Definite Proof for the Conversion of vacuum-energy into mechanical energy based on the measurement of machine power

by Claus Turtur and Wolfram Knapp Wolfenbüttel, 2009 – April – 02

Abstract

In some recent work the existence of the dark energy of the universe, also known as vacuum-energy, was investigated theoretically [1,2] and experimentally [3,4], resulting in the possibility to convert this energy into mechanical energy within the laboratory. A rotor within an electrical field was propelled by vacuum-energy, whereby ideally no electrical energy from the field-source should be used.

A final proof that the observed rotation of the rotor is really based on vacuum-energy, is established for sure, as soon as the produced mechanical engine power of the rotor is larger, than the electrical power losses, which occur because of imperfections of the electrical isolation within the machine converting vacuum-energy. Such imperfections of the isolation cause a discharge of the source of the electrical field, which has to be compensated in the real setup of an experiment in order to avoid that the field will disappear in the course of time.

This proof was brought with the experiment reported here, whereby an electrical power loss of $P_{el} = (2.87 \pm 0.89) \cdot 10^{-9} Watt$ is seen in comparison with a produced mechanical engine power of approx. $P_{mech} \approx (1.5 \pm 0.5) \cdot 10^{-7} Watt$, so that at least the difference of $P_{mech} - P_{el}$ is taken from vacuum-energy for sure.

(1.) Basics

The existence of the vacuum-energy is nowadays generally accepted. It is verified by measurements of the expansion of the universe within physical cosmology [5,6,7,8]. This type of verification of the vacuum-energy is based on the gravitation caused by the mass connected with the vacuum-energy, since energy is equivalent to mass.

In the Theory of General Relativity, as the modern theory of the gravitation, the gravitative effect of vacuum-energy results in the cosmological constant Λ [9,10,11]. Although the existence of the vacuum-energy is proven, its energy-density is still unclear today. The value of the energy-density is regarded as the largest discrepancy in modern physics. As an average over several literature references of cosmology, the energy-density can be estimated at about $(9.0 \pm 0.27) \cdot 10^{-10} J/m^3$, whereas in Geometrodynamics a value of $2\hbar c \pi^2 \cdot L_P^{-4} = 3.32 \cdot 10^{+113} J/m^3$ is suspected [12]. However the latter value is calculated by an integration over all wavelengths of the quantum mechanical zero point oscillations within the vacuum (these are infinitesimally many), whereby divergence problems are suppressed simply by the means of cut-off radii. Several other approaches to suppress the divergence problems of these improper integrals (leading to the energy density) result in further other values for the energy-density of the vacuum [13,14], but they do not solve the problem of the ambiguity.

At least the existence of vacuum-energy is beyond dispute, so that it should be possible to verify this energy in the laboratory. That is indeed the case. Two possible ways to this proof have been developed, namely for a metallic rotor in the electrostatic field in [15] and for a superconducting rotor in the magnetic field in [16]. Since the work presented here is based on the first mentioned method, this one is briefly recapitulated in the following lines.
In Fig. 1 a metallic disk (so-called field-source, drawn in red) is electrically charged and thus it produces an electrostatic field, which interacts with the rotor (in blue drawn colour), causing an attractive force, which can be computed with simple elementary methods of classical electrodynamics, namely with the image-charge-method [17,18]. This force is well-known, it is the same force, with which an electrostatically charged plastic ruler attracts paper confetti as everybody knows from childhood. An

other way to understand this attractive force is, to regard the field-source and the rotor as opposite plates of a capacitor, which are known to attract each other. But the crucial point is, that the capacitor plates are not parallel to each other, so that the force-vectors are somehow diagonal relatively to the flux-lines of the field. Consequently there is a component of the force exerting a torque onto the rotor, resulting in a rotation as soon as the bearing allows the capacitor plates (which are the rotor blades) to rotate.

The trick is now: During the rotating the distance between the blue and the red capacitor plate does not change at all, so that the rotation should be continued endlessly, as long as the capacitor is electrically charged. In fact this rotation is actually proven experimentally in [19]. The fact that the experiment of [19] was carried out in air, led to doubts of physicist colleagues, who reminded that the rotation could be produced by the recoils of ionized gas-molecules of the surrounding air [20,21], because the voltage between the field-source and the rotor can sometimes reach several 10kV. In order to exclude this argument, the experiment was transferred into the vacuum, in order to avoid gas ions and their recoils - and the rotor rotated in the vacuum, without being driven by gas ions [4].

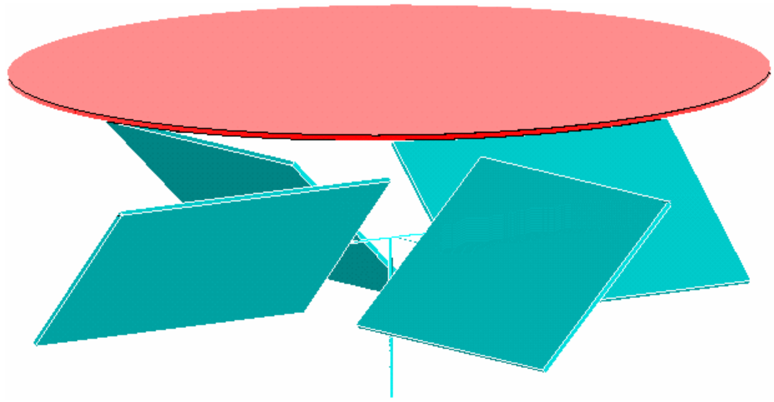

Fig. 1:
Sketch of the principle of the experimental setup of an electrostatic rotor for the conversion of vacuum-energy into classical mechanical energy.
Red: The field-source
Blue: The rotor

The fact that the rotor is really driven by a part of the vacuum-energy, namely by the energy of quantum-electro-dynamic zero point oscillations of electromagnetic waves, is substantiated in [22] theoretically. In addition, theoretical analyses of other colleagues [23,24,25,26,27,28] support the possibility of such a conversion of vacuum-energy.

Nevertheless a certain risk might exist, that some electric charge could flow off from the field-source into the rotor and thus drive the rotor. But it is not necessary to analyse all imaginable types of artefacts driving the rotor with classical electrical energy. The better way is to exclude all types of artefacts which might bring the energy to drive the rotor. This is what we did now with a measurement of the electrical power loss of the HV-supply (inevitable in the real existing setup of an experiment) and comparing this power with the mechanical engine power produced by the rotor. As soon as this electrical power loss is smaller than the mechanical engine power of the rotor, it is clear undoubtedly, that the mechanical drive of the rotor is coming from vacuum-energy. At least that portion of the engine power, by which the mechanical power is larger than the electrical power loss is for sure converted from the vacuum-energy, because there is no other source of energy in contact with the rotor. This experimental proof is now done successfully. It is described in the following chapters.

(2.) The experimental setup

For practical reasons the operation of the electrostatic rotor requires the difficult adjustment of several experimental parameters. On of them, which is very critical for the occurrence of the rotation at all, is the adjustment of the rotor's axis in the minimum of the electrostatic potential under the field-source, which is particularly critically, if the rotor shall spin inside a metallic chamber with electrically conducting walls, such as inside a vacuum chamber, because the metal walls affect the flux-lines of the electric field remarkably (as observed in [4,19]). The most easy and effective way to avoid, that this disturbance of the flux-lines will prevent the rotor from spinning at all, is the utilization of a so-called „self-adjusting-mechanism", which is based on the fact that a rotor swimming on the surface of a liquid has more degrees of freedom than necessary for the mere rotation, namely the rotor can move laterally (horizontally) beyond the field-source. And this degree of freedom is utilized with the aid of the attractive Coulomb forces, which pull the rotor into the minimum of the electric potential made by the field-source. Thus the adjustment of the rotor-axis is done self-actuating perfectly. Even asymmetries of the vacuum chamber (such as resulting from welded tubes and flanges) do not prevent the „self-adjusting-mechanism“ from working safely. This is the reason why we decided to use the swimming rotor on the surface of a liquid as shown in Fig. 2. But it is necessary to use a liquid with a vapour pressure as low as possible. We found an used a special vacuum-oil (Type: „Ilmvac, LABOVAC-12S“) with a vapour pressure of $10^{-8}\,mbar$. Unfortunately this vacuum-oil has a rather large dynamic viscosity of $\eta = 94\,milli\,Poise$ (at 40°C according to manufacturer data) which had to be accepted although it makes the rotation very slow. But this disadvantage of the oil made it necessary to have a low weight rotor swimming with very small forces of friction. This is the reason, why the rotor was a lightweight construction as shown in Fig. 2. The rotor blades, which are made of very this aluminium are mounted inside a plastic tub with very thin walls, swimming on the oil like a boat. Cavities are avoided, in order to avoid problems with the vacuum.

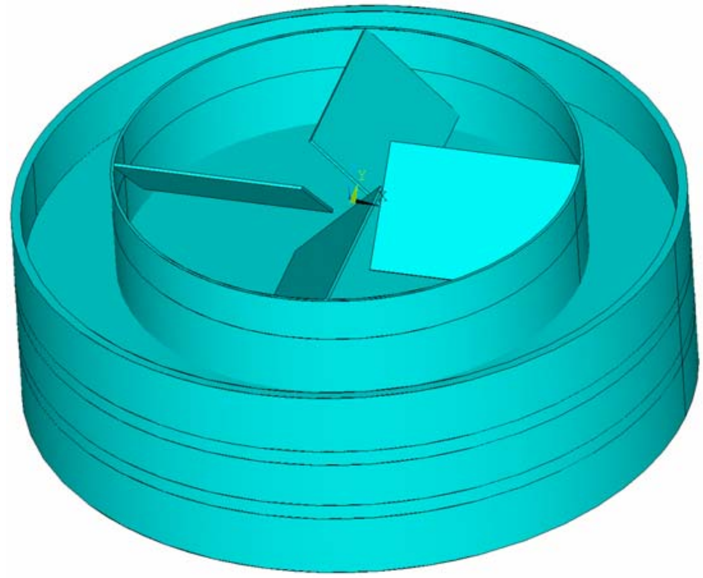

Fig. 2:
Electrostatic rotor in a thin-walled plastic floating body as a lightweight construction (walls: 230µm thick poly-propylene, rotor blades: 70 µm thick aluminium), which can move one the surface of the oil because of it low weight. The total diameter of the rotor tub is 64 mm. It is swimming in an oil container with an outer diameter of 97 mm. Sharp metallic edges are protected and rounded by an isolating sealing in order to prevent the emission of electrically charged particles due to large electric field strength at the edges (which has been important at pre-tests under air).

Rotor and field-source have been put together with a cylindrical oil container of a diameter of 9.7 cm into a vacuum chamber with a diameter of a bit more than 10 cm as can be seen in Fig. 3.

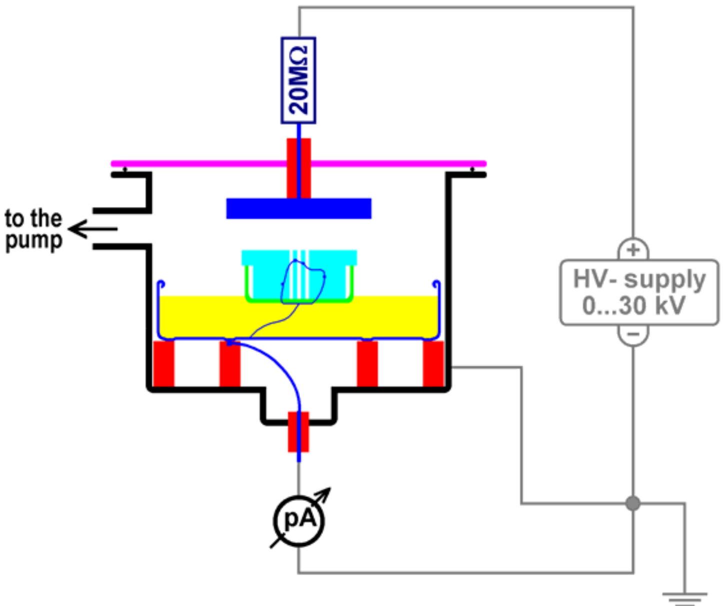

Fig. 3:
The vacuum chamber with the oil container and the rotor for the conversion of vacuum-energy. The bearing of the rotor is: swimming on oil, enabling the self-adjusting-mechanism of the rotor relatively to the field-source.
Electrically conducting components are drawn in blue, ceramic isolators in red. For further details please see the text below. The pressure under which the measurements have been performed has been $4...5 \cdot 10^{-4}\,mbar$, which turned out to be sufficient for the required proof of the engine power.

Inside the vacuum chamber (made of high-grade steel, drawn in black colour, the acrylic glass of the top flange in violet colour) there is an aluminium tub (blue) with vacuum oil (yellow). The polypropylene floating body (green) is swimming on the oil, carrying the aluminium rotor, which consists of four rotor blades (light blue). The rotor blades are electrically connected by copper filaments (dark blue, diameter 30 µm) with each another and with the bottom of the oil container. The oil container and the rotor are electrically insulated with ceramic insulators (red) against the vacuum chamber. Every electrical charge taken up by the rotor has to flow through the Pikoamperemeter Keithley 486 („pA ") and is detected there. With a well-known value of the high voltage (grey, equipment „Bertan ARB 30 ") the electrical power taken by the rotor is determined (if there is such power at all).
The electrostatic field for the drive of the rotor is produced by the field-source made of aluminium (dark blue), which is mounted at the top flange held by a ceramic isolator. In order to avoid a damage of the Pikoamperemeter in the case of electric breakthrough, a resistor of 20 megaohms is put between the electric power supply and the field-source. In the real measurement 20 megaohms is such small resistor (in comparison with the disconnection between field-source and rotor), that it will not be noticed at all.

Only if the experimentation parameters are adjusted properly, the rotor begins to spin as soon as the high voltage is switched on – if the torque which the rotor takes up inside the electric field is strong enough to surmount the friction of the oil. Actually there is a threshold, which must be exceeded by the torque, so that the rotor can begin to spin. (Obviously the oil behaves like a thixotropic fluid.)
As soon as the rotor spins, the goal of the measurement is the following:

On the one hand the mechanical engine power (produced by the rotor) has to be determined; on the other hand the electrical power loss has to be determined, which is inevitable in a real existing setup because of practical reasons. At least some very small creepage or leakage currents result in a loss of electrical charge on the field-source, and this amount of charge being lost has to be replaced in order to keep the electric field constant. Of course in the case of ideal isolation, no electric charge would be lost and thus no electrical power loss would arise. But in reality at least some atoms of the residual gas inside the vacuum chamber will produce some loss of electrical charge. A successful proof of the conversion of vacuum-energy is given, if the electrical power loss is clearly smaller than the mechanical power driving the rotor, because in this case the electrical power can not be sufficient to explain the spinning of the rotor. This is the way to exclude all types of experimental artefacts at all, which might drive the rotor.

We now have to perform two measurements: At first we have to determine the mechanical power which the rotor produces so that it can rotate. This is done in section 3. And then we have to determine the electrical power loss (in section 4), which should be smaller then the result of section 3.

<u>(3.) Measurement of the mechanical engine power</u>

The mechanical power has been measured „ex-situ" outside the vacuum chamber, with the rotor swimming on the oil and the driving torque being produced by a thin copper filament (diamter $50\ \mu m$) being twisted by a well defined angle. Fig. 4 displays a sketch of the principle of the setup. The way how the torque has been produced and transmitted was the following:
After waiting until the rotor came into its rest position, the copper filament was twisted by turning the rotating wheel at the top of the filament. This produces a torque making the rotor spin. From the knowledge of the torque and the angular velocity of the rotor, the mechanical engine power driving the rotor could be determined as shown below. With the means of such measurements, a mathematical connection between the duration for one turn and driving engine power was determined for several values of angular velocity.

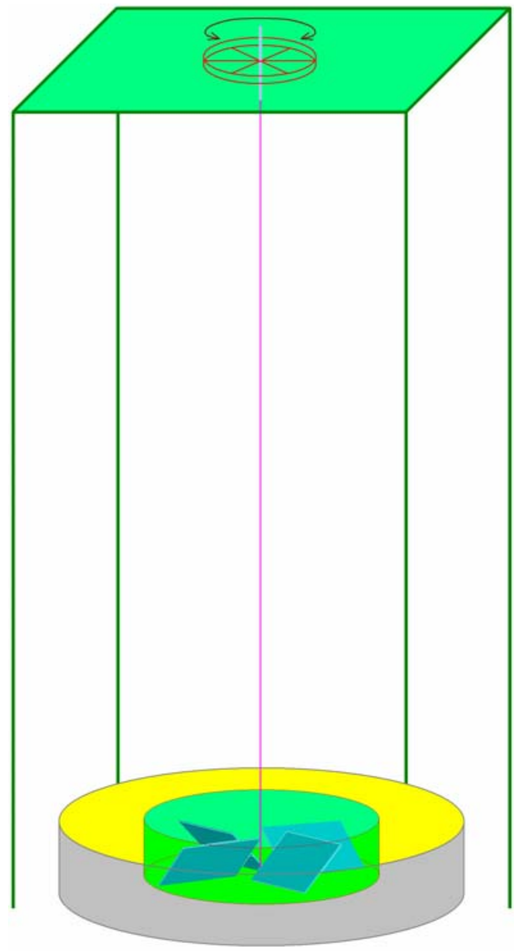

Fig.4:
Setup for the determination of the classical mechanical power which drives the rotor as a function of the duration per turn.
The rotor is fastened at the bottom end of a copper filament with which a torque can be applied to the rotor.
The bottom end of the copper torsion filament is used to apply an angle of torsion as required, so that the filament will produce a torque, which makes the rotor rotate.
It was paid attention to the position of the rotor inside the oil. The immersion depth of the rotor into the oil in this part of the experiment has to be (almost) the same as in the vacuum chamber (without torsion filament) in order to get the same friction between the oil and the rotor in both cases.

And this is the procedure how to determine the measurement of the mechanical engine power:

Step 1: Characterization of the copper filament (calibration of the torque versus the angle of torsion)
As preliminary work it was necessary to determine the torque as a function of the angle of distortion of the filament. For this purpose the rotor at the bottom end of the filament was replaced by a hollow plastic sphere (diameter $r_a = (39.7 \pm 0.1) \cdot 10^{-3} m$, mass $m = (2.732 \pm 0.002) \cdot 10^{-3} kg$) not using any oil in this phase of the experiment. Now the rotating wheel on the top was deflected, resulting in an oscillation of the sphere (duration of one period $T = (19.76 \pm 0.02)\,\text{sec.}$, length of the filament $l = (409 \pm 1) \cdot 10^{-3} m$). With elementary formulas of technical mechanics [29], the mathematical expression $Q_1 = \frac{G \cdot \pi \cdot R^4}{2 \cdot l} = (2.902 \pm 0.016) \cdot 10^{-7} Nm$ was calculated ($G =$ shear modulus of the copper and $R =$ radius of the filament), which is a factor of proportionality between the torque and the angle φ of the torsion, namely $M = Q \cdot \varphi$.

Step 2: Determination of the rotor's moment of inertia of rotation
Because of the irregular shape of the rotor with its rotor blades, it is not sensible to calculate the moment of inertia theoretically, but it is more accurate to measure it. Therefore the hollow plastic sphere at the bottom of the filament was replaced by the complete rotor with the floating body, still not using any oil. Now the rotating wheel on the top end of the filament was deflected again, resulting in an oscillation with a duration of one period of $T_b = (33.70 \pm 0.06)\,\text{sec.}$ and a filament length of $l_2 = (383 \pm 2) \cdot 10^{-3} m$, leading to $Q_2 = \frac{G \cdot \pi \cdot R^4}{2 \cdot l_2} = (3.099 \pm 0.025) \cdot 10^{-7} Nm$. (The torque at this filament length is now $M_2 = Q_2 \cdot \varphi$.) With standard formulas of technical mechanics we come to moment of inertia of $Y = \frac{Q_2 \cdot T_b^2}{4 \cdot \pi^2} = (8.916 \pm 0.078) \cdot 10^{-6} kg \cdot m^2$ for the rotor together with its floating body.

At this phase of the experiment, the torsion-filament is characterized as well as the rotor, as far as it is necessary for the determination of the mechanical engine power as a function of the angular velocity of the rotor.

Step 3: Determination of the mechanical engine power as a function of the duration per turn
Because of practical reasons, namely because of the proper adjustment of the rotor on the surface of the oil, the length of the the torsion-filament had to be changed once more, namely to $l_3 = (420 \pm 2) \cdot 10^{-3}\, m$, corresponding with a value of $Q_3 = (2.826 \pm 0.022) \cdot 10^{-7}\, Nm$.
Now the rotor could easily be driven by a well known torque be turning the rotating wheel for a given angle because of the proportionality $M_3 = Q_3 \cdot \varphi$. From the torque M and the angular velocity ω_u the engine power $P = M \cdot \omega_u = Q_3 \cdot \varphi \cdot \frac{2\pi}{T_\alpha}$ is calculated. The result is plotted in Fig. 5, where we see the engine power as a function of the duration T_α of a single turn.

The engine power at a duration in the range of $\frac{1}{2} ... 1 ... 2\, hours$ should be memorized, because this is, what we will observe later at the rotor inside the vacuum in section 4. This engine power is about $P_{mech} \approx 1.5 \cdot 10^{-7}\, Watt$. From this value we can now evaluate the requirements to the measurements of the electrical power. This can be demonstrated easily as following: Let us assume a voltage of $U \approx 25\, kV$ to make the rotor spin, and let us further assume $P_{mech} \approx 1.5 \cdot 10^{-7}\, Watt$. If the electrical power loss shall be remarkably smaller than the mechanical power, the electrical current has to be $I \ll \frac{P}{U} \approx \frac{1.5 \cdot 10^{-7}\, Watt}{25 \cdot 10^{3}\, Volt} = 6 \cdot 10^{-12}\, Ampere$. This is the demand to the measurement of the current.

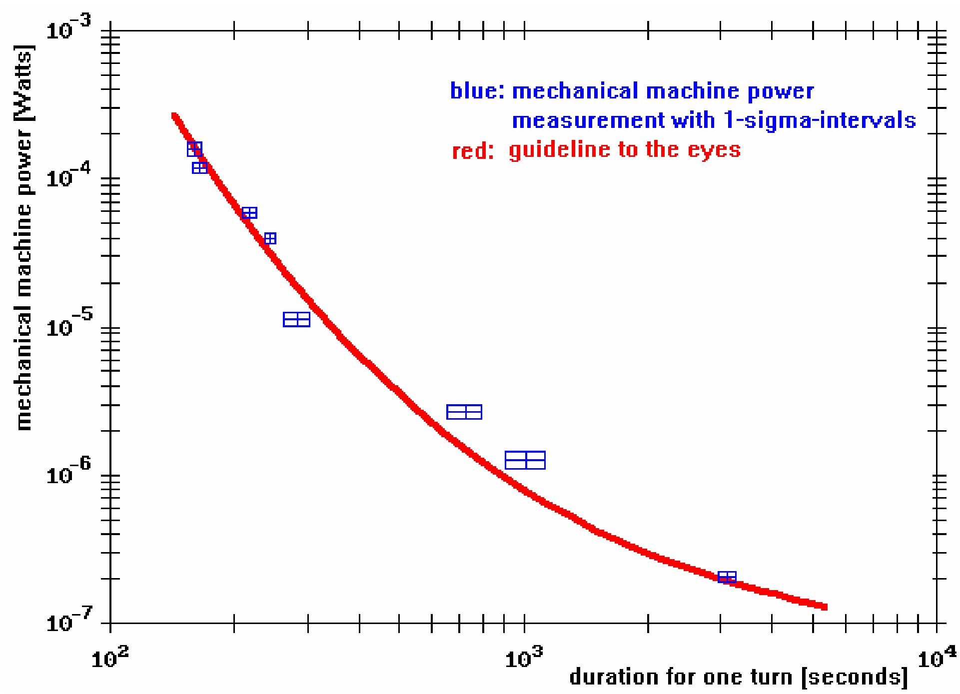

Fig. 5: Mechanical engine power of the rotor inside the floating body when rotating on the surface of the vacuum-oil. A duration of one turn per $\frac{1}{2} ... 1 ... 2\, Stunden$ leads to a mechanical power of about $1 ... 2 \cdot 10^{-7}\, Watt$.

(4.) Measurement of the electrical power loss

The following lines will describe measurement inside the vacuum and their analysis:

For the purpose of comparison, a measurement with an empty vacuum recipient was done, without high voltage, without oil, without rotor. The values of the electrical current have been recorded automatically (electronically) in order to provide them for a later computation of the integral average value. With a duration of measurement of 30 seconds we come to an integral average current of

$I_1 = (0.08 \pm 0.01)\,pA$. This demonstrates the limit of the precision of the current measurement, which perfectly fits the requirements given at the end of section 3.

After putting the rotor with the oil into the vacuum recipient (before closing the top flange of the chamber), it has been checked that the rotor blades and the negative contact of the high voltage supply are connected properly as well as the fact that the field-source and the positive contact of the high voltage supply are connected properly. In the same way it was checked, that (without the Pikoamperemeter being connected) the vacuum chamber, the field-source and the oil tub with the rotor are electrically disconnected (test with a Mega-Ohmmeter, Fluke).
In reality, a very very small current between the field-source and the rotor is possible, as we can see later after analyzing the data, but the resistance is by several orders of magnitude too large for a detection with a Mega-Ohmmeter, and the leakage currents are small enough that they will not disturb the aim of our measurements. This also indicates, that also the atoms of the residual gas in vacuum chamber (when being evacuated later) will transport less enough electrical charge, that the electrical power loss does not prevent the aim of our measurement. From this observation we can conclude that it is not necessary to improve the vacuum to a value better than given in Fig. 3. To reduce the pressure even more would have been a problem because of the presence of the oil.

After the pre-tests of the electrical connections were finished, the top flange was closed, carrying the field-source. Now the high voltage supply was to be connected, but not the Pikoamperemeter (still without evacuation of the chamber), so that and electrical field could be produced which activates the self-adjusting-mechanism of the rotor. Only after observing a rotation of the rotor, the vacuum pumps have been switched on. This rotation presumes substantial precision work to adjust all experimental parameters in an appropriate way, as for instance the amount of oil inside the tub, the distance between the rotor and the field-source, an adequate value of the voltage and so on… The coordination of experimental parameters has to be balanced properly.

After the vacuum pumps are switched on, at first we see a degas procedure of the vacuum oil, which is rather strong, because gas bubbles can elude only very slow from the oil because of the rather large viscosity of the oil. It is necessary to have a current limitation at the high voltage supply, because the residual gas will be conducting when the pressure passes the range of few millibars, where gas- and corona- discharges can be observed easily by optical visible luminous effects. The current limitation of the high voltage supply prevents the apparatus from being damaged. But on the other hand the high voltage supply can not be switched of completely during the begin of the pumping procedure, because without any high voltage, the gas bubbles from the degas procedure of the oil might move the rotor the wall of the oil tube, where it will adhere because of the toughness of the oil.

During the further evacuation of the chamber the conductivity of the residual gas decreases (together with the visible gas- and corona- discharges), so that the necessity for the current limitation of the power supply will not exist any further. This means that the high voltage can be regulated from 0 to 30kV, according to the specification of the power supply.

Only when the degas procedure of the oil is mostly done, the pressure in the vacuum recipient will come down to the value of $4...5 \cdot 10^{-4}\,mbar$ as said in Fig. 3. Now (after switching off the high voltage) all cables can be connected according to Fig. 3, also the Pikoamperemeter, because the risc for large electric currents does not exist any further.

This is the moment to adjust the high voltage to a value that the rotor will again begin to rotate. If there are still some gas bubbles in the oil, they will enhance the noise of the electrical signal of the current measurement (independently from the fact whether the voltage is high enough to make the rotor spin or not), which probably has is reason in the fact, that the bubbles move the rotor vertically, changing its distance from the field-source permanently. So for the measurement of the electrical current we had to wait until the degas procedure of the oil was almost over.
The voltage which is necessary to make the rotor rotate is higher than the voltage which activates the self-adjusting-mechanism (except for the case that the rotor adheres at the side wall of the oil tub). Depending on the distance between the rotor and the field-source, the voltage for the self-adjusting-mechanism could be between 3 and 20 kV and the voltage for the rotation could be 5 and 30 kV. But these are not exact values like a result of the measurement. These values shall only give a feeling in which range the rotor is operated.

With the rotor rotating, the voltage is measured and the current is recorded automatically again in order to get the data for the determination of the integral average value of the current later. The voltage was kept constant by the power supply. The current is noisy with amplitudes up to some pikoamperes, but with alternating algebraic sign, indicating the alternating direction of the current. This means that the electrical charges move statistically back and forth, not bringing electrical power into the rotor. This is the reason for the computation of the integral average value. But the integral average value is not completely zero. This means, that there is still some electrical DC-power existing. But this power will be soon seen to be smaller than the mechanical power of the rotor.

Data of a practical measurement: At a voltage of $U = 29.7\,kV$, the rotor rotated with a duration of about (1±½) hours for one turn. The integral average value of the current (duration of the measurement 90 seconds) was $I_3 = (-0.100 \pm 0.030)\,pA$. The noise and with it the uncertainty of the integral average value is larger than it was without rotor. The uncertainty of the integral average value is given as 1-sigma-intervall.
The algebraic sign of the electric current is not interpreted at all. It only indicates the direction in which the electric current passes the Pikoamperemeter and thus it does not have any importance for the determination of the electric power loss.

The electrical power loss is $P = U \cdot I = 29.7 \cdot 10^3 V \cdot (0.100 \pm 0.030) \cdot 10^{-12} A = (2.97 \pm 0.89) \cdot 10^{-9} Watt$. It might be due to imperfect isolation, but its reason is not really important, because it is much smaller than the produced mechanical power. It is plotted into the diagram of the power balance, which is now shown in Fig. 6.

As can be seen, the electrical power loss is by about one and a half orders of magnitude smaller (a factor of 30) than the produced mechanical power. Whatever reason the power loss has – one fact is obvious: The rotation of the rotor can not be explained by the electrical power. And because there is no other source of energy and power being delivered to the rotor, the rotor can only be driven by vacuum-energy.

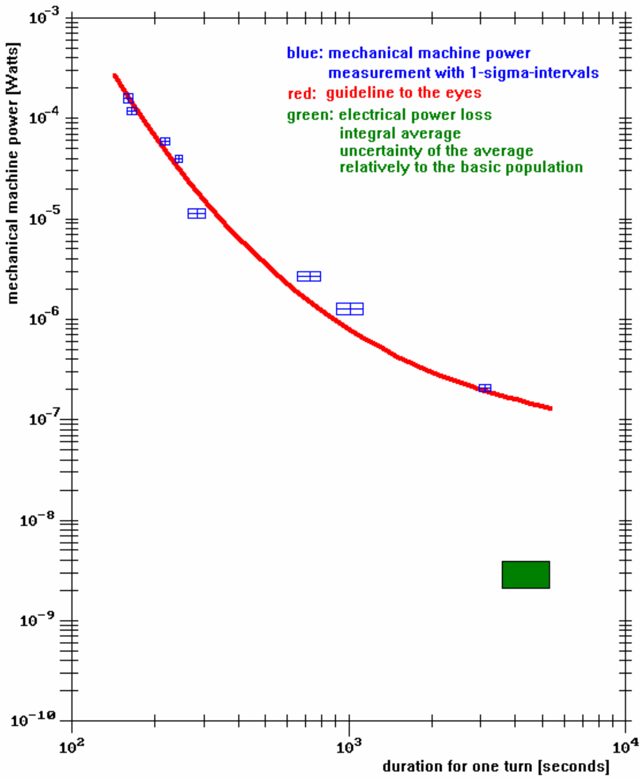

Fig. 6:
Comparison of the electrical power loss with the produced mechanical power. The uncertainty is given as 1-sigma-intervalls.

(5.) Resumée and Outlook

The measuring devices have been built up in a rather fast and uncomplicated manner in order to make a very first principle-experiment. Costs and effort have been dedicated only to those components, which could not be built up in an easy way, such as the vacuum chamber (containing a turbo molecular pump) and the measurement of the electric current with a least significant digit of $10^{-14}\,Amperes$. This approach allowed to test the quoted theory of the conversion of vacuum-energy very quick (the complete experimental work within a bit less than one and a half years), as it would not have been possible with long preliminary lead time such as it would have been necessary for the application of financial aid, for complicated constructions, for buying complicated devices, and so on.

The fact, that the result is so clear and unambiguous despite the simplicity of the setup (without the artefacts possibly arising from complicated machines), confirms the quoted theory of the conversion of vacuum-energy in a strong way.

Such a clear result encourages to perform now further developments and investigation, to put more effort into further experiments with the goal to enhance the mechanical engine power being converted from the vacuum-energy. It gives hope that it should be possible to enhance the mechanical power to a range which is capable for practical applications. But it is also clear, that this aim can only be achieved, if the diameter of the rotor is enhanced remarkably. So there are two parts for the next step: The first part is the enhancement of the mechanical power (by enhancing the rotor diameter), and the second part is the reduction of the electrical power loss (being achieved by a reduction of the pressure of the residual gas in the vacuum).

The clearness of the results presented here should hopefully inspire other scientific groups of fundamental experimental physics and of engineering sciences to reproduce the experiment, and first of all, to optimize it. Of course there will be several experimental difficulties to be overcome, but it looks worth being done.

Adresses of the Authors

Prof. Dr. rer. nat. Claus W. Turtur
University of Applied Sciences Braunschweig-Wolfenbüttel
Salzdahlumer Straße 46 – 48
Deutschland - 38302 Wolfenbüttel
Email: c-w.turtur@fh-wolfenbuettel.de
Internetseite: http://public.rz.fh-wolfenbuettel.de/%7Eturtur/physik/
Tel.: (++49) 5331 / 939 – 3412

and

Dr.-Ing. Wolfram Knapp
Otto-von-Guericke-University of Magdeburg
Institut für Experimentelle Physik / Abt. Nichtlineare Physik
Universitätsplatz 2
Deutschland - 39106 Magdeburg
Tel.: (++49) 391 / 67 – 12505
Fax.: (++49) 391 / 67 – 18109

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