attention.

Like every scientist, you don't like to do things without being recognized for them. Why do you write articles? So others will quote you. And what are you always counting? The number of quotations from my articles.

So the everyday blandness of science isn't your thing: you love the spotlight.

Yes. I think that what science and the arts have in common is that the artist does not feel he is an artist if he does not get public recognition. You might write for the drawer, but if you are a true artist you have to get it published. Right? Otherwise you are not a writer. Right? I know many artists personally. Most of them feel frustrated: they have not fulfilled themselves.

I read something you wrote in which you explain that our existence here is completely the result of multiple coincidences.

I believe that.

If everything is chance, and we could just as easily not have been here, why are we always looking for meaning and trying to place things in context?

Because in the same way as I say I can't bear to feel that I am playing out my life to no purpose, I think everyone is like that.

Don't you think – and I will put this a bit crudely – that in our era money has replaced knowledge as an ideal?

You have touched on an interesting point. I think you are right, and it grieves me very much. I was raised on values and education. My father was like that, he was a mathematical genius – his friends nicknamed him Mathi. He died when I was a boy. But until his death he imbued me with respect for education and the importance of education. The word "money" was never mentioned at home. But today I have to fight for my place, the scientist's place, and when I say that money is not my God, I am almost ostracized. I find that hard to take. You have touched on a delicate issue. I have these arguments with people who are very close to me. For many people, money has become God. We professors earn a pittance, but no one does anything about it. Why should a professor from the Weizmann Institute have to think about how much he is paying when he goes to a restaurant? We are also exploited because money is not our motivation and because we don't stand up for our rights.

We spoke about how you understand death in a different way. Do you also understand love in a different way?

All I can do is quote from "War and Peace."

That's not what I want.

I have to, because it is simply astonishing. I used the quote to open a lecture about the unbelievable need to believe.

All right.

It's one of the most famous quotes from "War and Peace," which is one of the books I connected with most in my whole life. Have you encountered "War and Peace"?

This is the first time I've heard of it.

Okay, sorry. When Prince Andrei dies, and Natasha is sitting on his deathbed, he says to her, “Love hinders death. Love is life. All, everything that I understand, I understand only because I love. Everything is, everything exists, only because I love. Everything is united by it alone. Love is God, and to die means that I, a particle of love, shall return to the general and eternal source” [Aylmer and Louise Maude translation].

I didn’t remember that, but I can see why you would.

Is there a better answer to your question?

No. I suppose you torment yourself because you didn’t write that.

Yes, it really bothers me.

What is the unbelievable need to believe?

There was a conference of psychoanalysts about the need people have to believe in something.

What do you believe in?

I believe that we have not yet exhausted what we know. That something far deeper is hidden there.

You believe in things hidden from the eye, not only in hard data?

I am a scientist. I accept only what can be proved. But I can believe in whatever I want. And I believe that we still have a great deal to discover, not least about ourselves.

You make music – is that another way to make discoveries?

Yes. That is my soul. It’s almost more important than science. I got a bit confused this year about which is more important, because I became a little immersed in science in the past few years. But I have an album that’s ready. I’ve been hiding it for 10 years, for fear of what people will say about the “singing scientist.” I told

myself: It will be when, when, when – and now all the whens have already happened.

So release it. What are you afraid of?

Maybe this time I am afraid like every artist – not like every scientist – that I will put it out and nothing will happen.

Okay, let's say you release it and nothing happens. So what?

I will no longer be able to say it's all that great; because if it didn't get public recognition it's apparently not all that great.

I don't agree. If there is something you love and believe in, what difference does it make what other people think about it?

Because I want to believe that I am not only imagining that ... I don't know why, but it's terribly important for me to have people sing my songs. Otherwise it's as though they don't exist for me. If there is no recognition, they don't exist. What has no recognition does not exist. Recognition is the way to transform something from fiction to substance.

A rock star? Is that what you want to be?

If I hadn't gone for a professorship – definitely. I started from music. I studied music in New York. I always agonized between music and physics, and at first music won. Now, at my supposedly advanced age, I see things somewhat differently. I want to skip over all kinds of initial barriers. I can't perform in pubs and start out like Shlomo Artzi. I need to make the quantum leap. I worked on an album for 10 years and finished it about a year and a half ago. The final touches were made by [the singer and musician] Izhar Ashdot. But the moment I got the appointment as Higgs convener, I put it aside.

Just release it.

When we are done with the Higgs convener I will release it.

I don't think there is another musician in the world who could say that. What consoles you?

Love.

Lovely.

For some reason I thought of Leonard Cohen when you asked what consoles me. Don't ask me why.

Why?

It's as though he was in my head. There is something in his songs that constantly addresses what consoles me. When he sings "Hallelujah" he is describing an act of love, right? Did you ever listen to the lyrics? Well, my songs are about physics and bring in love.

How do physics and love abut?

Through my songs.

And at the metaphysical level?

At the metaphysical level I think the two come from the same place.

Which is?

From the things we don't know that we don't know. You don't understand why, but you love. You don't understand why, but you do physics from the same place. I feel that physics and love come from the same place.