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# *THE MANUFACTURE AND SALE*
# OF
# SAINT EINSTEIN

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## 16 $E = mc^2$

*Mileva Einstein-Marity and Albert Einstein published a paper in 1905, in which they unsuccessfully attempted to derive the world famous equation* $E = mc^2$ *by fallacy of* Petitio Principii. *The Einsteins did not realize the full significance of this equation, were not the first to publish it, and learned of it from Henri Poincaré's and Fritz Hasenöhrl's published works. Albert Einstein was repeatedly confronted with accusations of his plagiarism of this formula throughout his career.*

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> "The relation $E = m_M c^2$ not derived by Einstein."—HERBERT IVES

### 16.1 Introduction

Contrary to popular myth, Einstein did not usher in the atomic age. In fact, he found the idea of atomic energy to be silly.[3360] Einstein was not the first person to state the mass-energy equivalence, or $E = mc^2$.[3361] Myths such as Einstein's supposed discoveries are not uncommon. Newton did not discover gravity, nor did he offer a viable explanation for it, nor did he believe that matter attracted other matter. Consider that few in his time knew that President Roosevelt was severely handicapped, being limited to a wheel chair, and the press cooperated in keeping Roosevelt's disability a secret. Is it difficult to believe that this same press presented Albert Einstein as a super-hero of science, when he was in fact less than that, much less? It was a good story for them to sell. Einstein wrote to Sommerfeld,

> "It is a bad thing that every utterance of mine is made use of by journalists as a matter of business."[3362]

Einstein *rarely* gave filmed interviews, but when he did, he came across as something considerably less than a "genius". Einstein's public appearances were scripted as were his lectures. His public appearances were most often repetitions of his lectures. He appeared oblivious to the distinction between an academic lecture and a media event. He appeared rehearsed and incapable of adapting to his audience. *The New York Times* reported on 17 June 1930 on page 3 that Einstein spoke at the Kroll Opera House to 4,000 delegates of the World Power Conference. Einstein lectured them on Physics, as if it were a class he was hosting. In an article titled, "4,000 Bewildered as Einstein Speaks," the *New York Times* reported,

> "It was the first time Dr. Einstein had ever consented to speak on Einstein, and it was the first serious public utterance he ever made without recourse to gigantic equations and mystifying mathematics. [***] He gestured sometimes with his hands, indicating how clear and obvious his reasoning was, and occasionally he looked up from his paper to smile upon his intent

hearers who, he seemed to assume, were grasping everything."

Einstein appeared to be an actor giving a performance.

The physics community and the media invented a comic book figure, "Einstein", with "$E = mc^2$" stenciled across his chest. The media and educational institutions portray this surreal and farcical image as a benevolent god to watch over us. Some modern portraits depict the man with a godly glow and all the other visual cues inspiring reverence, which paintings of Jesus have long exploited. Physics, as an institution, fostered the myth, and countless people in all walks of life have since molded themselves in the comic book image of "Einstein", replete with the Flammarion hairdo and the Twainesque mustachio. "More Einsteinisch than he," they pretend to the great "Einstein's" supposed supernatural powers, and imitate his comic book persona. For some, Einstein (often together with Marx and Freud) is seen as a source of tremendous ethnic pride.

To question "Einstein", the god, either "his" theories, or the priority of the thoughts he repeated, has become the sin of heresy. "His" writings are synonymous with truth, the undecipherable truth of a god hung on the wall as a symbol of ultimate truth, which truth is elusive to mortal man. No one is to understand or to question the arcana of "Einstein", but must let the shepherd lead his flock, without objection. Do not bother the believers with the facts!

R. S. Shankland stated,

> "About publicity Einstein told me that he had been *given* a publicity value which he did not *earn*. Since he had it he would use it if it would do good; otherwise not."[3363]

Albert Einstein stated on 27 April 1948,

> "In the course of my long life I have received from my fellow-men far more recognition than I deserve, and I confess that my sense of shame has always outweighed my pleasure therein."[3364]

Albert Einstein told Peter A. Bucky,

> "Peter, I fully realize that many people listen to me not because they agree with me or because they like me particularly, but because I am Einstein. If a man has this rare capacity to have such esteem with his fellow men, then it is his obligation and duty to use this power to do good for his fellow men."[3365]

Einstein "had been *given* a publicity value which he did not *earn*" so that he could promote political Zionism among Jews. Political Zionism is a racist movement among Jews meant to segregate Jews in Palestine in order to end the assimilation of Jews into other cultures and "races". In 1919, most Jews opposed this racist movement and the Zionists needed a famous spokesman to help overcome this resistence to Zionism among Jews.

Albert Einstein confided to his old friend and confidant Michele Besso, on 12 December 1919, that he planned to attend a Zionist conference dedicated to founding a Hebrew university in Palestine. Einstein wrote,

> "The reason I am going to attend is not that I think I am especially well qualified, but because my name, in high favor since the English solar eclipse expeditions, can be of benefit to the cause by encouraging the lukewarm kinsmen."[3366]

## 16.2 The "Quantity of Motion"—Momentum, *Vis Viva* and Kinetic Energy

Consider briefly the mass-energy equivalence. Huyghens and Leibnitz[3367] presented the quantity of motion, *vis viva*, energy, $E = m v^2$, as opposed to the Aristotelian-Cartesian-Newtonian quantity of motion,[3368] momentum, $\rho = m v$. This mathematical identity between energy[3369] and mass, $E = m v^2$, is the mass-energy equivalence, stated as a circle function, and "*celeritas*", "*c*", is simply one state of relative velocity—a particular case of "*velocity*", "*v*".

## 16.3 The Atom as a Source of Energy and Explosive Force

Isaac Newton asked if mass is convertible into light, and wondered if light might be subject to gravity. From Newton's *Opticks*,

> "QUERY 1. Do not bodies act upon light at a distance, and by their action bend its rays; and is not this action (*cæteris paribus*) strongest at the least distance?"

and,

> "QUERY 30. Are not gross bodies and light convertible into one another, and may not bodies receive much of their activity from the particles of light which enter their composition? [***] The changing of bodies into light, and light into bodies, is very conformable to the course of Nature, which seems delighted with transmutations. [***] why may not Nature change bodies into light, and light into bodies?"

S. Tolver Preston answered Newton's queries with a loud, "Yes!" In anticipation of Thomson, De Pretto and the Einsteins, S. Tolver Preston formulated atomic energy, the atomic bomb and superconductivity back in the 1870's, based on the formula for *vis viva* $E = m c^2$, and the formula for *kinetic*[3370] energy $E = \frac{1}{2} m c^2$, where *celeritas*, "*c*", signifies the speed of light. Pursuing George-Louis Le Sage's theory, Preston believed that if mass could be attenuated into æther and acquire the normal velocity of æther particles, it would represent a tremendous store of energy;

since æther particles move at light speed—a limiting velocity, the *vis viva* is equal to mass times the square of the speed of light and the kinetic energy is equal to one half of the mass times the square of the speed of light.

In the 1700's, George-Louis Le Sage proposed that gravity may propagate at light speed, in anticipation of the general theory of relativity,

> "How much less therefore would they be perceived if we assume for the [gravitational] corpuscles the velocity of light, which is nine hundred thousand times as great as that of sound."[3371]

The *vis viva* of these corpuscles is $E = mc^2$.

As but one example of Preston's amazing anticipation of 20th Century technology, and the powerful heuristic value of the æther-matter-energy hypothesis, Preston calculated the kinetic energy of masses moving at light speed:

> "165. To give an idea, first, of the enormous intensity of the store of energy attainable by means of that extensive state of subdivision of matter which renders a high normal speed practicable, it may be computed that a quantity of matter representing a total mass of only one grain, and possessing the normal velocity of the ether particles (that of a wave of light), encloses a store of energy represented by upwards of one thousand millions of foot-tons, or the mass of one single grain contains an energy not less than that possessed by a mass of forty thousand tons, moving at the speed of a cannon ball (1200 feet per second); or other wise, a quantity of matter representing a mass of one grain endued with the velocity of the ether particles, encloses an amount of energy which, if entirely utilized, would be competent to project a weight of one hundred thousand tons to a height of nearly two miles (1.9 miles)." [3372]

Preston stated in 1883,

> "Let us not deviate from the well-tried ground of the atomic constitution of matter, already won with so much labour, unless we are forced to do so, and let us work towards the great generalisation of the Unity of Matter and of Energy."[3373]

Einstein stated on 21 September 1909,

> "The theory of relativity has thus changed our views on the nature of light insofar as it does not conceive of light as a sequence of states of a hypothetical medium, but rather as something having an independent existence just like matter. Furthermore, this theory shares with the corpuscular theory of light the characteristic feature of a transfer of inertial mass from the emitting to the absorbing body. Regarding our conception of the structure of light, in particular of the distribution of energy in the

irradiated space, the theory of relativity did not change anything."[3374]

The mathematical and metaphysical identity of matter and energy is the product of an ancient search for an *Urstoff*, the fundamental stuff of the universe, a search critically analyzed by John E. Boodin.[3375] What is that something which we call "matter"? From at least the time of Thales onward this fundamental stuff of the Universe was seen by some as æther with our minds construing form from the motions in this hypothetical æther. Energy was an attribute of æther, the continuity of its motions. This evolved in the Monistic philosophy popular in the 1800's into the notion of the multiplicity of the Universe, with one identity, energy and matter as the conscious image of motion, which exist in the human mind as illusion drawn from multiplicity. A baseball "in motion" is not one thing which flies from place to place, but is a multiplicity of things we call "a baseball", but which is not the same stuff from place to place, all things being coexistent forever. J. J. Thomson reawoke an interest in atomism, and defined the identity he proposed between energy and matter, as the motion of the æther, leading many to the conclusion (Einstein sometimes supported, sometimes opposed) that, as John E. Boodin stated in 1908,

> "The atom is no longer regarded as eternal and indifferent, but is the storehouse of pent-up energy of enormous quantity, though, as in the case of radium, it may be in a very unstable equilibrium."[3376]

Albert and Mileva also agreed with Newton's corpuscular hypothesis, but without realizing its implications,

> "When a body emits the energy $L$ in the form of radiation, it thereby reduces its mass by $L/c^2$."

> "Gibt ein Körper die Energie $L$ in Form von Strahlung ab, so verkleinert sich seine Masse um $L/V^2$."[3377]

On 15 December 1919, *The New York Times* wrote on page 14:

> "**Obviously a Rash Prophecy.**
>
> As it was before the Royal Society that Sir OLIVER LODGE last week discussed atomic energies and the possibilities they offer, it is to be presumed that he spoke with some care. Yet, when he prophesied that within a century the power now derived from burning 1,000 tons of coal would be obtained by setting free the force latent in two ounces of some unnamed substance, one cannot help remembering that Sir OLIVER has two personalities—that he is an eminent scientist and a credulous listener to 'mediums.'
>
> That the atoms, instead of being mere ultimate divisions of dead matter, are alive with force nobody now doubts, but it seems hardly scientific to emphasize as Sir OLIVER did the astonishing velocity at which move the

missiles which some atoms shoot out without at the same time calling attention to the size of the missiles. He knows, of course, the formulae relating to speed, mass, and momentum, and that to get any appreciable amount of 'work' done by the radium particles he described it would seem that they would have to move far more rapidly than they do. And a way to harness them is hardly imaginable, as yet."

As opposed to Lodge, Albert Einstein believed that atomic energy could not be harnessed. Moszkowski, who wrongfully attributes priority for first formulating $E = mc^2$ to Einstein, wrote an interesting and historically significant chapter in his book *Einstein: The Searcher*, which I reproduce here in its entirety. Sir Oliver Lodge, Alexander Wilhelm Pflüger,[3378] and Alexander Moszkowski had discussed the possibility of using the atom as a source of power, which idea Albert Einstein rejected. Moszkowski's book is but one of many examples where Einstein tended to discount the possibility of harnessing the power of the atom, contrary to the modern misleading impression one receives from the media and large segments of the Physics community that he was the father of the idea. However, all of these works are derivative of H. G. Wells' *The World Set Free: A Story of Mankind*, Macmillan, London, (1914); also publish in Leipzig, Germany by B. Tauchnitz; and Frederick Soddy's *The Interpretation of Radium* of 1909 produced from lectures given in 1908.

Alexander Moszkowski wrote in 1921,

"CHAPTER II

## BEYOND OUR POWER

Useful and Latent Forces.—Connexion between Mass, Energy, and Velocity of Light.—Deriving Power by Combustion—One Gramme of Coal.—Unobtainable Calories—Economics of Coal.—Hopes and Fears.— Dissociated Atoms.

29*th March* 1920

WE spoke of the forces that are available for man and which he derives from Nature as being necessary for his existence and for the development of life. What forces are at our disposal? What hopes have we of elaborating our supply of these forces?

Einstein first explained the conception of energy, which is intimately connected with the conception of mass itself. Every amount of substance (I am paraphrasing his words), the greatest as well as the smallest, may be regarded as a store of power, indeed, it is essentially identical with energy. All that appears to our senses and our ordinary understanding as the visible, tangible mass, as the objective body corresponding to which we, in virtue of our individual bodies, abstract the conceptual outlines, and become aware of the existence of a definite copy is, from the physical point of view, a complex of energies. These in part act directly, in part exist in a latent form as strains which, for us, begin to act only when we release them from their state of strain by some mechanical or chemical process, that is, when we succeed in converting the potential energy into kinetic energy. It may be said, indeed, that we have here a physical picture of what Kant called the 'thing in itself.' Things as they appear in ordinary experience are composed of the sum of our direct sensations; each thing acts on us through its outline, colour, tone, pressure, impact, temperature, motion, chemical behaviour, whereas the thing in itself is the sum-total of its energy, in which there is an enormous predominance of those energies which remain latent and are quite inaccessible in practice.

But this 'thing in itself,' to which we shall have occasion to refer often with a certain regard to its metaphysical significance, may be calculated. The fact that it is possible to calculate it takes its origin, like many other things which had in no wise been suspected, in Einstein's Theory of Relativity.

Quite objectively and without betraying in the slightest degree that an astonishing world-problem was being discussed, Einstein expressed himself thus:

'According to the Theory of Relativity there is a calculable relation between mass, energy, and the velocity of light. The velocity of light (denoted by $c$, as usual) is equal to $3 \cdot 10^{10}$ cm. per second. Accordingly the square of $c$ is equal to 9 times $10^{20}$ cm. per second, or, in round numbers, $10^{21}$ cm. per second. This $c^2$ plays an essential part if we introduce into the calculation the mechanical equivalent of heat, that is, the ratio of a certain amount of energy to the heat theoretically derivable from it; we get for each gramme $20 \cdot 10^{12}$ that is, 20 billion calories.'

We shall have to explain the meaning of this brief physical statement in its bearing on our practical lives. It operates with only a small array of symbols, and yet encloses a whole universe, widening our perspective to a world-wide range!

To simplify the reasoning and make it more evident we shall not think of the conception of substance as an illimitable whole, but shall fix our ideas on a definite substance, say coal.

There seems little that may strike us when we set down the words:
'One Gramme of Coal.'

We shall soon see what this one gramme of coal conveys when we translate the above-mentioned numbers into a language to which a meaning may be attached in ordinary life. I endeavoured to do this during the above conversation, and was grateful to Einstein for agreeing to simplify his argument by confining his attention to the most valuable fuel in our economic life.

Once whilst I was attending a students' meeting, paying homage to Wilhelm Dove, the celebrated discoverer took us aback with the following remark: When a man succeeds in climbing the highest mountain of Europe he performs a task which, judged from his personal point of view, represents something stupendous. The physicist smiles and says quite simply, 'Two pounds of coal.' He means to say that by burning 2 lb. of coal we gain sufficient energy to lift a man from the sea-level to the summit of Mont Blanc.

It is assumed, of course, that an ideal machine is used, which converts the heat of combustion without loss into work. Such a machine does not exist, but may easily be imagined by supposing the imperfections of machines made by human hands to be eliminated.

Such effective heat is usually expressed in calories. A calorie is the amount of heat that is necessary to raise the temperature of a gramme of water by one degree centigrade. Now the theorem of the Mechanical Equivalent, which is founded on the investigations of Carnot, Robert Mayer, and Clausius, states that from one calorie we may obtain sufficient energy to lift a pound weight about 3 feet. Since 2 lb. of coal may be made to yield 8 million calories, they will enable us to lift a pound weight through 24 million feet, theoretically, or, what comes to the same approximately, to lift a 17-stone man through 100,000 feet, that is, nearly 19 miles: this is nearly seven times the height of Mont Blanc.

At the time when Dove was lecturing, Einstein had not yet been born, and when Einstein was working out his Theory of Relativity, Dove had long passed away, and with him there vanished the idea of the small value of the energy stored in substance to give way to a very much greater value of which we can scarce form an estimate. We should feel dumbfounded if the new calculation were to be a matter of millions, but actually we are to imagine a magnification to the extent of billions. This sounds almost like a fable when expressed in words. But a million is related to a billion in about the same way as a fairly wide city street to the width of the Atlantic Ocean. Our Mont Blanc sinks to insignificance. In the above calculation it would have to be replaced by a mountain 50 million miles high. Since this would lead far out into space, we may say that the energy contained in a kilogramme of coal is sufficient to project a man so far that he will never return, converting him into a human comet. But for the present this is only a theoretical store of energy which cannot yet be utilized in practice.

Nevertheless, we cannot avoid it in our calculations just as we cannot avoid that remarkable quantity $c$, the velocity of light that plays its part in the tiny portion of substance as it does in everything, asserting itself as a regulative factor in all world phenomena. It is a natural constant that preserves itself unchanged as 180,000 miles per second under all conditions, and which truly represents what appeared to Goethe as 'the immovable rock in the surging sea of phenomena,' as a phantasm beyond the reach of investigators.

It is difficult for one who has not been soaked in all the elements of physical thought to get an idea of what a natural constant means; so much the more when he feels himself impelled to picture the constant, so to speak, as the rigid axis of a world constructed on relativity. Everything, without exception, is to be subjected not only to continual change (and this was what Heraditus assumed as a fundamental truth in his assertion *panta rhei*, everything flows), but every length-measurement and time-measurement, every motion, every form and figure are dependent on and change with the position of the observer, so that the last vestige of the absolute vanishes from whatever comes into the realm of observation. Nevertheless, there is an absolute despot, who preserves his identity inflexibly among all phenomena—the velocity of light, $c$, of incalculable influence in practice and yet capable of measurement. Its nature has been characterized in one of the main propositions of Einstein stated in 1905: 'Every ray of light is propagated in a system at rest with a definite, constant velocity independent of whether the ray is emitted by a body at rest or in motion.' But this constancy of the omnipotent $c$ is not only in accordance with world relativity: it is actually the main pillar which supports the whole doctrine; the further one penetrates into the theory, the more clearly does one feel that it is just this $c$ which is responsible for the unity, connectivity, and invincibility of Einstein's world system.

In our example of the coal, from which we started, $c$ occurs as a square, and it is as a result of multiplying 300,000 by itself (that is, forming $c^2$) that we arrive at the thousands of milliards of energy units which we associated above with such a comparatively insignificant mass. Let us picture this astounding circumstance in another way, although we shall soon see that Einstein clips the wings of our soaring imagination. The huge ocean liner *Imperator*, which can develop a greater horsepower than could the whole of the Prussian cavalry before the war, used to require for one day's travel the contents of two very long series of coal-trucks (each series being as long as it takes the strongest locomotive to pull). We now know that there is enough energy in two pounds of coal to enable this boat to do the whole trip from Hamburg to New York at its maximum speed.

I quoted this fact, which, although it sounds so incredibly fantastic, is quite true, to Einstein with the intention of justifying the opinion that it contained the key to a development which would initiate a new epoch in history and would be the panacea of all human woe. I drew an enthusiastic picture of a dazzling Utopia, an orgy of hopeful dreams, but immediately noticed that I received no support from Einstein for these visionary aspirations. To my disappointment, indeed, I perceived that Einstein did not even show a special interest in this circumstance which sprang from his own theory, and which promised such bountiful gifts. And to state the conclusion of the story straight away I must confess that his objections were strong enough not only to weaken my rising hopes, but to annihilate them completely.

Einstein commenced by saying: 'At present there is not the slightest indication of when this energy will be obtainable, or whether it will be obtainable at all. For it would presuppose a disintegration of the atom effected at will—a shattering of the atom. And up to the present there is scarcely a sign that this will be possible. We observe atomic disintegration only where Nature herself presents it, as in the case of radium, the activity of which depends upon the continual explosive decomposition of its atom. Nevertheless, we can only establish the presence of this process, but cannot produce it; science in its present state makes it appear almost impossible that we shall ever succeed in so doing.'

The fact that we are able to abstract a certain number of calories from coal and put them to practical use comes about owing to the circumstance that combustion is only a molecular process, a change of configuration, which leaves fully intact the atoms of which the molecules are composed. When carbon and oxygen combine, the elementary constituent, the atom, remains quite unimpaired. The above calculation, 'mass multiplied by the square of the velocity of light,' would have a technical significance only if we were able to attack the interior of the atom; and of this there seems, as I remarked, not the remotest hope.

Out of the history of technical science it might seem possible to draw on examples contradictory to this first argument which is soon to be followed by others equally important. As a matter of fact, rigorous science has often declared to be impossible what was later discovered to be within the reach of technical attainment—things that seem to us nowadays to be ordinary and self-evident. Werner Siemens considered it impossible to fly by means of machines heavier than air, and Helmholtz proved mathematically that it was impossible. Antecedent to the discovery of the locomotive the 'impossible' of the academicians played an important part; Stephenson as well as Riggenbach (the inventors of the locomotive) had no easy task to establish their inventions in the face of the general reproach of craziness hurled at them. The eminent physicist Babinet applied his mathematical artillery to demolish the ideas of the advocates of a telegraphic cable between Europe and America. Philipp Reis, the forerunner of the telephone, failed only as a result of the 'impossible' of the learned physicist Poggendorff; and even when the practical telephone of Graham Bell (1876) had been found to work in Boston, on this side of the Atlantic there was still a hubbub of 'impossible' owing to scientific reasons. To these illustrations is to be added Robert Mayer's mechanical equivalent of heat, a determining factor in our above calculations of billions; it likewise had to overcome very strong opposition on the part of leading scientists.

Let us imagine the state of mankind before the advent of machines and before coal had been made available as a source of power. Even at that time a far-seeing investigator would have been able to discover from theoretical grounds the 8000 calories mentioned earlier and also their transformation into useful forces. He would have expressed it in another way and would have got different figures, but he would have arrived at the conclusion: Here is a virtual possibility which must unfortunately remain virtual, as we have no machine in which it can be used. And however far-sighted he may have been, the idea of, say, a modern dynamo or a turbine-steamer would have been utterly inconceivable to him. He would not have dreamed such a thing. Nay, we may even imagine a human being of the misty dawn of prehistoric ages, of the diluvial period, who had suddenly had a presentiment of the connexion between a log of wood and the sun's heat, but who was yet unaware of the uses of fire; he would argue from his primordial logic that it was not possible and never would be possible to derive from the piece of wood something which sends out warmth like the sun.

I believe now, indeed, that we have grounds for considering ourselves able to mark off the limits of possibility more clearly than the present position of science would seem to warrant. There is the same relation between such possibilities and absolute impossibilities as there is between Leibniz's *vérités de fait* and the *vérités éternelles*. The fact that we shall never succeed in constructing a plane isosceles triangle with unequal base angles is a *vérité éternelle*. On the other hand, it is only a *vérité de fait* that science is precluded from giving mortal man eternal life. This is only improbable in the highest degree, for the fact that, up to the present, all our ancestors have died is only a finite proof. The well-known Cajus of our logic books need not die; the chances of his dying are only $\frac{n}{n+1}$, where we denote the total of all persons that have passed away up to this moment by $n$. If I ask a present-day authority in biology or medicine what evidence there is that it will be possible to preserve an individual person permanently from death, he would confess: not the slightest. Nevertheless, Helmholtz declared: 'To a person who tells me that by using certain means the life of a person may be prolonged indefinitely I can oppose my extreme disbelief, *but I cannot contradict him absolutely*.'

Einstein himself once pointed out to me such very remote possibilities; it was in connexion with the following circumstance. It is quite impossible for a moving body ever to attain a velocity greater than that of light, because it is scientifically inconceivable. On the other hand, it is conceivable, and therefore within the range of possibility, that man may yet fly to the most distant constellations.

There is, therefore, no absolute contradiction to the notion of making available for technical purposes the billions of calories that occurred in our problem. As soon as we admit it as possible for discussion, we find ourselves inquiring what the solution of the problem could signify. In our intercourse we actually arrived at this question, and discovered the most radical answer in a dissertation which Friedrich Siemens has written about coal in general without touching in the slightest on these possibilities of the future. I imagine that this dissertation was a big trump in my hand, but had soon to learn from the reasoned contradiction of Einstein that the point at issue was not to be decided in this way.

Nevertheless, it will repay us to consider these arguments for a moment.

Friedrich Siemens starts from two premises which he seemingly bases on scientific reasoning, thus claiming their validity generally. They are: Coal is the measure of all things. The price of every product represents, directly or indirectly, the value of the coal contained in it.

As all economic values in over-populated countries are the result of work, and as work presupposes coal, capital is synonymous with coal. The economic value of each object is the sum-total of the coal that had to be used to manufacture the object in question. In over-populated states each wage is the value of the coal that is necessary to make this extra life possible. If there is a scarcity of coal, the wages go down in value; if there is no coal, the wages are of no value at all, no matter how much paper money be issued.

As soon as agriculture requires coal (this occurs when it is practised intensively and necessitates the use of railways, machines, artificial manures), coal becomes involved with food-stuffs. Thanks to industrialism, coal is involved in clothing and housing, too.

Since money is equivalent to coal, proper administration of finance is equivalent to a proper administration of coal resources, and our standard of currency is in the last instance a coal-currency. Gold as money is now concentrated coal.

The most advanced people is that which derives from one kilogramme of coal the greatest possibilities conducive to life. Wise statesmanship must resolve itself into wise administration of coal. Or, as it has been expressed in other words elsewhere: 'We must think in terms of coal.'

These fundamental ideas were discussed, and the result was that Einstein admitted the premises in the main, but failed to see the conclusiveness of the inferences. He proved to me, step by step, that Siemens' line of thought followed a vicious circle, and, by begging the question, arrived at a false conclusion. The essential factor, he said, is man-power, and so it will remain; it is this that we have to regard as the primary factor. Just so much can be saved to advantage as there is man-power available for purposes other than for the production of coal from which they are now released. If we succeed in getting greater use out of a kilogramme of coal by better management, then this is measurable in man-power, with which one may dispense for the mining of coal, and which may be applied to other purposes.

If the assertion: 'Coal is the measure of all things,' were generally valid, it should stand every test. We need only try it in a few instances to see that the thesis does not apply. For example, said Einstein: However much coal we may use, and however cleverly we may dispose of it, it will not produce cotton. Certainly the freightage of cotton-wool could be reduced in price, but the value-factor represented by man-power can never disappear from the price of the cotton.

The most that can be admitted is that an increase of the amount of power obtained from coal would make it possible for more people to exist than is possible at present, that is, that the margin of over-population would become extended. But we must not conclude that this would be a boon to mankind. 'A maximum is not an optimum.'

He who proclaims the maximum without qualification as the greatest measure of good is like one who studies the various gases in the atmosphere to ascertain their good or bad effect on our breathing, and arrives at the conclusion: the nitrogen in the air is harmful, so we must double the proportion of oxygen to counteract it; this will confer a great benefit on humanity!

[*Footnote:* *The parts included between * . . . * are to be regarded as supplementary portions intended to elucidate the arguments involved in the dialogue. In many points they are founded on utterances of Einstein, but also contain reflections drawn from other sources, as well as opinions and inferences which fall to the account of the author, as already remarked in the preface. One will not get far by judging these statements as right or wrong, for even the debatable view may prove itself to be expeditious and suggestive in the perspective of these conversations. Wherever it was possible, without the connexion being broken, I have called attention to the parts which Einstein corrected or disapproved of. In other places I refrained from this, particularly when the subject under discussion demanded an even flow of argument. It would have disturbed the exposition if I had made mention of every counter-argument of the opposing side in all such cases while the explanation was proceeding along broad lines.]

*Armed with this striking analogy, we can now subject the foundation of Siemens' theory to a new scrutiny, and we shall then discover that even the premises contain a trace of the *petitio principii* that finally receives expression in the radical and one-sided expression: 'Coal is everything.'

As if built on solid foundations this first statement looms before us: Coal is solar energy. This is so far indisputable. For all the coal deposits that are still slumbering in the earth were once stately plants, dense woods of fern, which, bearing the burden of millions of years, have saved up for us what they had once extracted as nutrition from the sun's rays. We may let the parallel idea pass without contention: In the beginning was not the Word, nor the Deed, but, in the beginning was the Sun. The energy sent out by the sun to the earth for mankind is the only necessary and inevitable condition for deeds. Deeds mean work, and work necessitates life. But we immediately become involved in an unjustifiable subdivision of the idea, for the propounder of the theory says next: '. . . Coal is solar energy, therefore coal is necessary if we are to work . . .' and this has already thrust us from the paths of logic; the prematurely victorious ergo breaks down. For, apart from the solar energy converted into coal, the warmth of our mother planet radiates on us, and furnishes us with the possibility of work. Siemens' conclusion, from the point of view of logic, is tantamount to: Graphite is solar energy; hence graphite is necessary, if we are to be able to work. The true expression of the state of affairs is: Coal is, for our present conditions of life, the most important, if not the exclusive, preliminary for human work.

And when we learn from political economy that 'in a social state only the necessary human labour and the demand for power-installations which require coal, and hence again labour for their production, come into question,' this in no way implies the assertion, as Siemens appears to assume, that coal can be made out of labour. But it does signify that work founded on the sun's energy need not necessarily be reducible to coal. And this probably coincides with Einstein's opinion, which is so much the more significant, as his own doctrine points to the highest measure of effect in forces, even if only theoretically.*

Nevertheless, it is a fact that every increase in the quantity of power derived, when expressed per kilo, denotes a mitigation of life's burdens; it is only a question of the limits involved.

Firstly, is technical science with its possibilities, as far as they can be judged at present, still able to guarantee the future for us? Can it spread out the effective work so far that we may rely peacefully on the treasures of coal slumbering in the interior of the earth?

Evidently not. For in this case we are dealing with quantities that may be approximately estimated. And even if we get three times, nay ten times, as many useful calories as before, there is a parallel calculation of evil omen that informs us: there will be an end to this feast of energy.

In spite of all the embarrassments due to the present shortage of coal we have still always been able to console ourselves with the thought that there is really a sufficiency, and that it is only a question of overcoming stoppages. It is a matter of fact that from the time of the foundation of the German Empire to the beginning of the World War coal production had been rising steadily, and it was possible to calculate that in spite of the stupendous quantities that were being removed from the black caves of Germany, there remained at least 2000 milliards of marks in value (taken at the nominal rate, that is, £100,000,000,000). Nevertheless, geologists and mining experts tell us that our whole supply will not last longer than 2000 years, in the case of England 500 years, and in that of France 200 years. Even if we allow amply for the opening up of new coal-fields in other continents, we cannot get over the fact that in the prehistoric fern forests the sun has stored up only a finite, exhaustible amount of energy, and that within a few hundred years humanity will be faced with a coal famine.

Now, if coal were really the measure of all things, and if the possibility of life depended only on the coal supply, then our distant descendants would not only relapse into barbarity, but they would have to expect the absolute zero of existence. We should not need to worry at all about the entropy death of the universe, as our own extinction on this earthly planet beckons to us from an incomparably nearer point of time.

At this stage of the discussion Einstein revealed prospects which were entirely in accordance with his conviction that the whole argument based on the coal assumption was untenable. He stated that it was by no means a Utopian idea that technical science will yet discover totally new ways of setting free forces, such as using the sun's radiation, or water power, or the movement of the tides, or power reservoirs of Nature, among which the present coal supply denotes only one branch. Since the beginning of coal extraction we have lived only on the remains of a prehistoric capital that has lain in the treasure-chests of the earth. It is to be conjectured that the interest on the actual capital of force will be very much in excess of what we can fetch out of the depositories of former ages.

To form an estimate of this actual capital, entirely independent of coal, we may present some figures. Let us consider a tiny water canal, a mere nothing in the watery network of the earth, the Rhine-falls at Schaffhausen, that may appear mighty to the beholder, but only because he applies his tourist's measure instead of a planetary one. But even this bagatelle in the household of Nature represents very considerable effectual values for us: 200 cubic metres spread over a terrace 20 metres high yield 67,000 horse-power, equivalent to 50,000 kilowatts. This cascade alone would suffice to keep illuminated to their full intensity 1,000,000 glow-lamps, each of 50 candle-power, and according to our present tariff we should have to pay at least 70,000 marks (£3500 nominally) per hour. The coal-worshipper will be more impressed by a different calculation. The Rhine-falls at Schaffhansen is equivalent in value to a mine that yields every day 145 tons of the finest brown coal. If we took the Niagara Falls as an illustration, these figures would have to be multiplied by about 80.

And by what factor would we have to multiply them, if we wished to get only an approximate estimate of the energy that the breathing earth rolls about in the form of the tides? The astronomer Bessel and the philosopher-physicist Fechner once endeavoured to get at some comparative picture of these events. It required 360,000 men twenty years to build the greatest Egyptian pyramid, and yet its cubical contents are only about the millionth of a cubic mile, and perhaps if we sum up everything that men and machinery have moved since the time of the Flood till now, a cubic mile would not yet have been completed. In contrast with this, the earth in its tidal motion moves 200 cubic miles of water from one quadrant of the earth's circumference to another *in every quarter of a day*. From this we see at once that all the coal-mines in the world would mean nothing to us if we could once succeed in making even a fraction of the pulse-beat of the earth available for purposes of industry.

If, however, we should be compelled to depend on coal, our imaginations cling so much more closely to that enormous quantity given by the expression $mc^2$, which was derived from the theory of relativity.

The 20 billion calories that are contained in each gramme of coal exercise a fascination on our minds. And although Einstein states that there is not the slightest indication that we shall get at this supply, we get carried along by an irresistible impulse to picture what it would mean if we should actually succeed in tapping it. The transition from the golden to the iron age, as pictured in Hesiod, Aratus, and Ovid, takes shape before our eyes, and following our bent of continuing this cyclically, we take pleasure in fancying ourselves being rescued from the serfdom of the iron and of the coal age to a new golden age. A supply, such as is piled up in an average city storing-place, would be sufficient to supply the whole world with energy for an immeasurable time. All the troubles and miseries arising from the running of machines, the mechanical production of wares, house-fires would vanish, and all the human labour at present occupied in mining coal would become free to cultivate the land, all railways and boats would run almost without expense, an inconceivable wave of happiness would sweep over mankind. It would mean an end of coal-, freight-, and food-shortage! We should at last be able to escape out of the hardships of the day, which is broken up by strenuous work, and soar upwards to brighter spheres where we would be welcomed by the true values of life. How alluring is the song of Sirens chanted by our physics with its high 'C,' the velocity of light to the second power, which we have got to know as a factor in this secret store of energy.

But these dreams are futile. For Einstein, to whom we owe this formula so promising of wonders, not only denies that it can be applied practically, but also brings forward another argument that casts us down to earth again. Supposing, he explained, it were possible to set free this enormous store of energy, then we should only arrive at an age, compared with which the present coal age would have to be called golden.

And, unfortunately, we find ourselves obliged to fall in with this view, which is based in the wise old saw μηδεν γαν, *ne quid nimis*, nothing in excess. Applied to our case, this means that when such a measure of power is set free, it does not serve a useful purpose, but leads to destruction. The process of burning, which we used as an illustration, calls up the picture of an oven in which we can imagine this wholesale production of energy, and experience tells us that we should not heat an oven with dynamite.

If technical developments of this kind were to come about, the energy supply would probably not be capable of regulation at all. It makes no difference if we say that we only want a part of those 20 billion calories, and that we should be glad to be able to multiply the 8000 calories required to-day by 100. That is not possible, for if we should succeed in disintegrating the atom, it seems that we should have the billions of calories rushing unchecked on us, and we should find ourselves unable to cope with them, nay, perhaps even the solid ground, on which we move, could not withstand them.

No discovery remains a monopoly of only a few people. If a very careful scientist should really succeed in producing a practical heating or driving effect from the atom, then any untrained person would be able to blow up a whole town by means of only a minute quantity of substance. And any suicidal maniac who hated his fellows and wished to pulverize all habitations within a wide range would only have to conceive the plan to carry it out at a moment's notice. All the bombardments that have taken place ever since fire-arms were invented would be mere child's play compared with the destruction that could be caused by two buckets of coal.

At intervals we see stars light up in the heavens, and then become extinguished again; from these we infer that world catastrophes have occurred. We do not know whether it is due to the explosion of hydrogen with other gases, or to collisions between two stellar bodies. There is still room for the assumption that, immeasurably far away in yonder regions of celestial space, something is happening which a malevolent inhabitant of our earth, who has discovered the secret of smashing the atom, might here repeat. And even if our imaginations can be stretched to paint the blessings of this release of energy, they certainly fail to conjure up visions of the disastrous effects which would result.

Einstein turned to a page in a learned work of the mathematical physicist Weyl of Zürich, and pointed out a part that dealt with such an appalling liberation of energy. It seemed to me to be of the nature of a fervent prayer that Heaven preserve us from such explosive forces ever being let loose on mankind!

Subject to present impossibility, it is possible to weave many parallel instances. It is conceivable that by some yet undiscovered process alcohol may be prepared as plentifully and as cheaply as ordinary water. This would end the shortage of alcohol, and would assure delirium tremens for hundreds of thousands. The evil would far outweigh the good, although it might be avoidable, for one can, even if with great difficulty, imagine precautionary measures.

War technique might lead to the use of weapons of great range, which would enable a small number of adventurers to conquer a Great power. It will be objected: this will hold vice versa, too. Nevertheless, this would not alter the fact that such long-range weapons would probably lead to the destruction of civilization. Our last hope of an escape would be in a superior moral outlook of future generations, which the optimist may imagine to himself as the *force majeure*.

There are apparently only two inventions, in themselves triumphs of intellect, against which one would have no defence. The first would be thought-reading made applicable to all, and with which Kant has dealt under the term 'thinking aloud.' What is nowadays a rare and very imperfect telepathic 'turn' may yet be generalized and perfected in a manner which Kant supposed not impossible on some distant planet. The association and converse of man with his fellows would not stand the test of this invention, and we should have to be angels to survive it even for a day.

The second invention would be the solution of this $mc^2$- problem, which I call a problem only because I fail to discover a proper term, whereas so far was it from being a problem for Einstein that it was only in my presence he began to reckon it out in figures from the symbolic formula. To us average beings a Utopia may disclose itself, a short frenzy of joy followed by a cold douche: Einstein stands above it as the pure searcher, who is interested only in the scientific fact, and who, even at the first knowledge of it, preserves its essentially theoretical importance from attempts to apply it practically. If, then, another wishes to hammer out into a fantastic gold-leaf what he has produced as a little particle of gold in his physical investigations, he offers no opposition to such thought-experiments, for one of the deepest traits of his nature is tolerance.

A. Pflüger, one of the best qualified heralds of the new doctrine, has touched on the above matter in his essay, *The Principle of Relativity*. Einstein praised this pamphlet; I mentioned that the author took a view different from that of Einstein, of the possibility of making accessible the $mc^2$. In discussing the practical significance of this eventuality, Pflüger says: 'It will be time to talk of this point again a hundred years hence.' This seems a short time-limit, even if none of us will live to be present at the discussion. Einstein smiled at this pause of a hundred years, and merely repeated, 'A very good essay!' It is not for me to offer contradictions; and, as far as the implied prognostication is concerned, it will be best for mankind if it should prove to be false. If the optimum is unattainable, at least we shall be spared the worst, which is what the realization of this prophecy would inflict on us.

Some months after the above discussion had first been put to paper, the world was confronted by a new scientific event. The English physicist Rutherford had, with deliberate intention, actually succeeded in splitting up the atom. When I questioned Einstein on the possible consequences of this experimental achievement, he declared with his usual frankness, one of the treasures of his character, that he had now occasion to modify somewhat the opinion he had shortly before expressed. This is not to mean that he now considered the practical goal of getting unlimited supply of energy as having been brought within the realm of possibility. He gave it as his view that we are now entering on a new stage of development, which may perhaps disclose fresh openings for technical science. The scientific importance of these new experiments with the atom was certainly to be considered very great.

In Rutherford's operations the atom is treated as if he were dealing with a fortress: he subjects it to a bombardment and then seeks to fire into the breach. The fortress is still certainly far from capitulating, but signs of disruption have become observable. A hail of bullets caused holes, tears, and splinterings.

The projectiles hurled by Rutherford are alpha-particles shot out by radium, and their velocity approaches two-thirds that of light. Owing to the extreme violence of the impact, they succeeded in doing damage to certain atoms enclosed in evacuated glass tubes. It was shown that atoms of nitrogen had been disrupted. It is still unknown what quantities of energy are released in this process. This splitting up of the atom carried out with intention can, indeed, be detected only by the most careful investigations.

As far as practical applications are concerned, then, we have got no further, although we have renewed grounds for hope. The unit of measure, as it were, is still out of proportion to the material to be cut. For the forces which Rutherford had to use to attain this result are relatively very considerable. He derived them from a gramme of radium, which is able to liberate several milliard calories, whereas the net practical result in Rutherford’s experiment is still immeasurably small. Nevertheless, it is scientifically established that it is possible to split up atoms of one’s own free will, and thus the fundamental objection raised above falls to the ground.

There is also another reason for increased hope. It seems feasible that, under certain conditions, Nature would automatically continue the disruption of the atom, after a human being had intentionally started it, as in the analogous case of a conflagration which extends, although it may have started from a mere spark.

A by-product of future research might lead to the transmutation of lead into gold. The possibility of this transformation of elements is subject to the same arguments as those above about the splitting up of the atom and the release of great quantities of energy. The path of decay from radium to lead lies clearly exposed even now, but it is very questionable whether mankind will finally have cause to offer up hymns of thanksgiving if this line from lead on to the precious metals should be continued, for it would cause our conception of the latter to be shattered. Gold made from lead would not give rise to an increase in the value of the meaner metal, but to the utter depreciation of gold, and hence the loss of the standard of value that has been valid since the beginning of our civilization. No economist would be possessed of a sufficiently far-sighted vision to be able to measure the consequences on the world’s market of such a revolution in values.

The chief product would, of course, be the gain in energy, and we must bear this in mind when we give ourselves up to our speculations, however optimistic or catastrophic they may be. The impenetrable barrier ‘impossible’ no longer exists. Einstein’s wonderful ‘Open Sesame,’ mass times the square of the velocity of light, is thundering at the portals.

And mankind finds a new meaning in the old saw: One should never say *never*!”

Moszkowski cites the work of Alexander Wilhelm Pflüger. Pflüger stated,

“Daraus folgt aber nicht, daß das RP [Relativitätsprinzip] keine praktische Bedeutung für die Technik hätte. Nach hundert Jahren wollen wir wieder darüber sprechen. Einstweilen nur dies: aus dem RP folgt, daß die Masse eines Körpers vergrößert wird, wenn man ihm Energie (etwa strahlende Wärme) zuführt. Man kann daher die Masse als Energie auffassen, und der alte Satz der Chemiker von der Erhaltung der Masse schmilzt dadurch mit dem Satz von der Erhaltung der Energie zusammen. Man findet ferner, daß jeder Körper, welcher in einem System ruht, von diesem aus beurteilt, die ungeheure Menge $mc^2$ „latente‘‘ Energie enthält, d. h. gleich seiner Masse, gemessen in Grammen, multipliziert mit dem Quadrat der Lichtgeschwindigkeit, gemessen in cm sec. Da $c = 3 \cdot 10t^{0}$ cm/sec ist, so enthält also ein Kilogramm eines beliebigen Körpers, z. B. der Kohle

$1000 \cdot 9 \cdot 10^{20}$ Erg = 23 Billionen Kalorien. Diese Energie steckt unzweifelhaft zum weitaus größten Teil in seinen Atomen. Von ihrer ungeheuren Größe gibt folgende Überlegung einen Begriff. Unser bisheriges Verfahren, Energie aus der Kohle zu gewinnen, beruht auf einem Molekularprozeß, der Vereinigung der intakt bleibenden Atome Kohlenstoff und Sauerstoff zu Kohlensäure, der sogenannten Verbrennung. Er liefert die lächerlich geringe Zahl von etwa 7000 Kalorien pro Kilo Kohle. Gelänge es, die Kohleatome zu zerbrechen und ihnen ihre latente Energie zu entreissen, so vermöchte ein Ozeandampfer von 50000 Pferdekräften mit einem Kilogramm Kohle zehn Jahre lang ununterbrochen zu fahren. Bei den heutigen Energiepreisen wäre die in diesem Kilogramm steckende Energie mehrere hundert Millionen Mark wert. Daß das keine Phantasie ist, lehrt das Beispiel des Radiums. Dieses erzeugt, indem das Radiumatom freiwillig auseinanderbricht, ungeheure Wärmemengen, für deren Quelle man früher keine Erklärung wußte. Das RP gibt diese Erklärung: es ist ein Teil der latenten Energie, die hier frei wird. Mit dieser kleinen Auswahl aus den Folgerungen des RP wollen wir diese Betrachtungen schließen."[3379]

Moszkowski's pontificating, which would otherwise might have been profound, appears to have been pretentiously and pompously plagiarized. It is difficult to believe that Moszkowski did not read H. G. Wells' book *The World Set Free: A Story of Mankind*, Macmillan, London, (1914), though Moszkowski does not mention it.

H. G. Wells wrote, *inter alia*, in 1913, in light of the Balkan Wars and in anticipation of the First World War and the Second World War,

"'And so,' said the professor, 'we see that this Radium, which seemed at first a fantastic exception, a mad inversion of all that was most established and fundamental in the constitution of matter, is really at one with the rest of the elements. It does noticeably and forcibly what probably all the other elements are doing with an imperceptible slowness. It is like the single voice crying aloud that betrays the silent breathing multitude in the darkness. Radium is an element that is breaking up and flying to pieces. But perhaps all elements are doing that at less perceptible rates. Uranium certainly is; thorium—the stuff of this incandescent gas mantle—certainly is; actinium. I feel that we are but beginning the list. And we know now that the atom, that once we thought hard and impenetrable, and indivisible and final and—lifeless—lifeless, is really a reservoir of immense energy. That is the most wonderful thing about all this work. A little while ago we thought of the atoms as we thought of bricks, as solid building material, as substantial matter, as unit masses of lifeless stuff, and behold! these bricks are boxes, treasure boxes, boxes full of the intensest force. This little bottle contains about a pint of uranium oxide; that is to say, about fourteen ounces of the element uranium. It is worth about a pound. And in this bottle, ladies and gentlemen, in the atoms in this bottle there slumbers at least as much energy as we could get by burning a hundred and sixty tons of coal. If at a word, in one instant I could suddenly release that energy here and now it would blow us and everything about us to fragments; if I could turn it into the machinery that lights this city, it could keep Edinburgh brightly lit for a week. But at present no man knows, no man has an inkling of how this little lump of stuff can be made to hasten the release of its store. It does release it, as a burn trickles. Slowly the uranium changes into radium, the radium changes into a gas called the radium emanation, and that again to what we call radium A, and so the process goes on, giving out energy at every stage, until at last we reach the last stage of all, which is, so far as we can tell at present, lead. But we cannot hasten it.'

'I take ye, man,' whispered the chuckle-headed lad, with his red hands tightening like a vice upon his knee. 'I take ye, man. Go on! Oh, go on!'

The professor went on after a little pause. 'Why is the change gradual?' he asked. 'Why does only a minute fraction of the radium disintegrate in any particular second? Why does it dole itself out so slowly and so exactly? Why does not all the uranium change to radium and all the radium change to the next lowest thing at once? Why this decay by driblets; why not a decay *en masse?* . . . Suppose presently we find it is possible to quicken that decay?'

The chuckle-headed lad nodded rapidly. The wonderful inevitable idea was coming. He drew his knee up towards his chin and swayed in his seat with excitement. 'Why not?' he echoed, 'why not?'

The professor lifted his forefinger. 'Given that knowledge,' he said, 'mark what we should be able to do! We should not only be able to use this uranium and thorium; not only should we have a source of power so potent that a man might carry in his hand the energy to light a city for a year, fight a fleet of battleships, or drive one of our giant liners across the Atlantic; but we should also have a clue that would enable us at last to quicken the process of disintegration in all the other elements, where decay is still so slow as to escape our finest measurements. Every scrap of solid matter in the world would become an available reservoir of concentrated force. Do you realise, ladies and gentlemen, what these things would mean for us?'

The scrub head nodded. 'Oh! go on. Go on.'

'It would mean a change in human conditions that I can only compare to the discovery of fire, that first discovery that lifted man above the brute. We stand to-day towards radio-activity as our ancestor stood towards fire before he had learnt to make it. He knew it then only as a strange thing utterly beyond his control, a flare on the crest of the volcano, a red destruction that poured through the forest. So it is that we know radio-activity to-day. This—this is the dawn of a new day in human living. At the climax of that civilisation which had its beginning in the hammered flint and the fire-stick of the savage, just when it is becoming apparent that our ever-increasing needs cannot be borne indefinitely by our present sources of energy, we discover suddenly the possibility of an entirely new civilisation. The energy we need for our very existence, and with which Nature supplies us still so grudgingly, is in reality locked up in inconceivable quantities all about us. We cannot pick that lock at present, but——'

He paused. His voice sank so that everybody strained a little to hear him.

'——we will.'

He put up that lean finger again, his solitary gesture.

'And then,' he said. . . .

'Then that perpetual struggle for existence, that perpetual struggle to live on the bare surplus of Nature's energies will cease to be the lot of Man. Man will step from the pinnacle of this civilisation to the beginning of the next. I have no eloquence, ladies and gentlemen, to express the vision of man's material destiny that opens out before me. I see the desert continents transformed, the poles no longer wildernesses of ice, the whole world once more Eden. I see the power of man reach out among the stars. . . .'

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Holsten, before he died, was destined to see atomic energy dominating every other source of power, but for some years yet a vast network of difficulties in detail and application kept the new discovery from any effective invasion of ordinary life. The path from the laboratory to the workshop is sometimes a tortuous one; electro-magnetic radiations were known and demonstrated for twenty years before Marconi made them practically available, and in the same way it was twenty years before induced radio-activity could be brought to practical utilisation. The thing, of course, was discussed very much, more perhaps at the time of its discovery than during the interval of technical adaptation, but with very little realisation of the huge economic revolution that impended. What chiefly impressed the journalists of 1933 was the production of gold from bismuth and the realisation albeit upon unprofitable lines of the alchemist's dreams; there was a considerable amount of discussion and expectation in that more intelligent section of the educated publics of the various civilised countries which followed scientific development; but for the most part the world went about its business—as the inhabitants of those Swiss villages which live under the perpetual threat of overhanging rocks and mountains go about their business—just as though the possible was impossible, as though the inevitable was postponed for ever because it was delayed.

It was in 1953 that the first Holsten-Roberts engine brought induced radio-activity into the sphere of industrial production, and its first general use was to replace the steam-engine in electrical generating stations. Hard upon the appearance of this came the Dass-Tata engine—the invention of two among the brilliant galaxy of Bengali inventors the modernisation of Indian thought was producing at this time—which was used chiefly for automobiles, aeroplanes, waterplanes, and such-like, mobile purposes. The American Kemp engine, differing widely in principle but equally practicable, and the Krupp-Erlanger came hard upon the heels of this, and by the autumn of 1954 a gigantic replacement of industrial methods and machinery was in progress all about the habitable globe. Small wonder was this when the cost, even of these earliest and clumsiest of atomic engines, is compared with that of the power they superseded. Allowing for lubrication the Dass-Tata engine, once it was started cost a penny to run thirty-seven miles, and added only nine and quarter pounds to the weight of the carriage it drove. It made the heavy alcohol-driven automobile of the time ridiculous in appearance as well as preposterously costly. For many years the price of coal and every form of liquid fuel had been clambering to levels that made even the revival of the draft horse seem a practicable possibility, and now with the abrupt relaxation of this stringency, the change in appearance of the traffic upon the world's roads was instantaneous. In three years the frightful armoured monsters that had hooted and smoked and thundered about the world for four awful decades were swept away to the dealers in old metal, and the highways thronged with light and clean and shimmering shapes of silvered steel. At the same time a new impetus was given to aviation by the relatively enormous power for weight of the atomic engine, it was at last possible to add Redmayne's ingenious helicopter ascent and descent engine to the vertical propeller that had hitherto been the sole driving force of the aeroplane without overweighting the machine, and men found themselves possessed of an instrument of flight that could hover or ascend or descend vertically and gently as well as rush wildly through the air. The last dread of flying vanished. As the journalists of the time phrased it, this was the epoch of the Leap into the Air. The new atomic aeroplane became indeed a mania; every one of means was frantic to possess a thing so controllable, so secure and so free from the dust and danger of the road, and in France alone in the year 1943 thirty thousand of these new aeroplanes were manufactured and licensed, and soared humming softly into the sky.

And with an equal speed atomic engines of various types invaded industrialism. The railways paid enormous premiums for priority in the delivery of atomic traction engines, atomic smelting was embarked upon so eagerly as to lead to a number of disastrous explosions due to inexperienced handling of the new power, and the revolutionary cheapening of both materials and electricity made the entire reconstruction of domestic buildings a matter merely dependent upon a reorganisation of the methods of the builder and the house-furnisher. Viewed from the side of the new power and from the point of view of those who financed and manufactured the new engines and material it required, the age of the Leap into the Air was one of astonishing prosperity. Patent-holding companies were presently paying dividends of five or six hundred per cent, and enormous fortunes were made and fantastic wages earned by all who were concerned in the new developments. This prosperity was not a little enhanced by the fact that in both the Dass-Tata and Holsten-Roberts engines one of the recoverable waste products was gold—the former disintegrated dust of bismuth and the latter dust of lead—and that this new supply of gold led quite naturally to a rise in prices throughout the world.

This spectacle of feverish enterprise was productivity, this crowding flight of happy and fortunate rich people—every great city was as if a crawling ant-hill had suddenly taken wing—was the bright side of the opening phase of the new epoch in human history. Beneath that brightness was a gathering darkness, a deepening dismay. If there was a vast development of production there was also a huge destruction of values. These glaring factories working night and day, these glittering new vehicles swinging noiselessly along the roads, these flights of dragon-flies that swooped and soared and circled in the air, were indeed no more than the brightnesses of lamps and fires that gleam out when the world sinks towards twilight and the night. Between these high lights accumulated disaster, social catastrophe. The coal mines were manifestly doomed to closure at no very distant date, the vast amount of capital invested in oil was becoming unsaleable, millions of coal miners, steel workers upon the old lines, vast swarms of unskilled or under-skilled labourers in innumerable occupations, were being flung out of employment by the superior efficiency of the new machinery, the rapid fall in the cost of transit was destroying high land values at every centre of population, the value of existing house property had become problematical, gold was undergoing headlong depreciation, all the securities upon which the credit of the world rested were slipping and sliding, banks were tottering, the stock exchanges were scenes of feverish panic;—this was the reverse of the spectacle, these were the black and monstrous under-consequences of the Leap into the Air.

There is a story of a demented London stockbroker running out into Threadneedle Street and tearing off his clothes as he ran. 'The Steel Trust is scrapping the whole of its plant,' he shouted. 'The State Railways are going to scrap all their engines. Everything's going to be scrapped—everything. Come and scrap the mint, you fellows, come and scrap the mint!'

In the year 1955 the suicide rate for the United States of America quadrupled any previous record.

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Viewed from the standpoint of a sane and ambitious social order, it is difficult to understand, and it would be tedious to follow, the motives that plunged mankind into the war that fills the histories of the middle decades of the twentieth century.

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The sky above the indistinct horizons of this cloud sea was at first starry and then paler with a light that crept from north to east as the dawn came on. The Milky Way was invisible in the blue, and the lesser stars vanished. The face of the adventurer at the steering-wheel, darkly visible ever and again by the oval greenish glow of the compass face, had something of that firm beauty which all concentrated purpose gives, and something of the happiness of an idiot child that has at last got hold of the matches. His companion, a less imaginative type, sat with his legs spread wide over the long, coffin-shaped box which contained in its compartments the three atomic bombs, the new bombs that would continue to explode indefinitely and which no one so far had ever seen in action. Hitherto Carolinum, their essential substance, had been tested only in almost infinitesimal quantities within steel chambers embedded in lead. Beyond the thought of great destruction slumbering in the black spheres between his legs, and a keen resolve to follow out very exactly the instructions that had been given him, the man's mind was a blank. His aquiline profile against the starlight expressed nothing but a profound gloom.

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The gaunt face hardened to grimness, and with both hands the bomb-thrower lifted the big atomic bomb from the box and steadied it against the side. It was a black sphere two feet in diameter. Between its handles was a little celluloid stud, and to this he bent his head until his lips touched it. Then he had to bite in order to let the air in upon the inducive. Sure of its accessibility, he craned his neck over the side of the aeroplane and judged his pace and distance. Then very quickly he bent forward, bit the stud, and hoisted the bomb over the side.

'Round,' he whispered inaudibly.

The bomb flashed blinding scarlet in mid-air, and fell, a descending column of blaze eddying spirally in the midst of a whirlwind. Both the aeroplanes were tossed like shuttlecocks, hurled high and sideways and the steersman, with gleaming eyes and set teeth, fought in great banking curves for a balance. The gaunt man clung tight with hand and knees; his nostrils dilated, his teeth biting his lips. He was firmly strapped. . . .

When he could look down again it was like looking down upon the crater of a small volcano. In the open garden before the Imperial castle a shuddering star of evil splendour spurted and poured up smoke and flame towards them like an accusation. They were too high to distinguish people clearly, or mark the bomb's effect upon the building until suddenly the façade tottered and crumbled before the flare as sugar dissolves in water. The man stared for a moment, showed all his long teeth, and then staggered into the cramped standing position his straps permitted, hoisted out and bit another bomb, and sent it down after its fellow.

The explosion came this time more directly underneath the aeroplane and shot it upward edgeways. The bomb box tipped to the point of disgorgement, and the bomb-thrower was pitched forward upon the third bomb with his face close to its celluloid stud. He clutched its handles, and with a sudden gust of determination that the thing should not escape him, bit its stud. Before he could hurl it over, the monoplane was slipping sideways. Everything was falling sideways. Instinctively he gave himself up to gripping, his body holding the bomb in its place.

Then that bomb had exploded also, and steersman, thrower, and aeroplane were just flying rags and splinters of metal and drops of moisture in the air, and a third column of fire rushed eddying down upon the doomed buildings below. . . .

§ 4.

Never before in the history of warfare had there been a continuing explosive;

indeed, up to the middle of the twentieth century the only explosives known were combustibles whose explosiveness was due entirely to their instantaneousness; and these atomic bombs which science burst upon the world that night were strange even to the men who used them. Those used by the Allies were lumps of pure Carolinum, painted on the outside with unoxidised cydonator inducive enclosed hermetically in a case of membranium. A little celluloid stud between the handles by which the bomb was lifted was arranged so as to be easily torn off and admit air to the inducive, which at once became active and set up radio-activity in the outer layer of the Carolinum sphere. This liberated fresh inducive, and so in a few minutes the whole bomb was a blazing continual explosion. The Central European bombs were the same, except that they were larger and had a more complicated arrangement for animating the inducive.

Always before in the development of warfare the shells and rockets fired had been but momentarily explosive, they had gone off in an instant once for all, and if there was nothing living or valuable within reach of the concussion and the flying fragments, then they were spent and over. But Carolinum, which belonged to the β-group of Hyslop's so-called 'suspended degenerator' elements, once its degenerative process had been induced, continued a furious radiation of energy and nothing could arrest it. Of all Hyslop's artificial elements, Carolinum was the most heavily stored with energy and the most dangerous to make and handle. To this day it remains the most potent degenerator known. What the earlier twentieth-century chemists called its half period was seventeen days; that is to say, it poured out half of the huge store of energy in its great molecules in the space of seventeen days, the next seventeen days' emission was a half of that first period's outpouring, and so on. As with all radio-active substances this Carolinum, though every seventeen days its power is halved, though constantly it diminishes towards the imperceptible, is never entirely exhausted, and to this day the battle-fields and bomb fields of that frantic time in human history are sprinkled with radiant matter, and so centres of inconvenient rays.

What happened when the celluloid stud was opened was that the inducive oxidised and became active. Then the surface of the Carolinum began to degenerate. This degeneration passed only slowly into the substance of the bomb. A moment or so after its explosion began it was still mainly an inert sphere exploding superficially, a big, inanimate nucleus wrapped in flame and thunder. Those that were thrown from aeroplanes fell in this state, they reached the ground still mainly solid, and, melting soil and rock in their progress, bored into the earth. There, as more and more of the Carolinum became active, the bomb spread itself out into a monstrous cavern of fiery energy at the base of what became very speedily a miniature active volcano. The Carolinum, unable to disperse, freely drove into and mixed up with a boiling confusion of molten soil and superheated steam, and so remained spinning furiously and maintaining an eruption that lasted for years or months or weeks according to the size of the bomb employed and the chances of its dispersal. Once launched, the bomb was absolutely unapproachable and uncontrollable until its forces were nearly exhausted, and from the crater that burst open above it, puffs of heavy incandescent vapour and fragments of viciously punitive rock and mud, saturated with Carolinum, and each a centre of scorching and blistering energy, were flung high and far.

Such was the crowning triumph of military science, the ultimate explosive that was to give the 'decisive touch' to war. . . .

§ 5.

A recent historical writer has described the world of that time as one that 'believed in established words and was invincibly blind to the obvious in things.' Certainly it seems now that nothing could have been more obvious to the people of the earlier twentieth century than the rapidity with which war was becoming impossible. And as certainly they did not see it. They did not see it until the atomic bombs burst in their fumbling hands. Yet the broad facts must have glared upon any intelligent mind. All through the nineteenth and twentieth centuries the amount of energy that men were able to command was continually increasing. Applied to warfare that meant that the power to inflict a blow, the power to destroy, was continually increasing. There was no increase whatever in the ability to escape. Every sort of passive defence, armour, fortifications, and so forth, was being outmastered by this tremendous increase on the destructive side. Destruction was becoming so facile that any little body of malcontents could use it; it was revolutionising the problems of police and internal rule. Before the last war began it was a matter of common knowledge that a man could carry about in a handbag an amount of latent energy sufficient to wreck half a city. These facts were before the minds of everybody; the children in the streets knew them. And yet the world still, as the Americans used to phrase it, 'fooled around' with the paraphernalia and pretensions of war.

It is only by realising this profound, this fantastic divorce between the scientific and intellectual movement on the one hand, and the world of the lawyer-politician on the other, that the men of a later time can hope to understand this preposterous state of affairs. Social organisation was still in the barbaric stage. There were already great numbers of actively intelligent men and much private and commercial civilisation, but the community, as a whole, was aimless, untrained and unorganised to the pitch of imbecility. Collective civilisation, the 'Modern State,' was still in the womb of the future. . . .

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The enemy began sniping the rifle pits from shelters they made for themselves in the woods below. A man was hit in the pit next to Barnet, and began cursing and crying out in a violent rage. Barnet crawled along the ditch to him and found him in great pain, covered with blood, frantic with indignation, and with the half of his right hand smashed to a pulp. 'Look at this,' he kept repeating, hugging it and then extending it. 'Damned foolery! Damned foolery! My right hand, sir! My right hand!'

For some time Barnet could do nothing with him. The man was consumed by his tortured realisation of the evil silliness of war, the realisation which had come upon him in a flash with the bullet that had destroyed his skill and use as an artificer for ever. He was looking at the vestiges with a horror that made him impenetrable to any other idea. At last the poor wretch let Barnet tie up his bleeding stump and help him along the ditch that conducted him deviously out of range. . . .

When Barnet returned his men were already calling out for water, and all day long the line of pits suffered greatly from thirst. For food they had chocolate and bread. 'At first,' he says, 'I was extraordinarily excited by my baptism of fire. Then as the heat of the day came on I experienced an enormous tedium and discomfort. The flies became extremely troublesome, and my little grave of a rifle pit was invaded by ants. I could not get up or move about, for some one in the trees had got a mark on me. I kept thinking of the dead Prussian down among the corn, and of the bitter outcries of my own man. Damned foolery! It *was* damned foolery. But who was to blame? How had we got to this? . . .

'Early in the afternoon an aeroplane tried to dislodge us with dynamite bombs, but she was hit by bullets once or twice, and suddenly dived down over beyond the trees.

'From Holland to the Alps this day,' I thought, 'there must be crouching and lying between half and a million of men, trying to inflict irreparable damage upon one another. The thing is idiotic to the pitch of impossibility. It is a dream. Presently I shall wake up. . . .'

'Then the phrase changed itself in my mind. 'Presently mankind will wake up.'

'I lay speculating just how many thousands of men there were among these hundreds of thousands, whose spirits were in rebellion against all these ancient traditions of flag and empire. Weren't we, perhaps, already in the throes of the last crisis, in that darkest moment of a nightmare's horror before the sleeper will endure no more of it—and wakes?

'I don't know how my speculations ended. I think they were not so much ended as distracted by the distant thudding of the guns that were opening fire at long range upon Namur.'

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'And then, while I still peered and tried to shade these flames from my eyes with my hand, and while the men about me were beginning to stir, the atomic bombs were thrown at the dykes. They made a mighty thunder in the air, and fell like Lucifer in the picture, leaving a flaring trail in the sky. The night, which had been pellucid and detailed and eventful, seemed to vanish, to be replaced abruptly by a black background to these tremendous pillars of fire. . . .

'Hard upon the sound of them came a roaring wind, and the sky was filled with flickering lightnings and rushing clouds. . . .

‘There was something discontinuous in this impact. At one moment I was a lonely watcher in a sleeping world; the next saw every one about me afoot, the whole world awake and amazed. . . .

‘And then the wind had struck me a buffet, taken my helmet and swept aside the summerhouse of *Vreugde bij Vrede*, as a scythe sweeps away grass. I saw the bombs fall, and then watched a great crimson flare leap responsive to each impact, and mountainous masses of red-lit steam and flying fragments clamber up towards the zenith. Against the glare I saw the country-side for miles standing black and clear, churches, trees, chimneys. And suddenly I understood. The Central Europeans had burst the dykes. Those flares meant the bursting of the dykes, and in a little while the sea-water would be upon us. . . .’

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‘I do not think any of us felt we belonged to a defeated army, nor had we any strong sense of the war as the dominating fact about us. Our mental setting had far more of the effect of a huge natural catastrophe. The atomic bombs had dwarfed the international issues to complete insignificance. When our minds wandered from the preoccupations of our immediate needs, we speculated upon the possibility of stopping the use of these frightful explosives before the world was utterly destroyed. For to us it seemed quite plain that these bombs and the still greater power of destruction of which they were the precursors might quite easily shatter every relationship and institution of mankind.

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For a time in western Europe at least it was indeed as if civilisation had come to a final collapse. These crowning buds upon the tradition that Napoleon planted and Bismarck watered, opened and flared ‘like waterlilies of flame’ over nations destroyed, over churches smashed or submerged, towns ruined, fields lost to mankind for ever, and a million weltering bodies. Was this lesson enough for mankind, or would the flames of war still burn amidst the ruins?

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Leblanc was one of those ingenuous men whose lot would have been insignificant in any period of security, but who have been caught up to an immortal rôle in history by the sudden simplification of human affairs through some tragical crisis, to the measure of their simplicity. Such a man was Abraham Lincoln, and such was Garibaldi. And Leblanc, with his transparent childish innocence, his entire self-forgetfulness, came into this confusion of distrust and intricate disaster with an invincible appeal for the manifest sanities of the situation. His voice, when he spoke, was ‘full of remonstrance.’ He was a little, bald, spectacled man, inspired by that intellectual idealism which has been one of the peculiar gifts of France to humanity. He was possessed of one clear persuasion, that war must end, and that the only way to end war was to have but one government for mankind.

He brushed aside all other considerations. At the very outbreak of the war, so soon as the two capitals of the belligerents had been wrecked, he went to the president in the White House with this proposal. He made it as if it was a matter of course. He was fortunate to be in Washington and in touch with that gigantic childishness which was the characteristic of the American imagination. For the Americans also were among the simple peoples by whom the world was saved. He won over the American president and the American government to his general ideas; at any rate they supported him sufficiently to give him a standing with the more sceptical European governments, and with this backing he set to work—it seemed the most fantastic of enterprises—to bring together all the rulers of the world and unify them. He wrote innumerable letters, he sent messages, he went desperate journeys, he enlisted whatever support he could find; no one was too humble for an ally or too obstinate for his advances; through the terrible autumn of the last wars this persistent little visionary in spectacles must have seemed rather like a hopeful canary twittering during a thunderstorm. And no accumulation of disasters daunted his conviction that they could be ended.

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'Do you really think, Firmin, that I am here as—as an infernal politician to put my crown and my flag and my claims and so forth in the way of peace? That little Frenchman is right. You know he is right as well as I do. Those things are over. We—we kings and rulers and representatives have been at the very heart of the mischief. Of course we imply separation, and of course separation means the threat of war, and of course the threat of war means the accumulation of more and more atomic bombs. The old game's up. But, I say, we mustn't stand here, you know. The world waits. Don't you think the old game's up, Firmin?'

Firmin adjusted a strap, passed a hand over his wet forehead, and followed earnestly. 'I admit, sir,' he said to a receding back, 'that there has to be some sort of hegemony, some sort of Amphictyonic council——'

'There's got to be one simple government for all the world,' said the king over his shoulder.

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'Manifestly war has to stop for ever, Firmin. Manifestly this can only be done by putting all the world under one government. Our crowns and flags are in the way. Manifestly they must go.'

'Yes, sir,' interrupted Firmin, 'but *what* government? I don't see what government you get by a universal abdication!'

'Well,' said the king, with his hands about his knees, '*We* shall be the government.'

'The conference?' exclaimed Firmin.

'Who else?' asked the king simply.

'It's perfectly simple,' he added to Firmin's tremendous silence.

'But,' cried Firmin, 'you must have sanctions! Will there be no form of election, for example?'

'Why should there be?' asked the king, with intelligent curiosity.

'The consent of the governed.'

'Firmin, we are just going to lay down our differences and take over government. Without any election at all. Without any sanction. The governed will show their consent by silence. If any effective opposition arises, we shall ask it to come in and help. The true sanction of kingship is the grip upon the sceptre. We aren't going to worry people to vote for us. I'm certain the mass of men does not want to be bothered with such things. . . . We'll contrive a way for any one interested to join in. That's quite enough in the way of democracy. Perhaps later—when things don't matter. . . . We shall govern all right, Firmin. Government only becomes difficult when the lawyers get hold of it, and since these troubles began the lawyers are shy. Indeed, come to think of it, I wonder where all the lawyers are. . . . Where are they? A lot, of course, were bagged, some of the worst ones, when they blew up my legislature. You never knew the late Lord Chancellor. . . .

'Necessities bury rights. And create them. Lawyers live on dead rights disinterred. . . . We've done with that way of living. We won't have more law than a code can cover and beyond that government will be free. . . .

'Before the sun sets to-day, Firmin, trust me, we shall have made our abdications, all of us, and declared the World Republic, supreme and indivisible. I wonder what my august grandmother would have made of it! All my rights! . . . And then we shall go on governing. What else is there to do? All over the world we shall declare that there is no longer mine or thine, but ours. China, the United States, two-thirds of Europe, will certainly fall in and obey. They will have to do so. What else can they do? Their official rulers are here with us. They won't be able to get together any sort of idea of not obeying us. . . . Then we shall declare that every sort of property is held in trust for the Republic. . . .'

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The members of the new world government dined at three long tables on trestles, and down the middle of these tables Leblanc, in spite of the barrenness of his menu, had contrived to have a great multitude of beautiful roses.

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On this first evening of all the council's gatherings, after King Egbert had talked for a long time and drunken and praised very abundantly the simple red wine of the country that Leblanc had procured for them, he fathered about him a group of congenial spirits and fell into a discourse upon simplicity, praising it above all things and declaring that the ultimate aim of art, religion, philosophy, and science alike was to simplify. He instanced himself as a devotee to simplicity. And Leblanc he instanced as a crowning instance of the splendour of this quality. Upon that they all agreed.

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They arranged with a certain informality. No Balkan aeroplane was to adventure into the air until the search was concluded, and meanwhile the fleets of the world government would soar and circle in the sky. The towns were to be placarded with offers of reward to any one who would help in the discovery of atomic bombs. . . .

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The task that lay before the Assembly of Brissago, viewed as we may view it now from the clarifying standpoint of things accomplished, was in its broad issues a simple one. Essentially it was to place social organisation upon the new footing that the swift, accelerated advance of human knowledge had rendered necessary. The council was gathered together with the haste of a salvage expedition, and it was confronted with wreckage; but the wreckage was irreparable wreckage, and the only possibilities of the case were either the relapse of mankind to the agricultural barbarism from which it had emerged so painfully or the acceptance of achieved science as the basis of a new social order. The old tendencies of human nature, suspicion, jealousy, particularism, and belligerency, were incompatible with the monstrous destructive power of the new appliances the inhuman logic of science had produced. The equilibrium could be restored only by civilisation destroying itself down to a level at which modern apparatus could no longer be produced, or by human nature adapting itself in its institutions to the new conditions. It was for the latter alternative that the assembly existed.

Sooner or later this choice would have confronted mankind. The sudden development of atomic science did but precipitate and render rapid and dramatic a clash between the new and the customary that had been gathering since ever the first flint was chipped or the first fire built together. From the day when man contrived himself a tool and suffered another male to draw near him, he ceased to be altogether a thing of instinct and untroubled convictions. From that day forth a widening breach can be traced between his egotistical passions and the social need. Slowly he adapted himself to the life of the homestead, and his passionate impulses widened out to the demands of the clan and the tribe. But widen though his impulses might, the latent hunter and wanderer and wonderer in his imagination outstripped their development. He was never quite subdued to the soil nor quite tamed to the home. Everywhere it needed teaching and the priest to keep him within the bounds of the plough-life and the beast-tending. Slowly a vast system of traditional imperatives superposed itself upon his instincts, imperatives that were admirably fitted to make him that cultivator, that cattle-mincer, who was for twice ten thousand years the normal man.

And, unpremeditated, undesired, out of the accumulations of his tilling came civilisation. Civilisation was the agricultural surplus. It appeared as trade and tracks and roads, it pushed boats out upon the rivers and presently invaded the seas, and within its primitive courts, within temples grown rich and leisurely and amidst the gathering medley of the seaport towns rose speculation and philosophy and science, and the beginning of the new order that has at last established itself as human life. Slowly at first, as we traced it, and then with an accumulating velocity, the new powers were fabricated.

Man as a whole did not seek them nor desire them; they were thrust into his hand. For a time men took up and used these new things and the new powers inadvertently as they came to him, recking nothing of the consequences. For endless generations change led him very gently. But when he had been led far enough, change quickened the pace. It was with a series of shocks that he realised at last that he was living the old life less and less and a new life more and more.

Already before the release of atomic energy the tensions between the old way of living and the new were intense. They were far intenser than they had been even at the collapse of the Roman imperial system. On the one hand was the ancient life of the family and the small community and the petty industry, on the other was a new life on a larger scale, with remoter horizons and a strange sense of purpose. Already it was growing clear that men must live on one side or the other. One could not have little tradespeople and syndicated businesses in the same market, sleeping carters and motor trolleys on the same road, bows and arrows and aeroplane sharpshooters in the same army, or illiterate peasant industries and power-driven factories in the same world. And still less it was possible that one could have the ideas and ambitions and greed and jealousy of peasants equipped with the vast appliances of the new age. If there had been no atomic bombs to bring together most of the directing intelligence of the world to that hasty conference at Brissago, there would still have been, extended over great areas and a considerable space of time perhaps, a less formal conference of responsible and understanding people upon the perplexities of this world-wide opposition. If the work of Holsten had been spread over centuries and imparted to the world by imperceptible degrees, it would nevertheless have made it necessary for men to take counsel upon and set a plan for the future. Indeed already there had been accumulating for a hundred years before the crisis a literature of foresight; there was a whole mass of 'Modern State' scheming available for the conference to go upon. These bombs did but accentuate and dramatise an already developing problem.

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Coming in still closer, the investigator would have reached the police cordon, which was trying to check the desperate enterprise of those who would return to their homes or rescue their more valuable possessions within the 'zone of imminent danger.'

That zone was rather arbitrarily defined. If our spectator could have got permission to enter it, he would have entered also a zone of uproar, a zone of perpetual thunderings, lit by a strange purplish-red light, and quivering and swaying with the incessant explosion of the radio-active substance. Whole blocks of buildings were alight and burning fiercely, the trembling, ragged flames looking pale and ghastly and attenuated in comparison with the full-bodied crimson glare beyond. The shells of other edifices already burnt rose, pierced by rows of window sockets against the red-lit mist.

Every step farther would have been as dangerous as a descent within the crater of an active volcano. These spinning, boiling bomb centres would shift or break unexpectedly into new regions, great fragments of earth or drain or masonry suddenly caught by a jet of disruptive force might come flying by the explorer's head, or the ground yawn a fiery grave beneath his feet. Few who adventured into these areas of destruction and survived attempted any repetition of their experiences. There are stories of puffs of luminous, radio-active vapour drifting sometimes scores of miles from the bomb centre and killing and scorching all they overtook. And the first conflagrations from the Paris centre spread westward half-way to the sea.

Moreover, the air in this infernal inner circle of red-lit ruins had a peculiar dryness and a blistering quality, so that it set up a soreness of the skin and lungs that was very difficult to heal. . . .

Such was the last state of Paris, and such on a larger scale was the condition of affairs in Chicago, and the same fate had overtaken Berlin, Moscow, Tokio, the eastern half of London, Toulon, Kiel, and two hundred and eighteen other centres of population or armament. Each was a flaming centre of radiant destruction that only time could quench, that indeed in many instances time has still to quench. To this day, though indeed with a constantly diminishing uproar and vigour, these explosions continue. In the map of nearly every country of the world three or four or more red circles, a score of miles in diameter, mark the position of the dying atomic bombs and the death areas that men have been forced to abandon around them. Within these areas perished museums, cathedrals, palaces, libraries, galleries of masterpieces, and a vast accumulation of human achievement, whose charred remains lie buried, a legacy of curious material that only future generations may hope to examine. . . .

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Thence he must have assisted in the transmission of the endless cipher messages that preceded the gathering at Brissago, and there it was that the Brissago proclamation of the end of the war and the establishment of a world government came under his hands.

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And now it was that the social possibilities of the atomic energy began to appear. The new machinery that had come into existence before the last wars increased and multiplied, and the council found itself not only with millions of hands at its disposal, but with power and apparatus that made its first conceptions of the work it had to do seem pitifully timid. The camps that were planned in iron and deal were built in stone and brass; the roads that were to have been mere iron tracks became spacious ways that insisted upon architecture; the cultivations of foodstuffs that were to have supplied emergency rations, were presently, with synthesisers, fertilisers, actinic light, and scientific direction, in excess of every human need.

The government had begun with the idea of temporarily reconstituting the social and economic system that had prevailed before the first coming of the atomic engine, because it was to this system that the ideas and habits of the great mass of the world's dispossessed population was adapted. Subsequent rearrangement it had hoped to leave to its successors—whoever they might be. But this, it became more and more manifest, was absolutely impossible. As well might the council have proposed a revival of slavery. The capitalist system had already been smashed beyond repair by the onset of limitless gold and energy; it fell to pieces at the first endeavour to stand it up again. Already before the war half of the industrial class had been out of work, the attempt to put them back into wages employment on the old lines was futile from the outset—the absolute shattering of the currency system alone would have been sufficient to prevent that, and it was necessary therefore to take over the housing, feeding, and clothing of this worldwide multitude without exacting any return in labour whatever. In a little while the mere absence of occupation for so great a multitude of people everywhere became an evident social danger, and the government was obliged to resort to such devices as simple decorative work in wood and stone, the manufacture of hand-woven textiles, fruit-growing, flower-growing, and landscape gardening on a grand scale to keep the less adaptable out of mischief, and of paying wages to the younger adults for attendance at schools that would equip them to use the new atomic machinery. . . . So quite insensibly the council drifted into a complete reorganisation of urban and industrial life, and indeed of the entire social system.

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The world had already been put upon one universal monetary basis. For some months after the accession of the council, the world's affairs had been carried on without any sound currency at all. Over great regions money was still in use, but with the most extravagant variations in price and the most disconcerting fluctuations of public confidence. The ancient rarity of gold upon which the entire system rested was gone. Gold was now a waste product in the release of atomic energy, and it was plain that no metal could be the basis of the monetary system again. Henceforth all coins must be token coins. Yet the whole world was accustomed to metallic money, and a vast proportion of existing human relationships had grown up upon a cash basis, and were almost inconceivable without that convenient liquidating factor. It seemed absolutely necessary to the life of the social organisation to have some sort of currency, and the council had therefore to discover some real value upon which to rest it. Various such apparently stable values as land and hours of work were considered. Ultimately the government, which was now in possession of most of the supplies of energy-releasing material, fixed a certain number of units of energy as the value of a gold sovereign, declared a sovereign to be worth exactly twenty marks, twenty-five francs, five dollars, and so forth, with the other current units of the world, and undertook, under various qualifications and conditions, to deliver energy upon demand as payment for every sovereign presented. On the whole, this worked satisfactorily. They saved the face of the pound sterling. Coin was rehabilitated, and after a phase of price fluctuations began to settle down to definite equivalents and uses again, with names and everyday values familiar to the common run of people. . . .

[***]

'You know, sir, I've a fancy—it is hard to prove such things—that civilisation was very near disaster when the atomic bombs came banging into it, that if there had been no Holsten and no induced radio-activity, the world would have—smashed—much as it did. Only instead of its being a smash that opened a way to better things, it might have been a smash without a recovery. It is part of my business to understand economics, and from that point of view the century before Holsten was just a hundred years' crescendo of waste. Only the extreme individualism of that period, only its utter want of any collective understanding or purpose can explain that waste. Mankind used up material—insanely. They had got through three-quarters of all the coal in the planet, they had used up most of the oil, they had swept away their forests, and they were running short of tin and copper. Their wheat areas were getting weary and populous, and many of the big towns had so lowered the water level of their available hills that they suffered a drought every summer. The whole system was rushing towards bankruptcy. And they were spending every year vaster and vaster amounts of power and energy upon military preparations, and continually expanding the debt of industry to capital. The system was already staggering when Holsten began his researches. So far as the world in general went, there was no sense of danger and no desire for inquiry. They had no belief that science could save them, nor any idea that there was a need to be saved. They could not, they would not, see the gulf beneath their feet. It was pure good luck for mankind at large that any research at all was in progress. And as I say, sir, if that line of escape hadn't opened, before now there might have been a crash, revolution, panic, social disintegration, famine, and—it is conceivable—complete disorder. . . . The rails might have rusted on the disused railways by now, the telephone poles have rotted and fallen, the big liners dropped into sheet-iron in the ports; the burnt, deserted cities become the ruinous hiding-places of gangs of robbers. We might have been brigands in a shattered and attenuated world. Ah, you may smile, but that had happened before in human history. The world is still studded with the ruins of broken-down civilisations. Barbaric bands made their fastness upon the Acropolis, and the tomb of Hadrian became a fortress that warred across the ruins of Rome against the Colosseum. . . . Had all that possibility of reaction ended so certainly in 1940? Is it all so very far away even now?'

'It seems far enough away now,' said Edith Haydon.

'But forty years ago?'

'No,' said Karenin with his eyes upon the mountains, 'I think you underrate the available intelligence in those early decades of the twentieth century. Officially, I know, politically, that intelligence didn't tell—but it was there. And I question your hypothesis. I doubt if that discovery could have been delayed. There is a kind of inevitable logic now in the progress of research. For a hundred years and more thought and science have been going their own way regardless of the common events of life. You see—*they have got loose*. If there had been no Holsten there would have been some similar man. If atomic energy had not come in one year it would have come in another. In decadent Rome the march of science had scarcely begun. . . . Nineveh, Babylon, Athens, Syracuse, Alexandria, these were the first rough experiments in association that made a security, a breathing-space, in which inquiry was born. Man had to experiment before he found out the way to begin. But already two hundred years ago he had fairly begun. . . . The politics and dignities and wars of the nineteenth and twentieth centuries were only the last phoenix blaze of the former civilisation flaring up about the beginnings of the new. Which we serve. . . .

'Man lives in the dawn for ever,' said Karenin. 'Life is beginning and nothing else but beginning. It begins everlastingly. Each step seems vaster than the last, and does but gather us together for the next. This Modern State of ours, which would have been a Utopian marvel a hundred years ago, is already the commonplace of life. But as I sit here and dream of the possibilities in the mind of man that now gather to a head beneath the shelter of its peace, these great mountains here seem but little things. . . .'"

While undoubtedly visionary, Wells' book was more of a road map to the future, than a prophecy. It led Leo Szilard and Werner Heisenberg toward the development of an "atomic bomb", as Wells called it, after Otto Hahn discovered nuclear fission.[3380] Wells was very much aware of the impact his work might have on the future. He wrote,

"Man began to think. There were times when he was fed, when his lusts and his fears were all appeased, when the sun shone upon the squatting-place and dim stirrings of speculation lit his eyes. He scratched upon a bone and found resemblance and pursued it and began pictorial art, moulded the soft, warm clay of the river brink between his fingers, and found a pleasure in its patternings and repetitions, shaped it into the form of vessels, and found that it would hold water. He watched the streaming river, and wondered from what bountiful breast this incessant water came; he blinked at the sun and dreamt that perhaps he might snare it and spear it as it went down to its resting-place amidst the distant hills. Then he was roused to convey to his brother that once indeed he had done so—at least that some one had done so—he mixed that perhaps with another dream almost as daring, that one day a mammoth had been beset; and therewith began fiction—pointing a way to achievement—and the august prophetic procession of tales."

Much of what Wells proposed on the scientific front was eventually fulfilled, and much of what he predicted may yet take place. Albert Einstein, picking up the theme from Emory Reves' *The Anatomy of Peace* of 1945, took his script as the protagonist "Leblanc" in the atomic age from Wells' *A World Set Free* of 1913, and stated, *inter* *alia*,

> "The release of atomic energy has not created a new problem. It has merely made more urgent the necessity of solving an existing one. One could say that it has affected us quantitatively, not qualitatively. So long as there are sovereign nations possessing great power, war is inevitable. That is not an attempt to say when it will come, but only that it is sure to come. That was true before the atomic bomb was made. What has been changed is the destructiveness of war. [***] The secret of the bomb should be committed to a world government, and the United States should immediately announce its readiness to give it to a world government."[3381]

Both Wells' and Einstein's call for a world government matched Judaic Messianic prophecies. Einstein promoted the two most fundamental goals of Jewish prophecy, the "restoration of the Jews to Palestine" and the formation of a world government after an apocalyptic war to end all wars.

Wells dedicated his book of 1913 not to Albert Einstein, but,

> "*TO FREDERICK SODDY'S 'INTERPRETATION OF RADIUM' THIS STORY, WHICH OWES LONG PASSAGES TO THE ELEVENTH CHAPTER OF THAT BOOK, ACKNOWLEDGES AND INSCRIBES ITSELF*"

Frederick Soddy opposed Einstein and the theory of relativity. Soddy stated at the fourth gathering of Nobel Prize winners in Lindau on 30 June 1954 that the theory of relativity is a "swindle"—"an orgy of amateurish metaphysics" (Soddy's lecture criticizing Einstein and the theory of relativity was "revised" before publication).[3382] Soddy stated in 1908:

"CHAPTER XI.

Why is radium unique among the elements ?—Its rate of change only makes it remarkable—Uranium is more wonderful than radium— The energy stored up in a pound of uranium—Transmutation is the key to the internal energy of matter—The futility of ancient alchemy—The consequences if transmutation were possible— Primitive man and the art of kindling fire—Modern man and the problem of transmutation—Cosmical evolution and its sinews of war—Atomic disintegration a sufficient, if not the actual primary source of natural energy—Radioactivity and geology—Quantity of radium in the earth's crust—The earth probably not a cooling globe—Mountain formation by means of radium—The temperature of the moon and planets—Ancient mythology and radioactivity—The serpent 'Ouroboros'—The 'Philosopher's Stone' and the 'Elixir of Life'—The 'Fall of Man' and the 'Ascent of Man'—The great extension in the possible duration of past time—Speculations on possible forgotten races of men—Radium and the struggle for existence—Existence as a struggle for physical energy—The new prospect.

THIS interpretation of radium is drawing to a close, but perhaps the more generally interesting part of it remains to be dealt with. We have steadily followed out the idea of atomic disintegration to its logical conclusions, so far as they can at present be drawn, and we have found it able to account for all the surprising discoveries that have been made in radioactivity, and capable of predicting many, and perhaps even more unexpected, new ones. Let us from the point of vantage we have gained return to the starting point of our inquiries and see what a profound change has come over it since the riddle has been read. Radium, a new element, giving out light and heat like Aladdin's lamp, apparently defying the law of the conservation of energy, and raising questions in physical science which seemed unanswerable, is no longer the radium we know. But although its mystery has vanished, its significance and importance have vastly gained. At first we were compelled to regard it as unique, dowered with potentialities and exhibiting peculiarities which raised it far above the ordinary run of common matter. The matter was the mere vehicle of ultra-material powers. If we now ask, why is radium so unique among the elements, the answer is not because it is dowered with any exceptional potentialities or because it contains any abnormal store of internal energy which other elements do not possess, but simply and solely because it is changing comparatively rapidly, whereas the elements before known are either changing not at all or so slowly that the change has been unperceived. At first sight this might seem an anti-climax. Yet it is not so. The truer view is that this one element has clothed with its own dignity the whole empire of common matter. The aspect which matter has presented to us in the past is but a consummate disguise, concealing latent energies and hidden activities beneath an hitherto impenetrable mask. The ultra-material potentialities of radium are the common possession of all that world to which in our ignorance we used to refer as mere inanimate matter. This is the weightiest lesson the existence of radium has taught us, and it remains to consider the easy but remorseless reasoning by which the conclusion is arrived at.

Two considerations will make the matter clear. In the first place, the radioactivity of radium at any moment is, strictly speaking, not a property of the mass of the radium at all, although it is proportional to the mass. The whole of the new set of properties is contributed by a very small fraction of the whole, namely, the part which is actually disintegrating at the moment of observation. The whole of the rest of the radium is as quiescent and inactive as any other non-radioactive element. In its whole chemical nature it is an ordinary element. The new properties are not contributed at all by the main part of the matter, but only by the minute fraction actually at the moment disintegrating.

Let us next compare and contrast radium with its first product, the emanation, and with its original parent, uranium. Uranium on the one hand, and the emanation on the other, represent, compared with radium, diametrically opposed extremes. Uranium is changing so slowly that it will last for thousands of millions of years, the emanation so rapidly that it lasts only a few weeks, while radium is intermediate with a period of average life of two thousand five hundred years.

We have seen that in many ways the emanation is far more wonderful than radium, as the rate its energy is given out is relatively far greater. But this is compensated for by the far shorter time its activity lasts. Also, if we compared uranium with radium, we should say at once that radium is far more wonderful than the uranium, whereas in reality it is not so, as the uranium, changing almost infinitely more slowly, lasts almost infinitely longer.

The arresting character of radium is to be ascribed solely to the rate at which it happens to be disintegrating. The common element uranium, well known to chemists for a century before its radioactivity was suspected, is in reality even more wonderful. It is only very feebly radioactive, and therefore is changing excessively slowly, but it changes, we believe, into radium, expelling several $\alpha$-particles and so evolving large amounts of energy in the process. Uranium is a heavier element than radium, and the relative weights of the two atoms, which is a measure of their complexity, is as 238 is to 226. This bottle contains about a pound of an oxide of uranium which contains about seven-eighths of its weight of the element uranium. In the course of the next few thousand million years, so far as we can tell, it will change, producing over thirteen ounces of radium, and, in that change into radium alone, energy is given out, as radioactive energy, aggregating of itself an enormous total, while the radium produced will also change, giving out a further enormous aggregate quantity of energy.

So that uranium, since it produces radium, contains all the energy contained in a but slightly smaller quantity of radium and more. It may be estimated that uranium evolves during complete disintegration at least some fourteen per cent more energy than is evolved from the same weight of radium. But what are we to say about the other heavy elements — lead, bismuth, mercury, gold, platinum, etc.—although their atoms are not quite so heavy as uranium or radium, and although none of them, so far as we yet know, are disintegrating at all? Is this enormous internal store of energy confined to the radioactive elements, that is to the few which, however slowly, are actually changing? Not at all, in all probability. Regarded merely as chemical elements between radioactive elements and non-radioactive elements, there exists so complete a parallelism that we cannot regard the radioactive elements as peculiar in possessing this internal store of energy, but only as peculiar in evolving it at a perceptible rate. Radium especially is so completely analogous in its whole chemical nature, and even in the character of its spectrum, to the non-radioactive elements, barium, strontium, and calcium, that chemists at once placed radium in the same family as these latter, and the value of its atomic weight confirms the arrangement in the manner required by the Periodic Law. It appears rather that this internal store of energy we learned of for the first time in connection with radium is possessed to greater or lesser degree by all elements in common and is part and parcel of their internal structure.

Let us, however, for the sake of conciseness, leave out of account altogether the non-radioactive elements, of which as yet we know nothing certainly. At least we cannot escape from the conclusion that the particular element uranium has relatively more energy stored up within it even than radium. Uranium is a comparatively common element. The mines of Cornwall last year produced, I believe, over ten tons of uranium.

I have already referred to the total amount of energy evolved by radium during the course of its complete change. It is about a quarter of a million times as much energy as is evolved from the same weight of coal in burning. The energy evolved from uranium would be some fourteen per cent greater than from the same weight of radium. This bottle contains about one pound of uranium oxide, and therefore about fourteen ounces of uranium. Its value is about £1. Is it not wonderful to reflect that in this little bottle there lies asleep and waiting to be evolved the energy of at least one hundred and fifty tons of coal? The energy in a ton of uranium would be sufficient to light London for a year. The store of energy in uranium would be worth a thousand times as much as the uranium itself, if only it were under our control and could be harnessed to do the world's work in the same way as the stored energy in coal has been harnessed and controlled.

There is, it is true, plenty of energy in the world which is practically valueless. The energy of the tides and of the waste heat from steam fall into this category as useless and low-grade energy. But the internal energy of uranium is not of this kind. The difficulty is of quite another character. As we have seen, we cannot yet artificially accelerate or influence the rate of disintegration of an element, and therefore the energy in uranium, which requires a thousand million years to be evolved, is practically valueless. On the other band, to increase the natural rate, and to break down uranium or any other element artificially, is simply transmutation. If we could accomplish the one so we could the other. These two great problems, at once the oldest and the newest in science, are one. Transmutation of the elements carries with it the power to unlock the internal energy of matter, and the unlocking of the internal stores of energy in matter would, strangely enough, be infinitely the most important and valuable consequence of transmutation.

Let us consider in the light of present knowledge the problem of transmutation, and see what the attempt of the alchemist involved. To build up an ounce of a heavy element like gold from a lighter element like silver would require in all probability the expenditure of the energy of some hundreds of tons of coal, so that the ounce of gold would be dearly bought. On the other hand, if it were possible artificially to disintegrate an element with a heavier atom than gold and produce gold from it, so great an amount of energy would probably be evolved that the gold in comparison would be of little account. The energy would be far more valuable than the gold. Although we are as ignorant as ever of how to set about transmutation, it cannot be denied that the knowledge recently gained constitutes a very great help towards a proper understanding of the problem and its ultimate accomplishment. We see clearly the magnitude of the task and the insufficiency of even the most powerful of the forces at our disposal in a way not before appreciated, and we have now a clear perception of the tremendous issues at stake. Looking backwards at the great things science has already accomplished, and at the steady growth in power and fruitfulness of scientific method, it can scarcely be doubted that one day we shall come to break down and build up elements in the laboratory as we now break down and build up compounds, and the pulses of the world will then throb with a new force, of a strength as immeasurably removed from any we at present control as they in turn are from the natural resources of the human savage.

It is, indeed, a strange situation we are confronted with. The first step in the long, upward journey out of barbarism to civilisation which man has accomplished appears to have been the art of kindling fire. Those savage races who remain ignorant of this art are regarded as on the very lowest plane. The art of kindling fire is the first step towards the control and utilisation of those natural stores of energy on which civilisation even now absolutely depends. Primitive man existed entirely on the day-to-day supply of sunlight for his vital energy, before he learned how to kindle fire for himself. One can imagine before this occurred that he became acquainted with fire and its properties from naturally occurring conflagrations.

With reference to the newly recognised internal stores of energy in matter we stand to-day where primitive man first stood with regard to the energy liberated by fire. We are aware of its existence solely from the naturally occurring manifestations in radioactivity. At the climax of that civilisation the first step of which was taken in forgotten ages by primitive man, and just when it is becoming apparent that its ever-increasing needs cannot indefinitely be borne by the existing supplies of energy, possibilities of an entirely new material civilisation are dawning with respect to which we find ourselves still on the lowest plane—that of onlookers with no power to interfere. The energy which we require for our very existence, and which Nature supplies us with but grudgingly and in none too generous measure for our needs, is in reality locked up in immense stores in the matter all around us, but the power to control and use it is not yet ours. What sources of energy we can and do use and control, we now regard as but the merest leavings of Nature's primary supplies. The very existence of the latter till now have remained unknown and unsuspected. When we have learned how to transmute the elements at will the one into the other, then, and not till then, will the key to this hidden treasure-house of Nature be in our hands. At present we have no hint of how even to begin the quest.

The question has frequently been discussed whether transmutation, so impossible to us, is not actually going on under the transcendental conditions obtaining in the sun and the stars. We have seen that it is actually going on in the world under our eyes in a few special cases and at a very slow rate.

The possibility now under consideration, however, is rather that it may be going on universally or at least much more generally, and at much more rapid rate under celestial than under terrestrial conditions. From the new point of view it may be said at once that if it were so, many of the difficulties previously experienced in accounting for the enormous and incessant dissipation of energy throughout the universe would disappear.

Last century has wrought a great change in scientific thought as to the nature of the gigantic forces which have moulded the world to its present form and which regulated the march of events throughout the universe. At one time it was customary to regard the evolution of the globe as the result of a succession in the past times of mighty cataclysms and catastrophes beside which the eruptions of a Krakatoa or Peke would be insignificant. Now, however, we regard the main process of moulding as due rather to ever-present, continuous, and irresistible actions, which, though operating so slowly that over short periods of time their effect is imperceptible, yet in the epochs of the cosmical calendar effected changes so great and complete that the present features of the globe are but a passing incident of a continually shifting scene. Into the arena of these silent world-creating and destroying influences and processes has entered a new-corner—' Radioactivity'—and it has not required long before it has come to be recognised that in the discovery of radioactivity, or rather of the sub-atomic powers and processes of which radioactivity is merely the outward and visible manifestation, we have penetrated one of Nature's innermost secrets.

Whether or no the processes of continuous atomic disintegration bulk largely in the scheme of cosmical evolution, at least it cannot be gainsaid that these processes are at once powerful enough and slow enough to furnish a sufficient and satisfactory explanation of the origin of those perennial outpourings of energy by virtue of which the universe to-day is a going concern rather than a cold, lifeless collocation of extinct worlds. Slow, irresistible, incessant, unalterable, so apparently feeble that it has been reserved to the generation in which we live to discover, the processes of radioactivity, when translated in terms of a more extended scale of space and time, appear already as though they well may be the ultimate controlling factors of physical evolution. For slow processes of this kind do the effective work of Nature, and the occasional intermittent displays of Plutonic activity correspond merely to the creaking now and again of an otherwise silent mechanism that never stops.

It is one of the most pleasing features of this new work that geologists have been among the very first to recognise the applicability and importance of it in their science. I am not competent to deal adequately with or discuss the geological problems that it has raised. But this story would be incomplete if I did not refer, though it must be but briefly, to the labours of Professor Strutt who initiated the movement and to those of Professor Joly who has carried it on. These workers carried out careful analyses of the representative rocks in the earth's crust for the amount of radium they contained.

Absolutely, the quantity of radium in common rocks is of course very small, although with the refined methods now at the disposal of investigators it is quite measurable. The important fact which has transpired, however, is that the rocks examined contain on the average much larger quantities of radium, and therefore necessarily of its original parent uranium, than might be expected. The amount of heat which finds its way in a given time from the interior of the globe to the surface and thence outwards into external space has long been accurately known. Strutt concluded that if there existed only a comparatively thin crust of rocks less than fifty miles thick of the same composition, as regards the content of radium, as the average of those he examined, the radium in them would supply the whole of the heat lost by the globe to outer space. He concluded that the surface rocks must form such a thin crust, and that the interior of the globe must be an entirely different kind of material, free from the presence of radium. Otherwise the world would be much hotter inside than is known to be the case. So far then as the earth is concerned, a quantity of radium less than in all probability actually exists would supply all the heat lost to outer space. So that there is no difficulty in accounting for the necessary source of heat to maintain the existing conditions of temperature on the earth over a period of past time as long as the uranium which produces the radium lasts, that is to say, for a period of thousands of millions of years.

Professor Joly in his Presidential Address to the Geology section of the British Association at Dublin in 1908 has considered in detail the effect of the radium in the rocks of the Simplon Tunnel in producing the unexpectedly high temperatures there encountered, and has come to the conclusion that without undue assumptions it is possible to explain the differences in the temperature of the rocks by the differences in their radium content. He went on to propound a new theory of mountain formation on the lines that local concentrations of radium, brought about by sedimentation, cause local increases of temperature in the earth’s crust. At these places the strength of the crust to stress is weakened, conditioning its upheaval and folding and even over-thrusting for many miles, with the formation of mountain ranges. The rhythmic succession of periods of sedimentation followed by upheaval many times repeated is the common theory of mountain formation. In the concentration of radium in the sedimentary deposit Joly finds a sufficient explanation of and cause for the next subsequent upheaval.

Leaving this globe and taking a survey of the solar system, it has always struck me as remarkable that the temperature of the constituent worlds so far as we know them seems to be roughly in proportion to their size. The moon we regard as quite cold. The Earth and Mars have similar temperatures, while Jupiter and Saturn are probably nearly red-hot. Of course this agrees well enough with the old idea that these bodies were steadily cooling, the process being the slower the greater the mass. But it agrees also with the newer idea that the temperature is probably more or less constant, as the result of an equilibrium in which the heat lost by radiation is counterbalanced by new internal sources of heat provided by slow atomic disintegrations.

With regard to the sun itself, it is certain that the loss of heat cannot be supplied by the presence of radium. For this to be the case a very large part of the sun's mass must consist of uranium, and this we know from the spectroscope is very improbable. Still it is by no means to be concluded that the heat of the sun and stars is not in the first place of internal rather than, as has been the custom to regard it, of external origin. Obviously we are only at the beginning of our knowledge of the internal stores of energy in matter, and the mere fact that these stores existed, and in a few actual cases within our knowledge were slowly evolved and became available for the purposes of cosmical evolution, justified us in regarding them as the probable, as they were certainly the sufficient, first source from which the available energy of all Nature was derived.

There is one other sphere in which these discoveries touch human life strangely into which I cannot forbear altogether from entering, although I am all unfitted to act as guide. Radioactivity has accustomed us in the laboratory to the matter-of-fact investigation of processes which require for their completion thousands of millions of years. In one sense the existence of such processes may be said largely to have annihilated time. That is to say, at one bound the limits of the possible extent of past and future time have been enormously extended. We are no longer merely the dying inhabitants of a world itself slowly dying, for the world, as we have seen, has in itself, in the internal energy of its own material constituents, the means, if not the ability, to rejuvenate itself perennially. It is, of course, true, *upon present existing knowledge*, that the extent of the possible duration of time is merely increased and that on the new scale exactly the same principles apply as before. Yet the increase is so extensive that it practically constitutes a reversal of the older views. At the same time, it will be admitted that physical science can no longer, as at one time she felt justified in doing, impose a definite limit to the continuance of the existing conditions of things. The idea that evolution is proceeding in continuous cycles, without beginning and without end, in which the waste energy of one part of the cycle is transformed in another part of the cycle back into available forms, is at least as possible and conceivable in the present state of knowledge as the older idea, which was based on a too wide application of those laws of the availability of energy we have found to hold within our own experience. It remains for the future to decide whether what happens to be at present our sole experience of the laws of energy does apply, as has hitherto been quite definitely assumed, to the universe as a whole, and to all the conditions therein within which it is impossible for us to perform our experiments. This reservation is one legitimate consequence of the recent ideas, for we have learnt from them how easy it is to give to the generalisations of physical science a universal application they do not in fact possess.

If, then, the world is no longer slowly dying from exhaustion, but bears within itself its own means of regeneration, so that it may continue to exist in much the same physical condition as at present for thousands of millions of years, what about Man? The revelations of radioactivity have removed the physical difficulties connected with the sufficiency of the supply of natural energy, which previously had been supposed to limit the duration of man's existence on this planet, but it adds of itself nothing new to our knowledge as to whether man has shared with the world its more remote history. Here again it is interesting and harmless to indulge in a little speculation, and I may mention one rather striking point.

It is curious how strangely some of the old myths and legends about matter and man appear in the light of the recent knowledge. Consider, for example, the ancient mystic symbol of matter, known as Ouroboros—'the tail devourer'—which was a serpent, coiled into a circle with the head devouring the tail, and bearing the central motto 'The whole is one.' This symbolises evolution, moreover it is evolution in cycle—the latest possibility—and stranger still it is evolution of matter—again the very latest aspect of evolution—the existence of which was strenuously denied by Clerk Maxwell and others of only last century. The idea which arises in one's mind as the most attractive and consistent explanation of the universe in light of present knowledge, is perhaps that matter is breaking down and its energy being evolved and degraded in one part of a cycle of evolution, and in another part still unknown to us, the matter is being again built up with the utilisation of the waste energy. The consequence would be that, in spite of the incessant changes, an equilibrium condition would result, and continue indefinitely. If one wished to symbolise such an idea, in what better way could it be done than by the ancient tail-devouring serpent?

Some of the beliefs and legends which have come down to us from antiquity are so universal and deep-rooted that we are accustomed to consider them almost as old as the race itself. One is tempted to inquire how far the unsuspected aptness of some of these beliefs and sayings to the point of view so recently disclosed is the result of mere chance or coincidence, and how far it may be evidence of a wholly unknown and unsuspected ancient civilisation of which all other relic has disappeared. It is curious to reflect, for example, upon the remarkable legend of the philosopher's stone, one of the oldest and most universal beliefs, the origin of which, however far back we penetrate into the records of the past, we do not seem to be able to trace to its source. The philosopher's stone was accredited the power not only of transmuting the metals, but of acting *as the elixir of life*. Now, whatever the origin of this apparently meaningless jumble of ideas may have been, it is really a perfect and but very slightly allegorical expression of the actual present views we hold to-day. It does not require much effort of the imagination to see in energy the life of the physical universe, and the key to the primary fountains of the physical life of the universe to-day is known to be transmutation. Is then this old association of the power of transmutation with the elixir of life merely a coincidence? I prefer to believe it may be an echo from one of many previous epochs in the unrecorded history of the world, of an age of men which have trod before the road we are treading to-day, in a past possibly so remote that even the very atoms of its civilisation literally have had time to disintegrate.

Let us give the imagination a moment's further free scope in this direction, however, before closing. What if this point of view that has now suggested itself is true, and we may trust ourselves to the slender foundation afforded by the traditions and superstitions which have been handed down to us from a prehistoric time? Can we not read into them some justification for the belief that some former forgotten race of men attained not only to the knowledge we have so recently won, but also to the power that is not yet ours? Science has reconstructed the story of the past as one of a continuous Ascent of Man to the present-day level of his powers. In face of the circumstantial evidence existing of this steady upward progress of the race, the traditional view of the Fall of Man from a higher former state has come to be more and more difficult to understand. From our new standpoint the two points of view are by no means so irreconcilable as they appeared. A race which could transmute matter would have little need to earn its bread by the sweat of its brow. If we can judge from what our engineers accomplish with their comparatively restricted supplies of energy, such a race could transform a desert continent, thaw the frozen poles, and make the whole world one smiling Garden of Eden. Possibly they could explore the outer realms of space, emigrating to more favourable worlds as the superfluous to-day emigrate to more favourable continents. One can see also that such dominance may well have been short-lived. By a single mistake, the relative positions of Nature and man as servant and master would, as now, become reversed, but with infinitely more disastrous consequences, so that even the whole world might be plunged back again under the undisputed sway of Nature, to begin once more its upward toilsome journey through the ages. The legend of the Fall of Man possibly may indeed be the story of such a past calamity.

I cannot fittingly conclude this series of lectures without, however inadequately, directing attention to one further outstanding feature of general interest, which this interpretation of radium will in the course of time bring home to all thoughtful minds.

The vistas of new thought which have opened out in all, directions in the physical sciences, to which man is merely incidental and external, have in turn reacted powerfully upon those departments of thought in which man is central and supreme. I am aware that in this field, concerned with the most profound of all questions — the relation of man to his external environment — it has lately been the custom for the physicist not to intrude. This phase of opinion is perhaps somewhat of the nature of a reaction from the other extreme of an earlier generation, in which science arrogated to itself the right to pronounce the final judgment upon the questions in dispute. At least it will be admitted that if the progress of physical science completely transforms, as it has recently so transformed, our notions of the outer world in which we live, its claim to be heard upon the relations of this world to its inhabitants cannot be resisted. Another reason why perhaps the physicist has hesitated to encroach too directly upon the eternal problems of life has been that he could contribute little of hope or comfort for the race from his philosophy. In the past his conclusions concerning physical evolution and destiny have intensified rather than lightened the existing gloom. To what purpose is the incessant upward struggle of civilisation which history and the biological sciences has made us aware of, if its arena is a slowly dying world, destined to carry ultimately all it bears to one inevitable doom? At least this reason for silence no longer exists. We find ourselves in consequence of the progress of physical science at the pinnacle of one ascent of civilisation, taking the first step upwards out on to the lowest plane of the next. Above us still rises indefinitely the ascent to physical power—far beyond the dreams of mortals in any previous system of philosophy. These possibilities of a newer order of things, of a more exalted material destiny than any which have been foretold, are not the promise of another world. They exist in this, to be fought and struggled for in the old familiar way, to be wrung from the grip of Nature, as all our achievements and civilisation have, in the past, been wrung by the labour of the collective brain of mankind guiding, directing, and multiplying the individual's puny power. This is the message of hope and inspiration to the race which radium has contributed to the great problems of existence. No attempt at presentation of this new subject could be considered complete which did not, however imperfectly, suggest something of this side.

Released as physical science now is from the feeling of hopelessness in dealing with such matters, and at the same time in possession of vast generalisations concerning matter and energy of more than mere abstract significance to the race, it is fitting to attempt to see how far purely physical considerations will take us in delimiting the major controlling influences which regulate our existence.

It is possible, without breaking any of the new ground, to go a long way. Just as you must feed a child at school before it can be educated, as you must provide a man with the possibility of something more than a brute struggle for life before he can be civilised, so generally in the same sense the physical conditions which encircle existence of necessity take precedence over every other consideration. Whatever other aspect of life is considered, and they are many and as yet but little dealt with by science for the most part, the physical aspect comes first, in the sense that if the physical conditions of life are unfavourable, nothing can be expected of any higher aspect.

Surveying the long chequered, but on the whole continuous, ascent of man from primeval conditions to the summit of his present-day powers, what has it all been at bottom but a fight with Nature for energy—for that ordinary physical energy of which we have said so much? Physical science sums up accurately in that one generalisation the most fundamental aspect of life in the sense already defined.

Of course life depends also on a continual supply of matter as well as on a continual supply of energy, but the struggle or physical energy is probably the more fundamental and general aspect of existence in all its forms. The same matter, the same chemical elements, serve the purposes of life over and over again, but the supply of fresh energy must be continuous. By the law of the availability of energy, which, whether universal or not, applies universally within our own experience, the transformations of energy which occur in Nature are invariably in the one direction, the more available forms passing into the waste and useless unavailable kind, and this process, so far as we yet know, is never reversed. The same energy is available but once. The struggle for existence is at the bottom a continuous struggle for fresh physical energy.

This is as far as the knowledge available last century went. What is now the case? The aboriginal savage, ignorant of agriculture and of the means of kindling fire, perished from cold and hunger unless he subsisted as a beast of prey and succeeded in plundering and devouring other animals. Although the potentialities of warmth and food existed all round him, and must have been known to him from natural processes, he knew not yet how to use them for his own purposes. It is much the same to-day. With all our civilisation, we still subsist, struggling among ourselves for a sufficiency of the limited supply of physical energy available, while all around are vast potentialities of the means of sustenance, we know of from naturally occurring processes, but do not yet know how to use or control. Radium has taught us that there is no limit to the amount of energy in the world available to support life, save only the limit imposed by the boundaries of knowledge.

It cannot be denied that, so far as the future is concerned, an entirely new prospect has been opened up. By these achievements of experimental science Man's inheritance has increased, his aspirations have been uplifted, and his destiny has been ennobled to an extent beyond our present power to foretell. The real wealth of the world is its energy, and by these discoveries it, for the first time, transpires that the hard struggle for existence on the bare leavings of natural energy in which the race has evolved is no longer the only possible or enduring lot of Man. It is a legitimate aspiration to believe that one day he will attain the power to regulate for his own purposes the primary fountains of energy which Nature now so jealously conserves for the future. The fulfilment of this aspiration is, no doubt, far off, but the possibility alters somewhat the relation of Man to his environment, and adds a dignity of its own to the actualities of existence."[3383]

## 16.4 The Inertia of Energy

Maxwell's equations implicitly contain the formula $E = mc^2$. Simon Newcomb pioneered the concept of relativistic energy in 1889.[3384] Preston, J. J. Thomson,[3385] Poincaré,[3386] Olinto De Pretto,[3387] Fritz Hasenöhrl,[3388] [etc. etc. etc.] each effectively (Albert Einstein, himself, did not expressly state it in 1905), or directly, presented the formula $E = mc^2$, before 1905, and Max Planck[3389] refined the concept in 1906-1908, including Galileo's,[3390] Huyghens',[3391] Newton's,[3392] Boscovich's,[3393] Schopenhauer's,[3394] Mach's,[3395] Bolliger's,[3396] Geissler's,[3397] Bessel's,[3398] Stas',[3399] Eötvös',[3400] Kreichgauer's,[3401] Landolt's,[3402] Heydweiller's[3403] and Hecker's implications that inertial mass and gravitational mass are equivalent—before Albert Einstein.[3404] Einstein was familiar with Poincaré's 1900 paper, which implicitly contained the formula $E = mc^2$, and which presented the method for synchronizing clocks with light signals that Einstein copied without an attribution.[3405]

With respect to Planck's equation,[3406] G. N. Lewis gave us relativistic mass in 1908,[3407] and in 1909,

> "drew attention to the formula for the kinetic energy
>
> $$\frac{\Upsilon_\eta \ddot{\Upsilon}^\theta}{\gamma\ \Theta\ -\ ^{-\theta}\ \mathrm{H}\ \ddot{\Upsilon}^\theta\ \Delta^{\Theta\mathrm{H}\theta}} - \Upsilon_\eta \ddot{\Upsilon}^\theta$$
>
> and suggested that the last term should be interpreted as the energy of the particle at rest."[3408]

Louis Rougier's *Philosophy and the New Physics*[3409] contains much useful information on this subject. Max Jammer's *Concepts of Mass in Classical and Modern Physics*[3410] is yet more detailed, and Whittaker's *A History of the Theories of Aether and Electricity* in two volumes is phenomenal.

Poincaré, merely reiterating a common conception at the time, stated in 1904,

> "The calculations of Abraham and the experiments of Kaufmann have then shown that the mechanical mass, properly so called, is null, and that the mass of the electrons, or, at least, of the negative electrons, is of exclusively electro-dynamic origin. This forces us to change the definition of mass; we cannot any longer distinguish mechanical mass and electrodynamic mass, since then the first would vanish; there is no mass other than electrodynamic inertia. But, in this case the mass can no longer be constant, it augments with the velocity, and it even depends on the direction, and a body animated by a notable velocity will not oppose the same inertia to the forces which tend to deflect it from its route, as to those which tend to accelerate or to retard its progress."[3411]

Alexander Bain expressly stated in 1870 that,

> "matter, force, and inertia, are three names for substantially the same fact"

and,

"force and matter are not two things, but one thing"

and,

"force, inertia, momentum, matter, are all but one fact".[3412]

For Oliver Heaviside, in 1889, this fact was electromagnetism, the "electric force of inertia."[3413]

Schopenhauer stated the mass energy equivalence in 1819 in his book *The World as Will and Representation*,

> "Force and substance are inseparable, because at bottom they are one; for, as Kant has shown, matter itself is given to us only as the union of forces, that of expansion and that of attraction. Therefore there exists no opposition between force and substance; on the contrary, they are precisely one."[3414]

While discussing Schopenhauer's system, William Caldwell stated in 1893,

> "But some physicists have maintained that matter itself may be reduced to force, and modern psycho-physics has suggested that consciousness may be regarded as only psychical force—a higher kind of force doubtless than the various forms of energy with which we are familiar, but still a force which may be determined both qualitatively and quantitatively."[3415]

Stephen Moulton Babcock stated that the mass of a body was a function of its energy content in 1903, though he claimed that as a body absorbed energy its mass decreased,

> "PROFESSOR Stephen Moulton Babcock, who recently gave the world a new scientific truth in proving, after twenty years of research, that objects vary in weight according to their temperature, thus capped a long career of successful invention and discovery. [***] Scientists, however, have of late been concerned more with Doctor Babcock's recent discovery involving the origin and nature of matter. Always observing and with a mind 'budding and sprouting' with new ideas, Doctor Babcock more than twenty years ago took issue with that feature of the atomic theory which assumes that the atoms of a given element are all precisely alike. His doubts led him into a series of experiments which finally brought him to the surprising conclusion that when a chemical change takes place within a hermetically sealed flask the substances within lose in weight if heat is absorbed in the process and increase in weight if heat is given off.
>
> To test this result on a larger scale and with greater accuracy than had hitherto been possible, Doctor Babcock invented a form of hydrostatic balance which makes it possible to detect a difference of weight in a given substance amounting to only one unit in a hundred million. With such a

balance he found a perceptible difference between the weight of a piece of ice and that of the water resulting from the melting of the same ice.

This change of weight appears to depend solely upon the increase or decrease in the quantity of heat, or, in other words, in the energy inherent in the substance tested, and Doctor Babcock, therefore, summarizes his results in this far-reaching formula: 'The weight of a body is an inverse function of its inherent energy.' In other words, elements in combining or in changing their physical condition change in weight as they change in heat—they grow lighter as they grow hotter, and heavier as they cool. By implication this theory may be extended to include all matter, and if further experiments justify such a daring generalization we may go a step further and assume that, by a sufficient increase in the inherent energy of what we call matter, its weight, and therefore its mass—for weight is but a measure of mass—will entirely disappear.

If these revolutionary views can maintain themselves against the criticism which they are certain to arouse they may be justly said to constitute one of the greatest of scientific generalizations. It is an interpretation of the law of gravitation and, indeed, stands next to it in importance. The physical theory that all interstellar space is filled with ether, to which is attributed the properties of infinite energy and of absolute lack of weight, is corroborated by Doctor Babcock's theory: 'Since, when the energy stored upon any given atom is increased, its weight is thereby diminished, and infinite energy means of necessity zero weight.'"[3416]

Frederick Soddy stated in 1904,

"The work of Kaufmann may be taken as an experimental proof of the increase of apparent mass of the electron when its speed approaches that of light. Since during disintegration electrons are expelled at speeds very near that of light, which, after expulsion, experience resistance and suffer diminution of velocity, the total mass must be less after disintegration than before. On this view atomic mass must be regarded as a function of the internal energy, and the dissipation of the latter in radio-activity occurs at the expense, to some extent at least, of the mass of the system".[3417]

Thomson defined the inertia of his vortex atom based on its energy content. A. E. Dolbear wrote in this context that,

"*Hence, inertia, too, must be looked upon as probably due to motion*",

and,

"It is not *simply* an amount of material, but the *energy* the material has, which gives it its characteristic properties."[3418]

Sir Oliver Lodge wrote,

> "[The theory of relativity] attributes inertia to energy (not for the first time)."[3419]

Boscovich claimed that inertia is a relative quantity, and is not absolute.[3420] The pantheist John Toland argued that energy is essential to matter in his *Letters to Serena* in 1704.[3421] These same concepts are to be found in Heraclitus and in Aristotle, for example,

> "Wherefore, it is evident, that substance and form are each of them a certain energy. And therefore, according to this reasoning, it is evident that in substance energy is prior to potentiality. And, as we have stated, one energy invariably is antecedent to another in time, up to that which is primarily and eternally the moving cause."[3422]

## 16.5 The Einsteins' Energy Fudge

Herbert Ives published a paper in 1952, which argued that Einstein employed the irrational method of *Petitio Principii* in "deriving" the mass-energy equivalence in 1905. This evinces a repeated pattern of Einstein's irrationality, on top of his pattern of unoriginality, each signifying one goal—plagiarism,

> "In 1905 Einstein published a paper with the interrogatory title 'Does the Inertia of a Body Depend upon its Energy Content?', [A. Einstein, Ann. Physik **18**, 639 (1905).] a question already answered in the affirmative by Hasenöhrl. This paper, which has been widely cited as being the first proof of the 'inertia of energy as such,' describes an emission process by two sets of observations, in different units, the resulting equations being then subtracted from each other. It should be obvious *a priori* that the only proper result of such a procedure is to give 0 = 0, that is, no information about the process can be so obtained. However the fallacy of Einstein's argument not having been heretofore explicitly pointed out, the following analysis is presented: [***] What Einstein did by setting down these equations (as 'clear') was to *introduce* the relation
>
> $$L/(m - m')c^2 = 1.$$
>
> *Now this is the very relation the derivation was supposed to yield*. It emerges from Einstein's manipulation of observations by two observers because it has been slipped in by the assumption which Planck questioned. The relation $E = m_M c^2$ was not derived by Einstein."[3423]

Following Ives, Max Jammer wrote that,

"the mass of the body relative to $S$, before and after the emission,

$$T'_0 = m_0 c^2 \left[ \frac{1}{(1 - v^2/c^2)^{1/2}} - 1 \right] \tag{7}$$

and

$$T'_1 = m_1 c^2 \left[ \frac{1}{(1 - v^2/c^2)^{1/2}} - 1 \right]. \tag{8}$$

Einstein now mistakenly put $E_0{}' - E_0$ equal to $T_0{}' + C$ ($C$ is a constant) and $E_1{}' - E_1$ equal to $T_1{}' + C$, and thus obtained by subtraction and in virtue of Eq. (6),

$$T'_0 - T'_1 = E \left[ \frac{1}{(1 - v^2/c^2)^{1/2}} - 1 \right] \tag{9}$$

[. . .]whereas, in view of Eqs. (7) and (8) he should have obtained

$$T'_0 - T'_1 = (m_0 - m_1) c^2 \left[ \frac{1}{(1 - v^2/c^2)^{1/2}} - 1 \right], \tag{11}$$

[. . .]we see that Einstein unwittingly assumed that

$$\frac{E}{(m_0 - m_1) c^2} = 1, \tag{14}$$

which is exactly the contention to be proved."[3424]

Lloyd S. Swenson, Jr. wrote,

"Curiously, Einstein's own first derivation of the famous formula $E = mc^2$ was incorrect in the sense of begging the question of what was to be proved. Growing out of Einstein's subliminal obsession with the operational meaning of the constancy of the velocity of light, the mass-energy equivalence

$$m = \frac{E}{c^2}$$

had been assumed in interior calculations as

$$\frac{E}{m c^2} = 1$$

and thus the equivalences

$$E = m c^2$$

$$\frac{E}{c^2} = m$$

and

$$\sqrt{E/m} = c$$

were embedded in the premises, therefore predetermined in the conclusion. Though right for the wrong reasons at first, Einstein caught his mistakes and redressed his deductions in further publications in 1906 and 1907."[3425]

## 16.6 Hero Worship

Webster's New World Dictionary defines "relativity" as, *inter alia*,

> "4. *Physics* the fact, principle, or theory of the relative [***] as developed and mathematically formulated by Albert Einstein and H. A. Lorentz in the **special** (or **restricted**) **theory of relativity**".[3426]

Grolier's *Encyclopedia International*, states, under "Relativity, Theory of", as follows,

> "To explain this paradoxical result, G. F. FitzGerald and, independently, H. A. Lorentz suggested that the effect of the ether flow on the speed of light was masked by a contraction of the measuring apparatus caused by its motion through the ether. But J. H. Poincaré and Einstein independently realized that, since all efforts to detect the earth's absolute motion had failed, the principle of relativity must somehow be valid after all, despite the ether."[3427]

Subsequent to learning of FitzGerald's prior work, Lorentz never failed to acknowledge that FitzGerald had anticipated him, unlike Albert Einstein, who failed to cite Poincaré's work, which we know Einstein had read before 1905, in the Einsteins' 1905 paper, or in any of the expositions on the subject which Einstein later published in 1907, 1910, 1911, 1912 or 1916. Poincaré published his conclusions in 1895, ten years before Einstein, and repeated them often in widely read books and journals.

We know, from Solovine's accounts,[3428] that Einstein had extensively read

Poincaré. Poincaré first stated the principle of relativity ten years before Mileva and Albert, who then parroted one version of Poincaré's principle in almost identical form in 1905, and certainly not "independently". The Einsteins copied Poincaré's clock synchronization with lights signals procedure virtually verbatim, as well as his exposition on relative simultaneity and we know that Albert had read Poincaré's explanations before copying them without an attribution.

Why is Albert Einstein's name associated with the "principle of relativity", and not Poincaré's? Poincaré stated it first, ten years before the Einsteins, and the Einsteins copied it from him.

Who is to blame for this injustice? What could possibly motivate them, other than ethnic bias, ethnic guilt, self-doubt and/or hero worship? The facts are clear to all who are willing to look. Albert Einstein did not originate the special theory of relativity. That is clear.

Grolier's *Encyclopedia International* states under "Poincaré, Jules Henri",

> "In 1905 Poincaré showed that Maxwell's equations suggested a theory different from classical Newtonian mechanics. He thus anticipated an aspect of the theory of relativity derived independently by Einstein in the same year."[3429]

Poincaré, Lorentz, Larmor, Langevin, FitzGerald, Lange and Voigt anticipated Einstein on all important aspects of the theory.

Grolier's *Encyclopedia International* states in its article "Lorentz, Hendrik Antoon",

> "By extending Maxwell's electromagnetic theory of light, [Lorentz] incorporated many phenomena that it so far had failed to explain—in particular, the optical and electrical phenomena associated with moving bodies. His name is most widely known for the Lorentz contraction (or the Lorentz-Fitzgerald contraction), which says that a body moving with a velocity near that of light contracts in the direction of its motion. This forms an important part of the special theory of relativity."[3430]

The facts stated together record that, as Whittaker stated,

> "Einstein published a paper which set forth the relativity theory of Poincaré and Lorentz with some amplifications, and which attracted much attention. He asserted as a fundamental principle the *constancy of the velocity of light*, i.e. that the velocity of light *in vacuo* is the same in all systems of reference which are moving relatively to each other: an assertion which at the time was widely accepted, but has been severally criticized by later writers."

Instead of proving that Einstein was a pioneer, the facts indicate that, as Max Born stated,

> "[Einstein's] paper 'Zur Elektrodynamik bewegter Körper' in *Annalen der Physik* [***] contains not a single reference to previous literature. It gives you the impression of quite a new venture. But that is, of course, [***] not true."

Since Poincaré and Lorentz developed the theory, why aren't their names not only linked to the theory, but universally linked together? What makes the image of "Einstein" so sacrosanct, that it is today virtually a crime to tell the truth about the history of the special theory of relativity? Why, in the majority of the histories of the special theory of relativity, isn't Einstein, with his minor contribution of the relativistic equations for aberration and the Doppler-Fizeau effect (together with his many blunders), the curious footnote of a persistent copycat, and not the central theme? Certainly, it is more convenient to briefly credit Einstein with everything, but, since the ideas are considered so significant, one would think the originators deserve their due credit.

Many people knew that Einstein did not hold priority for much of what he wrote. Einstein, himself, was keenly aware of it. R. S. Shankland stated,

> "About publicity Einstein told me that he had been *given* a publicity value which he did not *earn*. Since he had it he would use it if it would do good; otherwise not."[3431]

Einstein stated on 27 April 1948,

> "In the course of my long life I have received from my fellow-men far more recognition than I deserve, and I confess that my sense of shame has always outweighed my pleasure therein."[3432]

Einstein told Peter A. Bucky,

> "Peter, I fully realize that many people listen to me not because they agree with me or because they like me particularly, but because I am Einstein. If a man has this rare capacity to have such esteem with his fellow men, then it is his obligation and duty to use this power to do good for his fellow men."[3433]

It is not uncommon for grandiose myths to accrue to overly idealized popular figures, including Albert Einstein. Theoretical Physics, as a field, was small, and not well known in the period from 1905-1919. Theoretical physicists were not well known, and, since those in the field knew that Einstein was a plagiarist, they largely ignored him.

In 1919, (on dubious grounds[3434]) Dyson, Davidson and Eddington, made Einstein internationally famous by affirming that experiment had confirmed, without an attribution to Soldner, Soldner's 1801 hypothesis, that the gravitational field of the sun should curve the path of light from the stars.[3435] Shortly after that, Einstein won the Nobel Prize, though it is unclear why he won it, other than as a reward for his new-found fame for reiterating Soldner's ideas, and for his pacificist stance during the First World War.

Einstein did not invent the atomic bomb. In fact, he was ignorant of the concepts behind the bomb. However, with the help of Alexander Sachs, Einstein was asked to sign a letter to President Roosevelt urging him to instigate what would eventually become the "Manhattan Project", the effort to develop an atomic bomb before the Nazis. Due to his ignorance, Leo Szilard and Eugene Wigner had to explain the concepts of the atomic bomb to Einstein, before he would sign the letter.[3436]

Einstein stated on 20 September 1952,

> "My part in producing the atomic bomb consisted in a single act: I signed a letter to President Roosevelt, pressing the need for experiments on a large scale in order to explore the possibilities for the production of an atomic bomb."[3437]

Note that Einstein signed, but did not write, the letter; and that his only contribution to the development of the bomb was his signature.

Given Einstein's rôle as a spokesperson for those who knew of the concept of the bomb, one may wonder, did Einstein frequently become the political toy of others? Consider Joffe's description of the man,

> "Einstein's thoughts were far away from political problems and this is why many of Einstein's speeches in this field were poorly thought out. For example: Once in the late twenties, a group of German scientists published an anti-Soviet appeal at the end of which I found Einstein's signature. When I showed this to him, and asked why he did it, he answered that he did not think about it, but he signed it because Planck telephoned him. I asked Einstein if he is on the side of Prussian capitalism in this fight for the new socialistic state against the old. And he replied, 'Of course not, I would not have signed it if I knew about the consequences. In the future, I will not participate in any political movements without consulting you.' And also, in my opinion, Einstein's support of Zionism was ill-conceived. His wife even convinced him to participate in a concert, which Zionists had organized in a synagogue. And one more example is Einstein's fascination with the American idea of a 'single state', which idea in essence was created in order to discredit each nation's movement toward independence, and to make it easier for big and rich countries to take over and exploit small ones. And Einstein, in the beginning, would only look at the façade of things and not look deeper into their true meaning."[3438]

Einstein, according to Joffe, was political "play dough".

On 15 March 1921, Kurt Blumenfeld warned Chaim Weizmann that it would be unwise to let Einstein make speeches during his trip to America on behalf of the Zionists,

> "Einstein is a poor speaker and often says things out of naiveté that are unwelcome to us[.]"[3439]

In December of 1930, the National German-Jewish Union told Einstein to stop prostituting science for his political agenda and to stop stereotyping Jewish people with his bigoted segregationalist Zionist nationalism.[3440] Einstein was forced to defend himself after World War II from the charges of Jewish anti-Zionists that his Zionism was destructive nationalism.[3441]

Why was Einstein, who had not known of, or understood, the concept of an atomic bomb, chosen to write to the President of the United States in an effort to persuade him to pursue research to make one? Was the popular image of the man far more potent than his mind?

When said program to develop an atomic bomb began, Einstein was not asked to participate, but rather was excluded from the research team. Why was Einstein, supposedly the most brilliant human being of all time, not a member of the team which developed the bomb, and upon whose work the fate of all of humanity might rest? Did Oppenheimer know that Einstein lacked the abilities needed to contribute to the research? It was apparently enough that Einstein's celebrity was exploited to draw attention to the need for research. That was Einstein's only rôle in the development of the atomic bomb. His ideas were not welcomed.

Einstein stated in 1945,

> "I do not consider myself the father of the release of atomic energy. My part in it was quite indirect. I did not, in fact, foresee that it would be released in my time. I believed only that it was theoretically possible. It became practical through the accidental discovery of chain reaction, and this was not something I could have predicted. It was discovered by Hahn in Berlin, and he himself misinterpreted what he discovered. It was Lise Meitner who provided the correct interpretation, and escaped from Germany to place the information in the hands of Niels Bohr. [***] I am not able to speak from any firsthand knowledge about the development of the atomic bomb, since I do not work in this field."[3442]

Otto Hahn's work was the critical factor in the development of the atomic bomb. Hahn considered Lise Meitner a minor figure—though she and Niels Bohr did work against Germany and assisted the Allies to develop the bomb, not so much as scientists, but rather as spies who betrayed Otto Hahn and Werner Heisenberg. In 1944, Otto Hahn won the Nobel Prize "for his discovery of the fission of heavy nuclei". It was a chemist, not a physicist, who let the genie out of the bottle.

## 16.7 Conclusion

How has the popular history become so corrupted as to ignore these facts? Why do we feel the need to perpetuate the comic book legend of "Einstein", as if he were the great discoverer of all physical truths? Einstein did not invent, nor predict the atomic bomb. Einstein did not derive or originate the formula $E = mc^2$. The awesome image of a thermonuclear explosion is spuriously used to promote Einstein as the god who supposedly unlocked the secrets of the atom, which he did not do. This is well known in the Physics community and yet the media continue to misinform the public about these facts just as they continue to that Einstein created the theory of relativity and was the first person to propose the idea of space-time. What motivates them to misinform the public? Why are the voices of those who tell the truth generally suppressed?

**and** T. H. Green and A. C. Bradley, "Can there be a Natural Science of Man?", *Mind*, Volume 7, Number 27, (July, 1882), pp. 321-348.T. H. Green, *Prolegomena to Ethics*, Clarendon Press, Oxford, (1883). ***Criticisms are found in:*** S. Pringle-Pattison, Hegelianism and Personality, W. Blackwood, Edinburgh, London, (1887); **and** E. B. McGilvary, "The Eternal Consciousness", *Mind*, New Series, Volume 10, Number 40, (October, 1901), pp. 479-497.

**3353**. Quoted in S. Clarke, *A Demonstration of the Being and Attributes of God And Other Writings*, Edited by Ezio Vailati, Cambridge University Press, (1998), p. 33.

**3354**. S. Clarke, "A Demonstration of the Being and Attributes of God", Proposition 5, *The Works of Samuel Clarke, D. D. Late Rector of St James's Westminster*, Volume 2, Third Sermon, John and Paul Knapton, London, (1738), pp. 539-540.

**3355**. D. Hartley, "Of the Being and Attributes of God, and of Natural Religion", *Observations on Man, His Frame, His Duty, and His Expectations in Two Parts*, Volume 2, Chapter 1, Printed by S. Richardson for James Leake and Wm. Frederick, booksellers in Bath and sold by Charles Hitch and Stephen Austen, booksellers in London, London, (1749), pp. 5-70, at 28.

**3356**. G. Teichmüller, *Die wirkliche und die scheinbare Welt: neue Grundlegung der Metaphysik*, W. Koebner, Breslau, (1882).

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