

Speaker: **Peter Atkins – Author and Former Professor of Chemistry at the University of Oxford**

Start time: **00:06**

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CONTENT

0:06

You get should get nervous. Because I'm going to add something to the last speaker that he forgot to mention. Which is corruption. So it's going to be all about corruption. But it's of course a scientific vision of corruption. I'm going to tell you about the most boring part of science. And I'm going to try to hold your attention on that boring subject for the next 15 minutes. And that's thermodynamics - and thermodynamics of course is boring because it arose in the 19th century when people were interested in the efficiency of heat engines, engines because they wanted to pump water out of the mines, so that the coal could be obtained.

0:58

So that we could go to war more effectively. And in the course of that they established the field that we now know as thermodynamics. And I will show you where corruption comes into that. And I will show you where this underlying image also comes in from that. And I also try to show why C.P. Snow now a totally forgotten author 50 years ago, said that it is a really a test of scientific literacy to know whether you can quote the second law of thermodynamics. If you can't, it's like not knowing not ever having read a work by Shakespeare. Totally meaningless today of course when no one has read a work by Shakespeare. But never-the-less you can see, I'm quite sure also that C.P. Snow himself didn't understand the second law of thermodynamics.

2:02

But, that's a separate issue. So I'm going to talk about TD (Thermodynamics) and TD comes in really two major laws. 1 is the first law of TD which says that the total amount of energy in the universe is constant. So in other words that's energy. Thermodynamacists get extremely excited when nothing happens at all. And one of the things not happening of course is the change of the amount of energy in the universe. So, at a stroke you can say what energy crisis. Of course where this particular lie lies is itself a very interesting question. How much energy did god trust us with on the first day of creation because whatever he chose to give us we are stuck with? Was it there, was it there, I could present arguments but I won't cause I only have a few minutes left.

3:11

Though it was actually down there - he knew exactly how much energy to trust mankind with. It was to trust him and her with absolutely nothing. But that's the first law. Deeply interesting, deeply boring, and I'm not going to spend any more time on it but I could of course make it interesting. The second law that everyone knows this, the entropy, the disorder of the universe is increasing all the time. Everything we do leads to an increase in disorder. In other words that is the plot of disorder against time. And we are approximately about well down near year dot still, but it's going to get worse. That is what we have to worry about. That is the crucial confrontation of humanity. So in other words what we've got is an energy crisis.

4:12

Everything we do makes it worse. Everything every time we use an energy resource we diminish that useful resource. So I'm going to focus on the second law that everything gets worse. So in other words the natural direction of change and this is really the essence of the second law is that everything actually gets worse - its corruption at the core of the universe. Everything we do is actually leading to corruption and decay. So if there's a message that I want you to take away today is that you should invest in corruption because because corruption drives everything. There is nothing that you do that is not driven by things getting worse - it is the ultimate law of the universe.

5:08

It is my most favourite law of the universe because I like to understand why little things happen, but what I want to convince you today is that it also tells you why big things happen. So when you leave this room you will understand the spring of the world. You will know that this doesn't happen. This is the natural direction of change. In other words matter and energy tend to disperse. That's the message which could should take home. That's is the message that the 19th century Thermodynamacists distilled out of their observations on on steam engines and so on. They didn't understand it - they codified it and it took someone like the Austrian physicist Ludwig Boltzmann's shortly before he committed suicide - I mean because he understood that things do happen and that really is a disappointed to Thermodynamacists.

6:23

Shortly before he committed suicide. He could understand it in terms of the behaviour of the underlying constituents of matter. That's what I mean by the second law of TDF - all of your teachers perhaps who said the second law is far too complicated for you to understand it. It's far too subtle said it because they did not understand it themselves. This is all that happens. That stuff never mind what the stuff is tends to decay into disorder. It might be energy spreading, it might be matter spreading but this is the spring of everything that changes. It may be the case though and this is the crucial point that you should take away with you as well, it may be the case that this decay into disorder can be tapped into.

7:20

By some kind of mechanism and it could be that that mechanism could be used to drive some construction. So, as the world sinks into disorder - on a cosmic scale, then locally disorder can be driven into order. And you can think that there is consequences of that - some of which are trivial, and some of which are profound. The blob up the top left might be the hydrocarbon fuel of and internal combustion engine. It burns and as those molecules are ripped apart in the combustion, so the molecules, the resultant molecules the carbon dioxide and the water molecules spread throughout the environment throughout the universe in general. And the heat that is released in the combustion also disperses.

8:24

But it maybe that you have designed the location where that dispersal occurs to tap into it, this is the actual machinery of the internal combustion engine. And you can link it for example to a pile of bricks and you can construct from that random pile of bricks. A whole cathedral. So locally order can emerge even though globally disorder has increased. That is the single message of the second law. Look for the source of global corruption, global decay, global increase of disorder but see that it because this world is a network, a reticulation of interconnected phenomenon, and mechanisms that out of it locally a structure can emerge.

9:25

This blob might be food, and from and this process might be digestion, and this series of gears might be the metabolic processes on inside your bodies. These bricks might be amino acids which are constructed into a which are brought together into a protein - an ordered structure. So as you eat, so you grow. So you can begin to see that this kind of corruption does indeed drive the universe. So, that great dispersal in the sky, the sun, generates releasing energy through the nuclear fusion processes that are taking part within it. Dispersing it through the solar system and beyond.

10:29

Captured on earth, maybe by the process of carbon dioxide and water being constructed into carbohydrates and so on you can begin now to see that there is a kind of relationship between what goes on out there 90 million miles away - the dispersing driving the emergence of the biosphere on earth. So it might be that that is today's breakfast - a kind of Japanese breakfast as you probably remember. Being digested, taking being lent into by the metabolic processes within us, the proteins growing into an organ. So as we eat, so we grow. And you can now begin to see the connection between the biosphere and ourselves. And of course you can trace that back also to see the connection between the dispersal of energy on the sun and the emergence of organisms on earth.

11:41

It gives you deep insight into the nature of change. This slide, a ketch slide, I mean to convey the sense that you can almost also understand the creative processes that take place inside you. Creative in the arts, creative in literature , creative in commerce, creative in industry, creative in science. Thinks of your brain as having a random collection of of currents - electric currents, synaptic currents, as though you were asleep and disorganised. But the second law enables you to understand is that through the process of digestion, dispersion within the stomach if you like - then, then, you you, you can see that those random currents might have been organised into coherent processes. That and out of it you can begin to see how breakfast can drive the emergence of music, beautiful music, aesthetic appreciation and so on.

13:13

There is nothing that you cannot understand through the second law of Thermodynamics. You can also understand really that great workings of the second law. I mean the world is unwinding getting more chaotic but it's doing so in an extraordinary subtle way. A way that we call natural selection and evolution. And through as it were Darwin had no idea that he was really unravelling a consequence of the second law. But we are being driven by that dispersal on the sun and the world has found and extraordinarily complex of of utilising that dispersion to drive the emergence of the biosphere and all the thoughts and the creativity that we find inept. Back to my initial image because I am really now at the end of my time - of course there is dispersal being represented in this fractal image.

14:15

But, it's a deeper image than that. And I think it's a deeper it's an image that underlines the entire scientific procedure and enterprise. That, although there is complexity arising from the ideas we have - when you look right at the core of the centre of the processes that surround us, then we discover that they are of the utmost simplicity.

14:49

What I have tried to explain to you, and I have 19 seconds left to summarise it, is that that core idea is that matter and energy simply collapse into disorder. That they are linked into the ecosystem that we inhabit, and out of that come ecosystem emerges extraordinarily wonder.

15:19

Thank you very much.

15:24

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