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Ionizing Radiation in Context 2

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(transcribed by L-I-G-H-T, verified by Giraffe and Burtlancast)

JB - John Barkhausen
RP - Ray Peat

JB: *Today on Politics and Science, the 27th of April, 2009, it's the second in a series. I'm looking at the uses and abuses of radiation in our culture, with a particular focus on ionizing radiation, i.e. nuclear technology. And again, this week, I'm very pleased to have Dr. Raymond Peat, endocrinologist, physiologist and science historian from Eugene, Oregon on the show today. And his website if you'd like more information is www.raypeat.com. Ray, can you hear me?*

RP: Yes.

JB: *Last week we talked about some of the systemic and long-term cumulative effects of x-rays and other types of radiation. We also discussed radiation from power plants. And our medical establishment often compares it to less harmful things, like sunlight. And you basically pointed out that it's like comparing apples and oranges.*

RP: The key idea is linear energy transfer: how much of the energy actually gets in your tissue and interacts with it.

JB: *I see. And the ionizing radiation has far more energy.*

RP: Yes. And some of it, like the isotopes getting into the air and food, release particles that have an extremely high energy transfer. So those are the worst. And the others penetrate deeply, and do damage along the way. But the intensity of that radiation isn't the main thing; [it's] is how much they interact with your tissue, and in what ways.

JB: *So those are actual radioactive particles.*

RP: Yes.

JB: *Last week we talked about those, and we touched a little bit on the history of radiation. You talked about some of the scientists getting badly damaged by handling radioactive substances. We didn't really focus on the history of the uses of radioactive materials in science, medicine, and the military (which is eventually how they really got popularized). But Ray, could you perhaps give us a little summary of how radioactive technology has crept into our culture?*

RP: Almost immediately when the Curies discovered how deadly poisonous radium and related isotopes were, the medical profession became very interested, because it was a fancier way to destroy tissue, instead of just poisons, surgery, cautery, acid, etc. They had a new technique that seemed technological and impressive. And so, it very quickly went from treating warts and tumors to all kinds of bizarre quackery. When I was in college, I knew people whose facial bones were collapsing because they have had an x-ray treatment for acne. And people whose hair had fallen out because they were treated for ringworm with x-rays. And so it's just total ignorance and arrogance, combined to using whatever turned up [at that time].

JB: *Who was treating them, Ray?*

RP: Regular doctors.

JB: *Just regular general practitioners?*

RP: Yes. And when I was a kid, shoe stores still had x-ray machines, so anyone could look at their feet bones and see if the shoes fit. Just a technological gadget that entertained people. But regular doctors had fluoroscopes that would let you watch a person breath, and their heart, stomach and intestines move, and so on. And they were pumping nearly lethal doses of radiation into people. [The doctors] would just stand there talking and watching for entertainment. Some of those things were putting out, well, 50 to 100 rads in even a short treatment. And if they had come in for a weekly exam, they would've soon been dead.

JB: *And just to compare that to a normal exposure from a chest x-ray, how much is that?*

RP: Oh, I guess approaching a thousand times more from some of those fluoroscopes.

JB: *Wow!*

RP: In the last few years, I've talked to people who had a combination of heart treatments, where they put a tube or a wire up into your heart to open a clogged artery. But they use a fluoroscope to watch where it's going. And these people get a tremendous amount of exposure that is cumulative. And it can cause brain degenerative diseases. And the heart surgeons who do that kind of work have a high incidence of brain cancer. And so, they are advised to wear a lead cap, so that they don't get brain cancer.[chuckles] But the various types of physicians who work with radiation, radiologists and heart surgeons especially, have a higher rate of girl children. And that's the same as electricians who work around high voltage power lines; or the birds that nest near the high tension lines. It doesn't have to be ionizing to have really major biological effects.

JB: *And why is it that they produce girl children instead of male children?*

RP: Apparently, the male fertilized egg is weaker at all stages: ovum, embryo, fetus. The female has a better resistance in general.

JB: *I see.*

RP: And it's partly because all these types of radiations imitate estrogen in their biological actions. And estrogen tends to bias the sexual ratio of the offspring.

JB: *These fluoroscopes you were talking about, they were a novelty? What year were you talking about originally where people were using it just to observe the breathing and things like that?*

RP: All throughout the '40s, into the '50s. The shoe stores, I think they were outlawed in the mid-1950s.

JB: *And in the '40s, doctors had any idea of the danger of x-rays? Or did they just think it was a momentary danger?*

RP: Doctors never have any idea about anything, except what they're told as good practice. The information was available, like [from] chiropractors and, you know, borderline people. And the medical profession had pamphlets in their office at that time. In the 1940s, I saw these pamphlets giving references to the research literature showing that radiation accelerates aging process. And meanwhile, real doctors were exposing their patients to doses that would not only accelerate aging, but would tremendously increase the cancer mortality. Leukemia was extremely high in that period. Not only from radioactive fallout from atmospheric bomb tests, but from the medical x-rays of pregnant women and fluoroscoping of the general patients too.

JB: *So it sounds like our culture was basically in love with modern technological gadgets.*

RP: Just the same as it is now. Some differences [exist], but the same principles [apply].

JB: *I'm sure most doctors have heard this information from a source that they respected, and have cut out most of the excessive practices.*

RP: Well yah. But the people who sell the equipment create mythologies, saying all those that warn you that radiation will accelerate aging are just quacks. Now, 60 years later, some of the best researchers show that radiation causes the formation of amyloid [fibrils], the type of substance that is incriminated in Alzheimer's disease, degenerative lung, kidney and pancreatic disease, and so on.

JB: *Amyloid is a plaque?*

RP: It's a type of protein that forms plaques. Normally, the very common structure of a protein is that there are helix structures, a spiral piece of a chain of protein. And with a certain disturbance, those spirals can break down and roll over against themselves and make a sheet arrangement called a *'[beta] pleated sheet'*. And those sheets can stick to [others] similar sheet structures [from] another protein. This array of pleated sheets sticking together in different protein molecules forms a long fibril. And then those fibrils are what actually forms the plaque. So first, you form the degraded protein, and then proteins form fibers, and the fibers condense into the visible plaques that they call amyloid.

JB: *And that's a common symptom in all Alzheimer's patients?*

RP: Yes. And it's turning up in practically all aged tissues. But it's accelerated by radiation, toxins, estrogen, and even microwaves, and other types of disturbing energies. [For example,] *in vitro*, you could produce amyloid fibrils with energies as low as [the one emanating from] ultrasounds or microwaves.

JB: *I thought ultrasound is actually protective of tissue. But, I guess, it does have some drawbacks then.*

RP: Yes. Everything that puts energy into cells and tissues in unbiological ways can cause some disruption.

JB: *I can see how that would be. We were talking to Professor Gilbert Ling a few weeks ago. And he was basically talking about the electrical nature of living tissue, how everything is basically in an electrical relationship, all the proteins and the water within a cell.*

RP: [The problem with all kinds of radiations, and even toxins, is precisely the electrical interactions between proteins and water]. The romantic classical physics - individuals who wanted to think mathematically about radiation, and who assured people that there was a threshold below which radiation wasn't harmful at all - claimed that a unit of radio energy [obligatorily] needed to be sufficiently [powerful] to break a chain of DNA before anything happened biologically (it takes a direct hit at a certain high energy [to cause a breakage]). That's where the idea of the danger of ionizing radiation came from. But before the ionizing radiation actually has a direct hit and breaks the DNA chain, it's doing many [and] much more subtler things, causing fluctuations in the electronic system of proteins, and causing subtle changes in the way water relates to those proteins. So if the medical and physics worlds had been paying closer attention to Gilbert Ling's work 50 years ago, most of these questions would've been settled in a very different way, with much more concern for protection than for promotion of industry.

JB: *So you feel like basically the marketing side of our culture is what's determined its medical course?*

RP: You know, the people with an x-ray machine to sell will tell doctors that “this one delivers 10 times less energy [and corresponds to] the below-the-threshold dose. And if you want, you can give a person a sub-threshold dose every six months, and they'll never have any harm from it”. But these little sub-threshold doses actually modify the water structure, which directs the way the tissue develops and affects things like the immune system, and the way nerves pattern themselves. And so, it redirects the course of your development. And in a young individual, that deviation of development can produce drastic and fatal effects very quickly. In mature people, it accelerates aging and degeneration more often than not (a fast cancer, or other lethal event).

JB: *So people became more and more concerned? Because it seems like there is more concern at this point.*

RP: People were already beginning to understand it in the 1930s. I mentioned last week that Thomas Edison after 1904 became a great opponent of the medical use of x-rays. And other people, especially in other countries, were studying the actual biological effects. And in the '30s, there was enough [accumulated empirical knowledge] that they should've shut down all medical x-rays, and banned the development of nuclear industry. But the government and the nuclear industry and the medical instrument corporations were reeducating the people, convincing them that those researchers [opposed to radiation] were only unrealistic quacks who hated technology. But the subtle effects of the interaction of radiation with cellular electronics, the cellular light effects, the water interactions with proteins, and so on, all of those were developing along another course all throughout the '30s, '40s and '50s. Albert Szent-Györgyi was one of these people working on the subtle but essential biological interactions of electrons, water and light. And he was just totally sidelined for 20 or 30 years, even though he'd won the Nobel prize for work on vitamin C and respiration. His work on light and cell luminescence, and so on, just put him out of the mainstream. People who criticized industry become the victims of corporate government campaigns [orchestrated] to convince the public not to listen to them. I guess the big nuclear corporations still do it. Some of them used to have weekly seminars where they would have people come in and tell all the physicists and engineers working there that radiation was actually good for them biologically. And then they would smear the people who had presented evidence of the toxic effects of radiation or of nuclear plants. For example, people were convinced that Sternglass was such a quack, and they wouldn't even look at his books. [Likewise with] Alice Stewart, who showed that medical x-rays were probably the main cause of childhood cancer. For about 30 years, she was ridiculed because the corporations campaigned and taught their employees that these were basically demented or insane people.

JB: *Do you think this mindset was connected in any way to the military use of atomic bombs?*

RP: Oh yes. The military once they started doing their atmospheric tests, they joined up with the medical, the x-ray industry and so on. And they had massive campaigns to tell the public that fallout was good for you, that it was below a threshold, and that it would actually stimulate you to be slightly irradiated. And the professors who criticized these campaigns were [retaliated against,] using some of the right wing organizations like the John Birch Society to create scandals: the professors would be identified as opponents of atmospheric bomb testing, and then they would create a scandal implicating them in some kind of immoral, or pro-communist activity, and get them fired for something other than their expressed opposition.

JB: *So it was really an organized campaign?*

RP: Yah. Yah. Very. Involving organizations like the John Birch's and the CIA, etc...And the national U.S. Public Health Service was a major player in that campaign to incriminate the critics and hide the evidence, destroying the evidence in many cases, and telling the public that they were safe. So, the public health service was very influential, especially [towards] the medical profession.

JB: *The Cold War started to really get bad when the universities and all of our public health services became affected.*

RP: Yes. There was no line between physics and biology. Because the people with the biological orientations, Szent-Györgyi, Gilbert Ling, and anyone interested in the subtle biology, were [all] called quacks. And Even the Cold War [ideology] got involved because the idea of acquired damage other than a random mutation was identified as a [inaudible 00-24-54] Soviet doctrine. And they were fired [for it]. So you had to be a certain kind of a genetic dogmatist to teach biology in the United States after 1950.

JB: *That is so bizarre. I think most people believe, you know, science is an objective empirical art; and that's basically the bottom line.*

RP: So a very good place to get insight into how the whole system works is to start with German romantic physics in the 19th century, and see how that directly led into the 20th century nuclear physics. They wanted to subjectify physics, make it part of a spiritual quest for unity, seeking the absolute. And facts got in the way. It was presented as a subjective art expression. And that's where the Heisenberg thing came in that you can't know the things on a fine level. It's all ultimately random. And so our mind, the knowing system, is the only thing that counts. So it's a sort of a victory of subjective idealism over empirical science.

JB: *That's interesting. I didn't know it started with the German romantic physics. It sounds like this was the beginning of eugenics and Aryan pure thought.*

RP: Yah, yah. Hitler was just a business-like application. The others were more refined in the theoreticals.

JB: *It's discouraging it should live on to this day.*

RP: Oh well, it was deliberately imported. The journals of human genetics originated in the Eugenics Movement. And they renamed themselves after the war. But the German physics and genetics people were idealized; and many of them were imported to become influential in the United States.

JB: *You talked about America's culture of love for new technology (and maybe most of the world's industrialized nations). In terms of selling nuclear technology, it seems like the equation $E=mc^2$, and Einstein's popularity, really played a big role in bringing that to the front of popular culture. I don't claim to understand what $E=mc^2$ means, except that it sounds, just on a superficial level, that energy is the same thing as matter. Which to me is a little confusing. It sounds like it's saying that everything is the same as everything else.*

RP: Yes. It only becomes really dangerous when they start saying that energy and information are the same. And that “knowing” and “matter” are the same. You can argue about how interactive energy and substance are. Einstein had an interesting exchange with Max Born, another physics worker, about whether the field of a particle is part of the substance of the particle. Einstein's position was that the field should count as matter. And so, from Einstein's perspective, there was nothing necessarily idealistic about it. But energy was just another form of matter (substance) that could be related to ordinary forms of matter. But when you invoke the quantum ideas, the Heisenberg principle, then you throw out matter and substitute mind and information. And much of the computer culture is committed to that kind of doctrine

about the nature of knowing and information. It wants to take the substance out of information.

JB: *So when you say that the field is part of matter, that means that the matter is part of its environment. Is that what you're saying?*

RP: Yes. All of the world, including our knowledge of the world, is part of the same substantial stuff. The process of knowing becomes substantial and physical. For example, there are people who have demonstrated luminescence in the visual center of the brain and in the optic nerve, and so on. That when we see a colored light, we actually light up with that color inside. And so it's putting consciousness right into the physical interaction with the different substances interacting. So you can think of our consciousness as a physical resonance. We are learning to tune ourselves up to the energy of the substance outside. And there is nothing anti-material, or ethereal about that kind of interpretation of consciousness. But the people who talked about information being transmitted along nerves which have a simple all-or-nothing, on-or-off-switch-like behavior, it reduces knowledge and its interactions with substance to something mathematical. So, many on-switches, and so many off-switches are supposed to amount to consciousness. But nothing is left that relates to how it experiences reality.

JB: *So what you object to is that they're reducing life to something that's just basically mechanical, and it doesn't really live in the environment.*

RP: Yes. If you see information as separated from substance, like the Heisenbergian idea, your interpretation is what makes the difference. Because you can never know the actual details of the fine structure of matter. And so, your theory of what you're perceiving is the real thing. And it reduces consciousness to a cluster of theories like states in the computer.

JB: *It sounds like it reduces confidence, too. It sounds like Heisenberg is saying that you can't know your own world.*

RP: You can't be sure about it. It's all probabilistic and random.

JB: *And is that essentially the message of quantum physics?*

RP: Yes. And the really bad consequence is that it all becomes deductive. The hypothesis is tested against the reality; but the reality is really statistical probability. And so, the definiteness is only on the side of theory. And that means that you can think your way to the absolute and the truth, but you don't have to learn your way because out of this probabilistic quantum world, nothing definite is going to come without the insertion of that specific set of deductive mind principles. And the other way of looking at it is that knowledge is always something that is inert in the past, except when we're learning new knowledge. The inflow from the changing world is where knowledge comes from.

JB: *When you're talking about not being able to know the world, did you think that the scientific attitude of quantum physics is used to basically claim: "even though there's radiation there, it may cause some harm, but we can't really know that"? I get the general impression that it's taking away the liability. Because you could be a*

corporation out there and pollute the heck out of the world and make a lot of people sick. But none of us can really know if that's really true, and so it's just the way it is.

RP: Yes. For decades, John Gofman went around working for the government saying that we can't know that this is causing terrible damage in the future ([he was promoting] the idea that you shouldn't act on anything that you haven't tested empirically; that you can't make your judgment as a one piece of the world, sensing the possibilities, but you have to do everything after the fact). The knowledge after the fact is the only thing that Gofman would recognize for years. And then suddenly, it occurred to him that if you're doing the damage, maybe it would be nice to take a precautionary attitude. And now people are talking about a precautionary principle that you should think about: what harm might happen in the future? Even though it hasn't been hypothesized and tested in the conventional scientific way. It's more like a common sense. You don't wait until the accident happens to avoid the accident.

JB: *Yes. But Ray, we have a product! We have to get it on the market! If we don't do that, we'll lose valuable marketing time!*

RP: Yes. It's how people forget their common sense when they see people in white coats being sponsored by big corporations, and [with] the government saying that we have no knowledge that this is going to harm you in the future.

JB: *It also sounds quantum physics is a very good physics for an authoritarian culture.*

RP: If you barely listened to a lot of physics professors, or tried talking to them, you realize that the whole physics culture has that authoritarian "textbooky" quality. They don't know anything if it isn't in the textbooks; and if it is in the textbooks, you can't question it. They are very hard people to actually talk to, except things like bowling or golfing and their weekend activities. They can act like regular people, but as professors, they are in a separate world.

JB: *So the textbook basically establishes the party line, and then that has to be stuck to.*

RP: Yes. And if you read the professional science textbooks, looking at older ones, it's [as] interesting as reading novels to see how a given professor was constructing his textbook. But there are sometimes interesting individual works of art; but the outstanding thing is how rigid they are.

JB: *When you say it's like reading a novel, how do you mean?*

RP: You can see the mind of the creator at work sorting out the things that are to be emphasized. And not expressing "maybe this happened and maybe this is true". The novel would get very complex and confusing if they tried to be empirical about their imagination. The textbook writers are always too sure of what they're saying. And they're almost always wrong.

JB: *In the textbooks?*

RP: Yes.[chuckles] When you look at old textbooks, it really makes me think of Monthy Python.[chuckles]

JB: *Maybe you should put some of those skits into screenplays, lol. One of the arguments I've heard now for bringing nuclear power back is, number one, global warming, because its purportedly creates less greenhouse gases. But Helen Caldicott, who agreed with many of the things you're stating about radiation and it's cumulative nature, said that the production of nuclear power involves tons of greenhouse gases. Because it's so energy intensive to not only build a nuclear power plant, but also produce the fuel that goes into it. And I think some of the arguments for bringing back nuclear power, because basically a new plant hasn't been built I think in 30 or 40 years, is, we should do what the French do, which is recycle the spent fuel rods that are slowly but surely building up. And [we should recycle] all the spent fuel rod pools outside of every nuclear reactor in this country [that has] no place for them to go.*

RP: Yes. There's a website called 'environmental devastation caused by reprocessing radioactive waste', and they mentioned that the French plant has annually discharged a 100 million gallons of radioactive waste in the English Channel by way of an underwater pipeline. And you probably heard of the industry and military dumping barrels.

JB: *Yes.*

RP: Hundreds or thousands of barrels of radioactive waste dropped in the ocean about 10 or 20 miles off the coastlines all over the world.

JB: *God.*

RP: And those things are leaking. And the food chain from the English Channel, it has already drifted up to the Arctic over to Canada. And it circulates, gets into the food chain. And then, 20 or 30 years later, the people on the continents are starting to eat the radioactive fish that have eaten the waste they dumped in barrels. But that was banned in the '90s after 60 years of dumping.

JB: *Who was dumping it? The military?*

RP: The Atomic Energy Commission, the Navy, the Army, and anyone who is authorized to use it. [They] would dump it. And the dumping in barrels was banned about 15 years ago. But they didn't ban putting a pipe out under the ocean and pumping it out.

JB: *God.*

RP: And so, this website says that the plant in La Hague alone has been discharging a hundred million gallons of waste every year. And another one in England, some in the United States, are dumping these immense amounts of waste from the reprocessing plants. More than they've dumped in barrels. So, someone knew that it was bad to dump barrels of radioactive stuff into the ocean, so then they started pumping it in pipes. We need some kind of a concept that doesn't specify whether the behavior is governed by insanity or criminality. Because it all amounts to the same thing.

JB: *The waste that's coming out of the pipes from reprocessing the nuclear waste, is it contaminated water, or is actually particles, or...?*

RP: Oh! Particles. Huge amounts of even uranium and plutonium are getting into the water. And the fish are taking it up. Strontium 90, and the further acting isotopes. But the whole range of junk is getting into the ocean still.

JB: *That's really discouraging. Well, I hope that perhaps people will take a second look at nuclear power before they actually start building anymore plants. It's never made any sense to me. They always claimed that they would solve the technological problem somewhere down the road. But when you have a process that's basically spewing out the worse poison known to man...*

RP: The United States has two very contaminated areas, besides what goes into the ocean and rivers. The Hanford Plant in Washington, and the Greenville Dump in South Carolina. A nearby town was finding their well water was contaminated with uranium. And the people reporting it said that it must [be caused by] some natural uranium mineral source upstream in the water table. They were only 20 miles from the Greenville nuclear dump. Wells in that area are being contaminated with all kinds of isotopes. Several years ago, I was driving south on I5, going about the speed limit in Northern California, and saw a huge truck coming up behind me going about 90 miles an hour. And as it went past, there was this giant vat on the back; a big, cylindrical tub was the only load. And it said "Greenville, South Carolina".

JB: *Wow!*
RP: The people who transport these giant vats of waste from Hanford to South Carolina aren't the safest type of driver.

JB: *I remember there was some debate about whether to allow them to move nuclear waste around the country in the back of semi-trucks. And they did decide to allow it.*

RP: Yah. Once, one of those trucks going across the mountains from a northern California reactor over to I5, heading for South Carolina, got stuck going around a corner [because] the road was so narrow. It was such a long truck that it wouldn't go around the corner of the highway. And they had to take the truck apart, which took all day. But the people in charge of the whole nuclear industry are no smarter than the people who [transport] cars on the freeway.

JB: *It just seems like such a vulnerable place to put such dangerous material. Another thing I wanted to talk about - it doesn't have to do with nuclear power - is incineration of medical waste. Now, I understand that goes on all the time. And that's actually putting it into the air. Do you know anything about that, Ray?*

RP: When they put radioactive iodine into a person, they don't worry about the person's urine. And when bodies are incinerated, that goes into the air; much of it is vaporized.

JB: *Oh. Oh that's true. I have never thought about that. I mean, there's actually those radioactivity or toxins that are in our bodies, if you get cremated.*

RP: You know, if they die with radium needles in their organs, for example. And just the mercury in teeth gets vaporized.

JB: *And it's actually more dangerous at that point than it is possibility in your mouth.*

RP: Mm-hmm.

JB: *I see. Now, you talked about Alzheimer's being caused by nuclear waste or ionizing radiation. Does it correspond with sites near power plants and nuclear reprocessing plants?*

RP: No one is very clear about that. But I think it'll turn out that it does. People are starting to look at the various sources, microwave radiations, like telephones and power lines. And there are some people who have been working on that for about 25 years and claim that it's so. And I suspect it is.

JB: *So you think – Oh, go ahead.*

RP: Cataracts are another interesting thing. They're easy to study in a way, because the cataract is a different state of the living matter. And people have been trained to understand what happens in a cataract. And it's probably analogous to what happens in Alzheimer's disease; it's a much simpler system made up of very few types of proteins. And it turns out that in the cataract, the proteins aren't even denatured. To make a cataract develop, you would think that the radiation would have to at least change the proteins. Surgeons get cataracts from exposure to x-rays; people who work around any kind of even low level radiation microwaves, and so on, get cataracts. And it turns out that the cataract is chemically almost identical to the surrounding tissue; but it's wetter, [containing a] slightly higher water content than the healthy tissue around it. And all that happens is a slight fluctuation in the electronic state of the protein; and that lets the water get out of control; it accumulates, rather than being under the influence of the systems of proteins, and the electronic fields of these proteins. It lets you see in a very concrete way how energy makes all the difference between the lens that works and the lens that's opaque. It's not thermal energy in the ordinary sense; but it would classify as thermal energy because it's just the vibrational state of the water molecules which has changed. And similar changes probably happen very early in a disease like Alzheimer's or cancer, [where] if the tissue was visible, you would probably see it as a changing state of the water and [of the] electronic behavior of the proteins, analogous to the opacity of the lens, long before you got any of the major deposition of amyloid and plaque formation that eventually shows up in the tumors, or the Alzheimer's brain, and so on.

JB: *So you're saying the radiation is changing in subtle ways the structure long before.*

RP: Yes. And if just microwaves and ultraviolet light can do it, then it shows that a gamma ray, or a dental x-ray bouncing off, [representing] relatively very weak transmissions passing through your brain, don't even have to ionize anything [at all]. All they have to do is slightly add some energy to the system. It cannot even be

sufficient to cause electrons to get into a chemically reactive state; but [it's] just enough to cause this semi-thermal fluctuation of electrons and water vibrations.

JB: *I see. And last week you did say that there are things that people can actually do to fortify themselves when exposed to things like x-rays, or any kind of stress.*

RP: Yes. Keeping your energy at a peak, like getting the damage done in the late afternoon; and the summer is best. And keeping your carbon dioxide up with adequate thyroid function, adequate progesterone, pregnenolone, testosterone and so on. [The use of] all of the tissue-protective hormones and nutrients. Magnesium in particular is the best established radiation protective nutrient. And coffee happens to protect against all kinds of radiations damage that have been studied. Niacinamide is a vitamin that is protective. And coffee happens to provide magnesium and niacin, as well as the protective caffeine and antioxidants.

JB: *That's great. Well, we didn't really get to talk about microwaves or Wi-Fi which, I guess, is another form. But maybe some other time, we'll get you back and talk about that if you're willing. Ray, thanks again for being here and for...*

RP: Okay. Thank you.

JB: *...for all your work. Goodbye.*

RP: Bye.