THE ETERNAL SOURCE OF ENERGY OF THE UNIVERSE, ORIGIN AND INTENSITY OF COSMIC RAYS *

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A little over one century ago many astronomers, including Laplace still thought that the system of heavenly bodies was unalterable and that they would perform their motions in the same manner through an eternity. But the gradual perfection of instruments and refinement of methods of investigation, achieved since that time, has led to the recognition that there is a continuous change going on in the celestial regions subjecting all bodies to ever varying influence. Where this change is leading to, and what is to be its final phase, have become questions of supreme scientific interest. In a communication to the Royal Society of Edinburgh dated April 19, 1852 and the Philosophical Magazine of October of the same year, Lord Kelvin drew attention to the general tendency in nature towards dissipation of mechanical energy, a fact borne out in daily observation of thermo-dynamic and dynamo-thermic processes and one of ominous significance. It meant that the driving force of the universe was steadily decreasing and that ultimately all of its motive energy will be exhausted none remaining available for mechanical work. In the macro-cosmos, with its countless conception, this process might require billion of years for its consummation; but in the infinitesimal worlds of the micro-cosmos it must have been quickly completed. Such being the case then, according to an experimental findings and deductions of positive science, any material substance (cooled down to the absolute zero of temperature) should be devoid of an internal movement and energy, so to speak, dead.

This idea of the great philosopher, who later honored me with his friendship, had a fascinating effect on my mind and in meditating over it I was struck by the thought that if there is energy within the substance it can only come from without. This truth was so manifest to me that I expressed it in the following axiom: "There is no energy in matter except that absorbed from the medium." Lord Kelvin gave us a picture of a dying universe, of a clockwork wound up and running down, inevitably doomed to come to a full stop in the far, far off future. It was a gloomy view incompatible with artistic, scientific and mechanical sense. I asked myself again and again, was there not some force winding up the clock as it runs down? The axiom I had formulated gave me a clue. If all energy is supplied to matter from without then this all important function must be performed by the medium. Yes--but how?

I pondered over this oldest and greatest of all riddles of physical science a long time in vain, despairingly remind of the words of the poet:

> Wo fass ich dich unendliche Natür?
> Euch Bruste wo Ihr Quellen alles Lebens
> An denen Himmel und Erdë hangt. . .

> Where, boundless nature, can I hold you fast?
> And where you breasts? Wells that sustain
> All life--the heaven and the earth are nursed.
> Goethe. Faust

What I strove for seemed unattainable, but a kind fate favored me and a few inspired experiments lifted the veil. It was a revelation wonderful and incredible explaining many mysteries of nature and disclosing as in a lightening flash the illusionary character of some modem theories incidentally also bearing out the universal truth of the above axiom.

When radio-active rays were discovered their investigators believed them to be due to liberation of atomic energy in the form of waves. This being impossible in the light of the preceding I concluded that they were produced by some external disturbance and composed of electrified particles. My theory was not seriously taken although it appeared simple and plausible. Suppose that bullets are fired against a wall. Where a missile strikes the material is crushed and spatters in all directions radial from the place of impact In this example it is perfectly clear that the energy of the flying pieces can only be derived from that of the bullets. But in manifestation of radio-activity no such proof could be advanced and it was, therefore, of the first importance to demonstrate experimentally the existence of this miraculous disturbance in the medium. I was rewarded in these efforts with quick success largely because of the efficient method I adopted which consisted in deriving from a great mass of air, ionized by the disturbance, a current, storing its energy in a condenser and discharging the same through an indicating device. This plan did away with the limitations

and incertitude of the electroscope first employed and was described by me in articles and patents from 1900 to 1905. It was logical to expect, judging from the behavior of known radiations, that the chief source of the new rays would be the sun, but this supposition was contradicted by observations and theoretical considerations which disclosed some surprising facts in this connection.

Light and heat rays are absorbed in their passage through a medium in a certain proportion to its density. The ether, although the most tenuous of all substances, is no exception to this rule. Its density has been first estimated by Lord Kelvin and conformably to his finding a column of one square centimeter cross section and of a length such that light, traveling at a rate of three hundred thousands kilometers per second, would require one year to traverse it, should weigh 4.8 grams. This is just about the weigh of a prism of ordinary glass of the same cross section and two centimeters length which, therefore, may be assumed as the equivalent of the ether column in absorption. A column of the ether one thousand times longer would thus absorb as much light as twenty meters of glass. However, there are suns at distances of many thousands of light years and it is evident that virtually no light from them can reach the earth. But if these suns emit rays immensely more penetrative than those of light they will be slightly dimmed and so the aggregate amount of radiations pouring upon the earth from all sides will be overwhelmingly greater than that supplied to it by our luminary. If light and heat rays would be as penetrative as the cosmic, so fierce would be the perpetual glare and so scorching the heat that life on this and other planets could not exist.

Rays in every respect similar to the cosmic are produced by my vacuum tubes when operated at pressures of ten millions of volts or more, but even if it were not confirmed by experiment, the theory I advanced in 1897 would afford the simplest and most probable explanation of the phenomena. Is not the universe with its infinite and impenetrable boundary a perfect vacuum tube of dimensions and power inconceivable? Are not its fiery suns electrodes at temperatures far beyond any we can apply in the puny and crude contrivances of our making? Is it not a fact that the suns and stars are under immense electrical pressures transcending any that man can ever produce and is this not equally true of the vacuum in celestial space? Finally, can there be any doubt that cosmic dust and meteoric matter present an infinitude of targets acting as reflectors and transformers of energy? If under ideal working conditions, and with apparatus on a scale beyond the grasp of the human mind, rays of surpassing intensity and penetrative power would not be generated, then, indeed, nature has made an unique exception to its laws.

It has been suggested that the cosmic rays are electrons or that they are the result of creation of new matter in the interstellar deserts. These views are too fantastic to be even for a moment seriously considered. They are natural outcroppings of this age of deep but unrational thinking, of impossible theories, the latest of which might, perhaps, deal with the curvature of time. What this world of ours would be if time were curved:

As there exists considerable doubt in regard to the manner in which the intensity of the cosmic rays varies with altitude the following simple formula derived from my early experimental data may be welcome to those who are interested in the subject.

$$I = (W+P) / (W+p)$$

In this expression W is the weight in kilograms of a column of lead of one square centimeter cross section and one hundred and eighty centimeters length, P the normal pressure of the atmosphere at sea level in kilograms per square centimeter, p the atmospheric pressure at the altitude under consideration and in like measure and I the intensity of the radiation in terms of that at sea level which is taken as unit. Substituting the actual values for W and P, respectively 1.9809 and 1.0133 kilograms, the formula reduces to

$$I = 2.99421 / (1.9809 + p)$$

Obviously, at sea level p = P hence the intensity is equal to 1, this being the unit of measurement. On the other hand, at the extreme limit of the atmosphere p = 0 and the intensity I = 1.5115.

The maximum increase with height is, consequently, a little over fifty-one percent. This formula, based on my finding that the absorption is proportionate to the density of the medium whatever it be, is fairly accurate. Other investigators might find different values for W but they will undoubtedly observe the same character of dependence, namely, that the intensity increases proportionately to the height for a few kilometers and then at a gradually lessening rate.

* Tesliana, spec. edition, Belgrade, YU, 1995., p. 56 - 59.