Michio Kaku looks to the physics of the future

Mar 14, 2011 20 comments

As well as being a co-founder of string field theory, Michio Kaku is a best-selling author, television presenter and all-round popularizer of science. His latest book, *Physics of the Future: How Science Will Change Daily Life by 2100* is based on interviews with more than 300 scientists at the top of their fields. Aaron Leonard met with Kaku in his office at the City College of New York to find out about his vision of the future – and how he juggles careers in science and the media

What benefits will science bring to the average person in the future?


Michio Kaku

Today a conventional MRI machine occupies a space about the size of this office, limiting where it can be installed and used. This is because huge coils are needed to make the magnetic field as uniform as possible in order to get those gorgeous pictures of the inside of the body. Using computer technology, which in turn is applied physics, you can now compensate for inhomogeneities of the magnetic field. The world's smallest MRI machine, made by physicists in Germany, is about one foot tall. Eventually it will be the size of a mobile phone and could be used anywhere.

In the future, chemotherapy will seem as primitive as leeches and bloodletting

We will also benefit from DNA chips that use Silicon Valley technology to locate cancer colonies decades before they form a tumour. The cancer will then be cured using nanotechnology. I had lunch recently with one of the world's leaders in research in nanoparticles. She's at the National Institute of Health in Washington and uses molecules like smart bombs to zero in on cancer cells. We are talking about a revolution in cancer research. In the future, chemotherapy will seem as primitive as leeches and bloodletting.

You write that Moore's Law – the theory that computer speed doubles roughly every two years – is not going to hold much longer for silicon devices, could you explain?

We are seeing the beginning of the end of Moore's Law for two reasons. One is heat build-up as a result of doing so many electronic operations in a very tiny space. The second is quantum leakage – Heisenberg's uncertainty principle eventually catches up with chip designers. In tiny circuits the uncertainty principle means that you can't know exactly where the electron is. And if you shrink a transistor to the size of a few atoms, the atoms themselves can leak out. We physicists are desperately trying to create the post-silicon era: quantum computers, atomic computers, molecular computers.

Given all the technical and financial constraints, what do you see as the future of Big Physics?

In 1993 Big Physics took a huge blow because plans to build the Superconducting Super Collider in the US were cancelled. The Europeans are now benefiting from a much smaller machine, the Large Hadron Collider. Physicists want to go to the next generation beyond that and build the International Linear Collider, but ultimately society as a whole has to make the decision – and unfortunately physicists don't interact with the larger society.

Science is getting more expensive and the public may simply pull the plug. That's why we have to interact with the rest of society. That's one reason why I write books. Even though we physicists created the architecture of the 20th century, the public doesn't know that. The public only looks in terms of those who massage money. Those who create wealth through things like the transistor or the laser, their names are mostly unknown.

Science is getting more expensive and the public may simply pull the plug

How do you see the interplay of science, politics and society in the future?

Science is a double-edged sword. The positive side can cut against ignorance, poverty and disease. The negative side can be very destructive when wielded by dictatorships, evil monarchies, governments that want to take other people's resources and subjugate them. Take a look at the two world wars; out of those came poison gas, saturation bombing and nuclear weapons. Scientists create the sword and we are the ones who have to interact with society and explain both sides – that is where I think we have been negligent. Which I think is very sad.

Being a tireless science popularizer must exact demands. How does it affect your research work?

I am a theoretical physicist. If I was an experimental physicist and my vacuum pump broke I would have to drop everything and fly back to New York to repair it. My laboratory is my own mind and I have chunks of equations in my head. If they don't fit properly into the right form, I have to massage them, manipulate them, take them apart and put them back together again.

Travelling does not interfere so much with this process – I can work while I stare out of an aeroplane window or a hotel window. An analogy would be a musician. A musician has partial melodies dancing in their head. When the melodies start to come together they go to a piano and plunk out a few notes, then they go back to daydreaming about melodies. Most of what a musician does is not with a piano at all.

My laboratory is my own mind

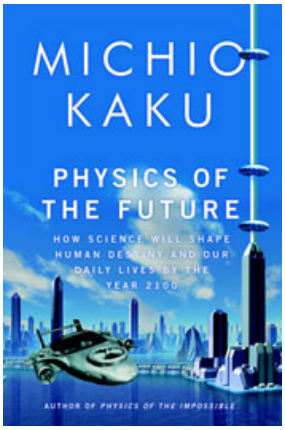
Are you optimistic about the future?

I think we are headed for a type I civilization, a planetary civilization where humans can do things like control the weather and harness all the light from the sun. Type II is a stellar civilization that can control the power of an entire star. Type III is a galactic civilization that controls the output of a 100 billion stars, plays with black holes and zips around the galaxy.

Today we are type 0 and get our energy from dead plants, oil and coal. When I open the newspaper I see the birth pangs of type I. For example, the Internet is the beginning of a

type I telephone system. We are privileged to be alive to witness the birth of a type I technology – a truly intelligent planetary communications system. Overall I'm pretty optimistic. I think we'll get to type I. The danger point is between type 0 and type I; that's when you have the power to destroy all life on your planet.

• *Physics of the Future* will be published in the US on 15 March by Doubleday.



Kaku's latest book

About the author

Aaron Leonard is a freelance journalist and writer based in New York City

20 comments

Comments on this article are now closed.

1 **Dileep Sathe**
Mar 15, 2011 9:02 AM
Pune, India

Future of Physics, then Big Physics

I think, we have to consider future of Physics, first, and then Big Physics. No doubt, doing scientific research is now becoming more and more expensive, as Prof. M. Kaku says. But it is also to be noted that even Frank Wilczek (who is now in mid-fifties) found classical mechanics very difficult to learn - see my comment on www.scientificameric…article.cfm. It is reasonable to assume that physics community could have lost 10 Frank-like promising students, 30/35 years ago, due to the similar difficulties. How can a field have bright future, if there is no young blood to take the challenges? Thinking of only Physics/Big Physics without considering teaching/learning of the same is similar to thinking of only heart without arteries/veins.

2 **easteinstein**
Mar 16, 2011 7:26 AM

Nightmare for the future human

as Prof.m.kaku say's "my labratory is my own mind" so his theory about future isn't applied and this is just science fiction book about future for kid's!.
nano technology and cancer therapy, this is old and also kid's theory about "science in human services". What about "nano technology and Nightmare for future human".
life is creature of DNA
Radiation, MRI Machines, are harmful to DNA to or creator!.

the only thing that human need for future is "clean and healthy enviroment",fresh air,water,food, clear blue sky with white clouds.
things that we are deprived of having that today!.

3 **parvatalu**
Mar 16, 2011 11:54 AM

Prof. kaku's Book

It is a wonderful idea of Prof.Kaku's work to share the thoughts with the common public.
The tragedy with today's science is that the style of teaching has not much changed in many of the developing/ underworld nations where many a good brains are seen/ upcoming Science for the sake of the degree is boring unless otherwise it is made intersting to the younger generation.The poor chap (student) who might be intersted in physics, maths, chemistry etc., may be scared off due to he inabilty of the teachers in many a cases.... not because of the individual's aptitude.This especially the case at secondary level/high school education.
We have to reconsider carrying the accumulated practical knowledge backed by the sound fundamentals of the

science to that level where science is made intersting to the budding studetns besides general public.

4 **Tom Sullivan**
Mar 17, 2011 8:41 PM

In Partial Agreement with Robert L. Oldershaw

With the present models the smallest particles are looked at as somewhat fixed in their size and parameters. A model that allows for each individual particle to have unique parameters and sizes may not be as pretty, but it may bring definitions that could be used across all domains, from sub-atom to galactic. So yes, new ideas and new theories must be embraced in conjunction with the pursuit of the present theories.

5 **olavdr**
Mar 17, 2011 11:17 PM

Evolution is not linear

Professor Kaku is extrapolating linearly from today. Common experience tels us that there will allways be a twist or bend that takes knowledge further. Physics might need someone or something from outside physics to get to next level. Physics has come to the border of mind/consciousness as indicated by quantum mechanics. Why are not physicists more interested in mind matters? My own observation tels me that the bulk of the scientific culture has been scared away and has left a big white spot on the cosmic map to New Age that is unable to handle it. String theory is very close to defining energies of the mind (particles that has no interaction with ”physical” particles). Are string theorists scared of walking down that alley? I have made an attempt to redefine some assumptions of string theory to accomodate mind phenomena, consciousness, dark matter and dark energy, but it is not invented by physicists and therefor unclean? The book is ”A Matter of Mind: Exploring the 11-dimensional Cosmos” (Found on Amazon and homepage) .
Olav Drageset

Edited by olavdr on Mar 17, 2011 11:43 PM.

6 **rajbanshiuk**
Mar 17, 2011 11:53 PM

the physics of the future

if we analyse the activities of daily life,we'll find that physics to play a great role in every activities which general people simply neglect considering them as the problems of physicists.if there were all physicists or at least with a little concepts of physics,there would be more progress in the society.i think if the education system had focused more in physiccal science from school level,the new generation would be more progressive enhancing the progress in this field.The present study of nature and their consequences also infers the requirement of the education in physical science working together for the continuation of the human beings in this beautiful nature. For this the popularization and to make aware of science specially physical science to the society is very important. i think for this the prof. Michio Kaku is doing his best by writing books in simple and understandable language for a layman.

7 **reader01**
Mar 18, 2011 3:31 PM

I read one of Mr. Kaku books (The Hyperspace)

But I have one question. Are computers based on DNA computing by two possible states: one and zero? The structure of DNA and combinations of its bases are more complex then only ones and zeroes.

8 **magesh**
Mar 18, 2011 7:07 PM
pune, India

Dark Matter Discovery

Future lies in dark matter discovery be it be Particle physics or Astro Physics. This discovery can only be made if we use Bio Sensors rather that Photo Diodes.
Dark matter discovery can change our views to how to see the universe like how the discovery of Gravitational lensing to locate a object in the outer space(stars galaxies etc). I think all physicsts should focus on this until anything not becoming too late.

9 **the_matrix_has_you**
Mar 18, 2011 8:26 PM

Hmm...

Still have to read one of his books (Physics of the Impossible) :)
Wish I could still be alive far into the future...as long as it doesn't end up like Orwell's 1984. XD

10 **magesh**
Mar 19, 2011 7:06 AM
pune, India

Why Dark Matter Physics Is So Important

I have seen UFO's many times and the way they interact with us is through dark matter physics and threaten us few can get mystified as it is paranormal but our uses bio sensors to detect it i.e we internaly has a dimension detecting it and they internaly has a technology of dark matter to interact with that dimension.So that's how i sense that dark matte discivery can be done through Bio Sensors(but it's hard to create one)

11 **mikki**
Mar 20, 2011 12:58 PM
I heard Dr. Kaku on 03/19/2011 at Space museum- nice guy. I hope he is not over-doing it to sell Books. I know, his string theory or unified theory would NEVER work the way he is trying to do.. 11 dimensions? Simply crazy... If Einstein could not, how anyone-else could by following in the foot-steps of Einstein?
There is a much simpler way to achieve the result.. The present crop would rather prefer to keep doing the old way and make their living...

12 **magesh**
Mar 27, 2011 11:29 AM
pune, India

When we have a steady state theory on cosmos

Dear Sir- This comment is for a different book Parellel Worlds. Steven weinberg first three minutes depicts the Big Bang theory and Parellel worlds depicts Multiverse. Just curious to know can deliver something in mixture of these two since its beyond my Imagination that would be of great help in understanding a better cosmos and dream of a final theory of our universe or atleast when likely we can reach that height.

13 **magesh**
Mar 27, 2011 12:27 PM
pune, India

11 D

11 dimensional cosmos is nothing but unification all physical forces like magnetism gravity light etc no need to get mystified but unification can be done during the Mr kaku predication of 2050.

14 **mikki**
Mar 28, 2011 10:22 AM
Quote:

> *Originally posted by* ***magesh*** ▸
> 11 dimensional cosmos is nothing but unification all physical forces like magnetism gravity light etc no need to get mystified but unification can be done during the Mr kaku predication of 2050.

Big bang or parallel U is a fools paradise- you seem to trust the present crop of scientists whose only interest is speculate all sorts of theories including Mystery or M-theory and claim 'no-god' (see Hawking), write false-Books to dupe innocents including the stupids who control the govt. funds and rob like the wallstreet thieves do... Have you ever heard of "Veda" (pure science) a summary of which you can find in "Gita" (Chap. 7)? Please read it- only takes few minutes...
Indra-Sun(s)-Planets make One Atom: whose Atom is this in which we live?

15 **jsherry2**
Mar 29, 2011 5:46 PM

What we do is nature

Dr. Kaku is, with all due respect, a human being. Not a celebrity. Not a superman. Simply a very intelligent, brilliantly articulate individual. It is people like Dr. Kaku that inspire of us to dream. We will never control nature. We are nature. Dr. Kaku very poignantly illustrates how we human beings are slowly evolving towards integration into a much larger sentience. That "being" I allude to is the universe itself.

If we choose to mire ourselves in the waste products of our rapidly overpopulating world, anthropomorphism will yield to irrelevance as we slowly strangle ourselves out of existence.

Pursuing the dreams of theoretic physics, bringing them forth into fruition, this is what I live everyday of my life hoping to contribute to. Dr. Kaku motivates me, and many others, to transform into reality the future he envisions. No better cliche can state this than the saying, "Reality is what you make of it". Better stated, what WE make of it.

J.E.H.Sherry, II, MSc., MD

16 **mikki**
Mar 30, 2011 12:36 PM

Quote:

> *Originally posted by* ***jsherry2*** ▸
> Dr. Kaku is, with all due respect, a human being. Not a celebrity. Not a superman. Simply a very intelligent, brilliantly articulate individual. It is people like Dr. Kaku that inspire of us to dream. We will never control nature. We are nature. Dr. Kaku very poignantly illustrates how we human beings are slowly evolving towards integration into a much larger sentience. That "being" I allude to is the universe itself.
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>
> J.E.H.Sherry, II, MSc., MD

Although admirable, the Reality is NOT ".. what you make of it" or we can dream of.. because Dr. Kaku and other like him- have shown a way to dream fiction- we should reject such out landish or stupid claims such as those.. for our own good.

17 **jsherry2**
Mar 31, 2011 11:38 PM

Reality

Reality exists only because we possess the consciousness to perceive it. In many ways, I share the same concerns that Mikki expresses in a paragraph about government abuse of science. However, I believe very strongly that very few of our colleagues studying theoretical physics allow themselves to be instruments of manipulation in those beauracracies in which we all struggle to coexist. And I am not an atheist. Far from it. The universe, in my opinion, is a living being unto itself. That being I refer to, some of we humble insignificant humans perceive of as God.

18 **jsherry2**
Apr 1, 2011 3:30 PM

I believe what you state, that we may live in an atom, call it "God" or even just a small part of that entity, is true. It dawned on me the other day, while listening to a show on current concepts involving black holes, that the very same, or their singularities, maybe the actual structural framework for our own atoms. I know it is still theoretical, but find it fascinating that someday we might be able to probe at this level, looking for minuscule amounts of "Hawking's Radiation" being emitted at the the event horizons of these entities. That presumes that Hawking's is correct about virtual particles colliding at the event horizon emitting a real particle, and that my completely wild conjecture is true. It also presumes that we will someday possess the precision instruments that would allow this particle emission to be detected from a macroscopic black hole.

19 **tevans714**

Apr 2, 2011 4:10 AM

Not Surprised

Quote:

> *Originally posted by* ***Ahmad_Reza_Estakhr*** ▸
> as Prof.m.kaku say's "my labratory is my own mind" so his theory about future isn't applied and this is just science fiction book about future for kid's!.
> nano technology and cancer therapy, this is old and also kid's theory about "science in human services".
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> things that we are deprived of having that today!.

Seriously? I'd like to note that the most closed-minded comment with the most ignorant content also has the most spelling and punctuation errors. I am fairly confident that the author of the above response isn't exactly educated in theoretical physics, and likely hasn't read any of Prof. Kaku's books. So, maybe educate yourself before you go judging this as child's play.

20 **mikki**
Apr 2, 2011 6:19 PM

Quote:

> *Originally posted by* ***jsherry2*** ▸
> I believe what you state, that we may live in an atom, call it "God" or even just a small part of that entity, is true. It dawned on me the other day, while listening to a show on current concepts involving black holes, that the very same, or their singularities, maybe the actual structural framework for our own atoms. I know it is still theoretical, but find it fascinating that someday we might be able to probe at this level, looking for minuscule amounts of "Hawking's Radiation" being emitted at the the event horizons of these entities. That presumes that Hawking's is correct about virtual particles colliding at the event horizon emitting a real particle, and that my completely wild conjecture is true. It also presumes that we will someday possess the precision instruments that would allow this particle emission to be detected from a macroscopic black hole.

Sorry doctor- I must disagree with you when it comes to Hawking- a 'no-god' expert. Have you read his recent book? I have read it- I am not sure who is better, Kaku or Hawking- both are trying to make money deceiving the readers with a fiction... shame on them ! Hawking is an applied mathematician- what does he know about Physics or Nature? Please forget his theory- his book propagates M or mystery theory- now, that's all we need to kill our time- worship the caliber of our fiction writers... and forget 'god'- who wants or cares for 'god'?