

# The Gravitational Wave: Anywhere, Anytime, in Everything and Its Potential Applications

Xia Cao \*

School of Chemistry and Biological Engineering, University of Science and  
Technology Beijing, Beijing, 100083, China

Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences,  
Beijing, 100083, China

\*Corresponding Author: E-mail: caoxia@ustb.edu.cn

## **Abstract**

The Einstein's general theory of relativity predicts that a powerful gravitational wave is produced when massive celestial bodies or two black holes collide. Only when the larger celestial bodies collide, the emitted gravitational waves can be detected. Here, we found that two objects can generate electromagnetic fields under the forces (tapping, friction, collision etc.), and the high frequency interaction between two objects can generate the electromagnetic wave, that is, the gravitational wave. The direction of the as generated electromagnetic field radiates perpendicularly to the tangent face of the force point and radiates outward, and the intensity of electromagnetic field depends on the nature of two objects and the value of force. Besides, the resulting gravity from the electromagnetic field is vertical to the contact surface and points to the inside of the contact surface. The results of a series of experiments indicate that the electromagnetic fields and gravitational waves should exist anywhere, anytime and in everything.

We have demonstrated that the electromagnetic field would be generated when the stones were knocked against each other, when the wind blew over the stone, and when the wind blew over the water. Thus, the formation mechanism of earth's circular gravitational waves was deduced and confirmed. Furthermore, we have demonstrated the cause of some natural phenomena including the geomagnetic field, the circular gravitational wave, the lightning strike and the auroral phenomenon. And it was experimentally confirmed that the changing electromagnetic field can cause and promote some chemical reactions, which is related to the human altitude sickness and

the biological orientation by geomagnetic field.

Besides, the electromagnetic field generated by each tapping can be collected wirelessly by copper mesh, sand, water, leaves and human body, etc., which are no contact with the acrylic sheet. The instantaneous voltage can be up to 3600 V, the instantaneous current can be up to 260  $\mu\text{A}$ , and the maximum power can reach 0.936 W with the power density of 46.8  $\text{W}/\text{m}^2$ . The results show that the ability of different objects to collect energy is different, and the ability of the same substance of the same quality to collect energy is also different. According to these discoveries, a series of power generation devices and self-powered systems have been designed, including the power generation bucket with water or sand, the power generation floor with sand, the power generation stone, the power generation road, the power generation by human body, the self-powered LED bulb, and the self-powered board for position location etc.

The above experimental results have great scientific significance and will certainly have profound influence in various fields in the very near future.

Firstly, it has been experimentally confirmed that the electromagnetic field will be generated, if there is a force. And high frequency interaction can generate the electromagnetic wave--gravitational wave, which can be generated anywhere and travel at the speed of light. So, it is correct that the law of gravitation says the propagation speed of gravitational wave is the speed of light. However, the Newton's hypothesis is wrong that the propagation speed of material interaction is infinite.

Secondly, the results provide a laboratory basis for the formation of geomagnetic field and Earth's ring-shaped gravitational waves. The formation cause of geomagnetic field is related to the friction between the earth and the atmosphere.

Thirdly, water, sands, trees and human body are natural and good energy collectors for electromagnetic wave, which helps to explain the phenomenon of lightning, human altitude sickness and biological orientation by the geomagnetic field.

Fourthly, as Faraday firstly discovered the electromagnetic induction, this is a new mode of power generation, which can be applied to the fields of new energy, such as power generation from ocean and desert, self-driven charging, wearable devices, power supply for Internet of Things, new wireless transmission, and sensing and positioning

etc. It will have an inestimable impact in the energy field on the conversion, regeneration and collection of energy.

Fifthly, a better explanation has been given for the generation of gravitational waves during the collisions of black holes, which provides a new way to further explore the universe in astronomy.

### **Key words**

New energy; electromagnetic field; gravitational wave; energy collectors; wireless transmission

### **1. Introduction**

As early as 1916, Einstein predicted the existence of gravitational waves in the universe based on the general theory of relativity.[1, 2] The gravitational waves refer to the gravitational radiations generated when the massive objects accelerate. When a large mass of celestial bodies collides, or a supernova breaks out, or two black holes collide, there will be the gravitational waves that travel through the universe at the speed of light. The gravitational waves are the waves in the curvature of space and time, which are produced by some violent collisions and explosions in the universe.[3] However, the gravitational wave is a speculation for a long time. In the past six decades, many physicists and astronomers have made countless efforts to prove the existence of gravitational waves.[4-6] Until 2016, LIGO scientific collaboration and Virgo collaboration detected the gravitational wave signals generated by the coalescence of two black holes by the advanced detector LIGO for the first time, which confirmed the Einstein's predictions about the gravitational waves.[7] Then the gravitational waves open up a whole new window to observe and explore the universe.[1]

As fossil energy depletion and environmental pollution problems from energy still plague humans, the development of new energy has received significant attention.[8-11] The research and development of renewable energy such as solar energy, wind energy, geothermal energy, ocean energy and biomass energy is rapidly expanding.[12-20] In the field of mechanical energy collection, triboelectric nanogenerator as an important representative of the new era of energy has greatly expand the possible coverage of energy collection, which can help solving the energy supply problems of

distributed and mobile devices with disordered small energy.[21-25] With the fast development of energy technology, more environmentally-friendly and sustainable ways of collecting new energy sources are needed.[26] In Einstein's theory of relativity, it is believed that the gravity is not a force, but the curvature of space and time, the gravitational wave and the energy.[27-29] There is the gravity in all things, so it can be inferred that there should be gravitational waves around everything, and there should be electromagnetic fields in or around everything. Though the gravitational wave can transmit energy in the form of gravitational radiation, it is difficult to collect energy from the gravitational wave.[30, 31] It has never been experimentally detected that the gravitational wave can be converted to other forms of energy.

The gravitational waves have always existed in space, and the general theory of relativity has been proven to be correct.[1, 3, 29] Then the gravitational waves and electromagnetic fields should exist anywhere, anytime and in everything. In order to prove the validity of the inferences and related conjectures about the gravitational waves, here some experiments have been done recently with two objects by colliding, tapping, rubbing and shaking. It had been found that the interactions between two objects can generate the electromagnetic fields. When the interactions were at a high frequency, the electromagnetic waves that are the gravitational waves were generated. The formation of geomagnetic field and related phenomena were proved experimentally to be related to the friction between the earth and the atmosphere. Besides, the collection and utilization of gravitational waves for new energy has been successfully realized. Some power generation devices and self-powered systems based on the new discoveries have been designed, including the power generation bucket with water and sand, the power generation floor with sand, the power generation stone, the power generation road, the power generation by human body, the self-powered LED bulb, and the self-powered board for position location etc. These principles and modes of power generation provide new explanations and new ideas for the formation of geomagnetic fields, the generation of circular gravitational waves, the production of thunderstorms and lightning strikes, the biological orientation by geomagnetic field etc. Therefore, it will have a profound impact on the entire scientific research fields,

including physics, astronomy, biology, chemistry, new energy and new wireless transmissions.

## **2. Results and discussions**

The electromagnetic field can be generated when there is a force between two objects including contacting, rubbing, tapping, and colliding etc. Figure 1a-b show the experimental setup for investigating the electromagnetic field generated by force. A LEDs lamp board was placed on the fixed acrylic sheet (Polymethyl methacrylate, PMMA). And the acrylic sheet can be tapped by hand from the bottom. The electromagnetic field tester (the maximum range of electric field is 2000 V/m) was overloaded when the distance above the acrylic sheet was less than 5 cm, which limits the detection for electromagnetic field. Figure 1c shows that the intensity of electric field generated by the tapping can instantaneously reach 1997.73 V/m, when the wireless detection distance is 5 cm above the acrylic sheet. The result shows that the electromagnetic field can be generated by the tapping or rubbing. As shown in Figure 1d-e, the medium LED lamp board (480 LEDs in series) were all driven by tapping the acrylic sheet. Due to the shooting angle, ambient lighting, exposure time and frequency of the camera, it's hard to capture photos showing that 480 LEDs were all on. But the LEDs can be seen by the naked eyes that they were all driven and dazzling. Even more, Figure 1f-g show the large LED lamp board (1350 LEDs in series) can be also driven by rubbing the acrylic sheet, which reflects the high intensity of the generated electromagnetic field.

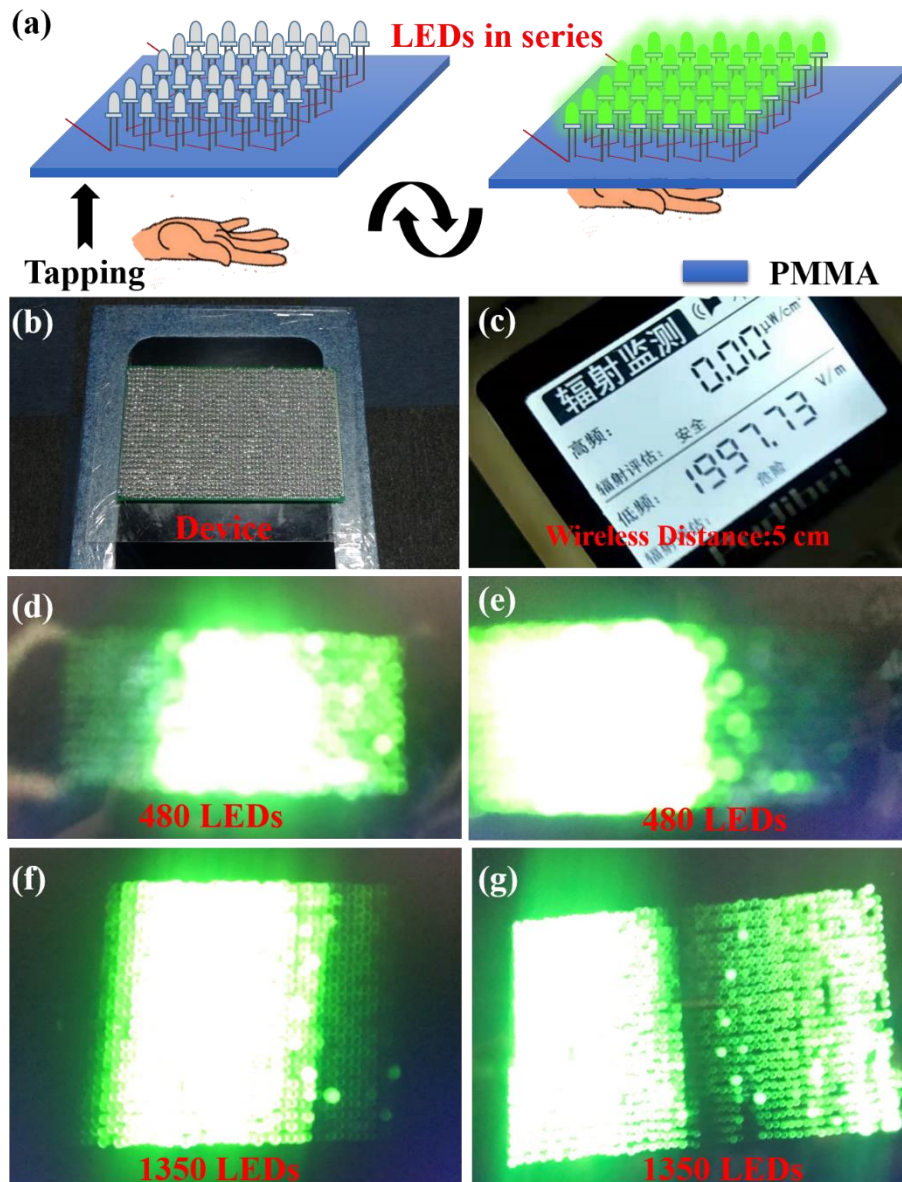


Figure 1. (a, b) Schematic diagram of the experimental setup and working principle of the device; (c) The electromagnetic field tester (the maximum detection range of electric field is 2000 V/m) at the wireless detection distance of 5 cm; (d, e) 480 LEDs in series were all driven by tapping; (f, g) 1350 LEDs in series were driven by rubbing.

The electromagnetic field generated by the tapping was further studied by wireless energy receivers. As shown in Figure 2a, the instantaneous voltage of the medium LED lamp board by tapping can be as high as 3600 V. And Figure 2b shows the instantaneous current can be as high as 260  $\mu$ A. The maximum power can up to 0.936 W and the maximum power density is 46.8 W/m<sup>2</sup>, which shows a high energy density. Besides,

the electromagnetic field generated by continuous tapping can be detected at the wireless detection distance of 5 m. Figure 2c-d show the instantaneous voltage and current when the wireless detection distance is 5 m, respectively. In addition, the force and angle of the tapping were not exactly the same because it was tapped by hands. Therefore, the electromagnetic field generated by tapping is different and constantly changing. As shown in Figure 2e, the changing electric field produces magnetic field, which represents that the electromagnetic field is generated. The direction of the as generated electromagnetic field radiates perpendicularly to the tangent face of the force point and radiates around, and the intensity of electromagnetic field depends on the nature of two objects and the value of force. The resulting gravity from the electromagnetic field is vertical to the contact surface and points to the inside of the contact surface, which can be proved by simple experiments of attracting small and light objects like scrap paper. As the frequency of human tapping is limited, the electromagnetic field generated is in the low-frequency range, which is difficult to be detected. In fact, the oscillating electromagnetic waves will propagate outward, when the speed of tapping reaches a certain high frequency. This also explains that the black holes will emit gravitational waves outward during their rotation and collision.[7, 32] In addition, Newton thought that the gravitation travels at the same speed as light and the propagation speed is infinitely fast. If energy is gravitation and the Newton's universal gravitation is correct, the speed of interaction between objects is the speed of electromagnetic wave propagation. However, it is known that the speed of light is not infinite, and the detectable electromagnetic waves can travel when the speed of tapping reaches a certain high frequency in the experiment. So, the Newton's hypothesis is wrong that the propagation speed of gravitation between objects is infinite. The electromagnetic fields generated by tapping were different due to the individual differences of hands, so some experimental phenomena and the causes of the phenomena are just presented below.

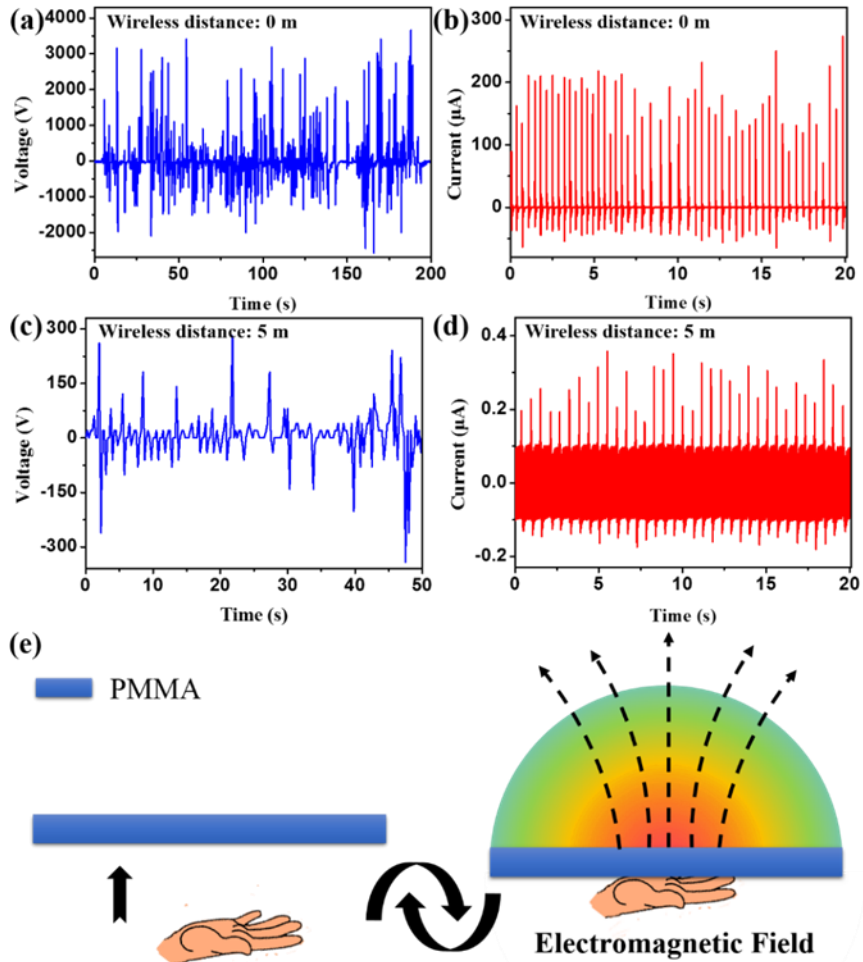


Figure 2. (a, b) The instantaneous voltage and current of the medium LED lamp board at the wireless detection distance of 0 m; (c, d) The instantaneous voltage and current of the medium LED lamp board at the wireless detection distance of 5 m; (e) Schematic diagram of the electromagnetic field generated by tapping.

The Einstein's general theory of relativity predicts that a powerful gravitational wave is produced when massive celestial bodies or two black holes collide. But it is difficult to detect the emitted gravitational waves. How do the earth's circular gravitational waves generate? The above experiments show that there are electromagnetic fields generated when two materials rub against or collide with each other. It can be speculated that two objects can generate electromagnetic fields under the forces, and high frequency interaction between two objects can generate the gravitational waves. The gravitational waves and electromagnetic fields should exist anywhere, anytime and in everything. We found that the collision of two small stones can generate the electromagnetic field. Figure 3a shows the experimental setup for



detecting the electromagnetic field generated by the collision of two stones. The electrical signals can be detected, when two stones collide and move apart constantly. As shown in Figure 3b-c, the voltage generated by the collision of two small stones can reach 10-20 V, and the current can reach 1-2  $\mu\text{A}$ . The signals were unstable due to the changeable force and different contact position. Besides, the LED can be driven by the collision of two small stones. Figure 3d-e show the LED was lit up when two stones were collided against each other. The earth mainly consists of land and sea, which is surrounded by the atmosphere. According to the above discovery, it can be inferred that the generation of earth's circular gravitational waves is related to the rotation and revolution of the earth.

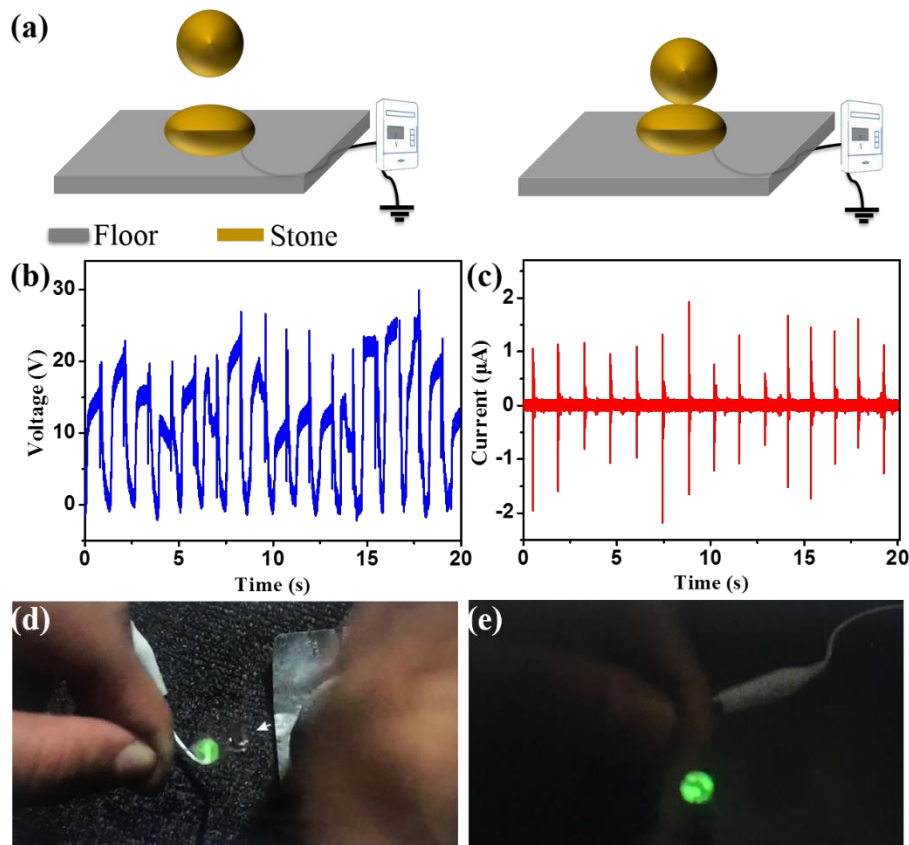


Figure 3. (a) Schematic diagram of the detection for electromagnetic field generated by the collision of two stones; (b) The voltage detected by the collision of two small stones; (c) The current detected by the collision of two small stones; (d, e) The LED driven by the collision of two small stones.

Will the electromagnetic field be generated when the earth rubs against the

atmosphere in the rapid rotation and revolution? The following experiment was designed to investigate the friction between the atmosphere and the earth. As shown in Figure 4a, the experimental setup was designed to investigate the electromagnetic field generated by the friction between the stone and wind. The detector can measure the electrical signals of the experimental setup when the stone was rubbed by the wind from the air blower. Figure 4b-c show the voltage and current generated by the friction between the stone and the wind at a high wind speed of 10 m/s and a low wind speed of 5 m/s. The change of electrical signals is obvious at different wind speeds, which can reflect the existence of electromagnetic field. Besides, the friction between the atmosphere and ocean was studied. As shown in Figure 4d, the experimental setup was designed to investigate the electromagnetic field generated by the friction between water and wind. The electrical signals of the experimental setup can be measured by the detector when the water was rubbed by the wind from the air blower. Figure 4e-f show the voltage and current generated by friction between the water and the wind at a high wind speed (10 m/s) and a low wind speed (5 m/s). The change of wind speed was relatively small and the friction between water and wind was relatively weak, so the voltage did not change much. Although the electrical signals were small, the change of electrical signals can be observed obviously. The earth rotates around the axis of rotation at a high speed of 466 m/s on the equator, and simultaneously revolves around the sun at a high speed of 29800 m/s. The high-speed movement of the earth causes it to rub with the atmosphere sharply, which can generate enough electromagnetic field that attracts objects on the surface of the earth. It can be proved indirectly that the electromagnetic field is generated when the earth including the land and the ocean rub against the atmosphere.

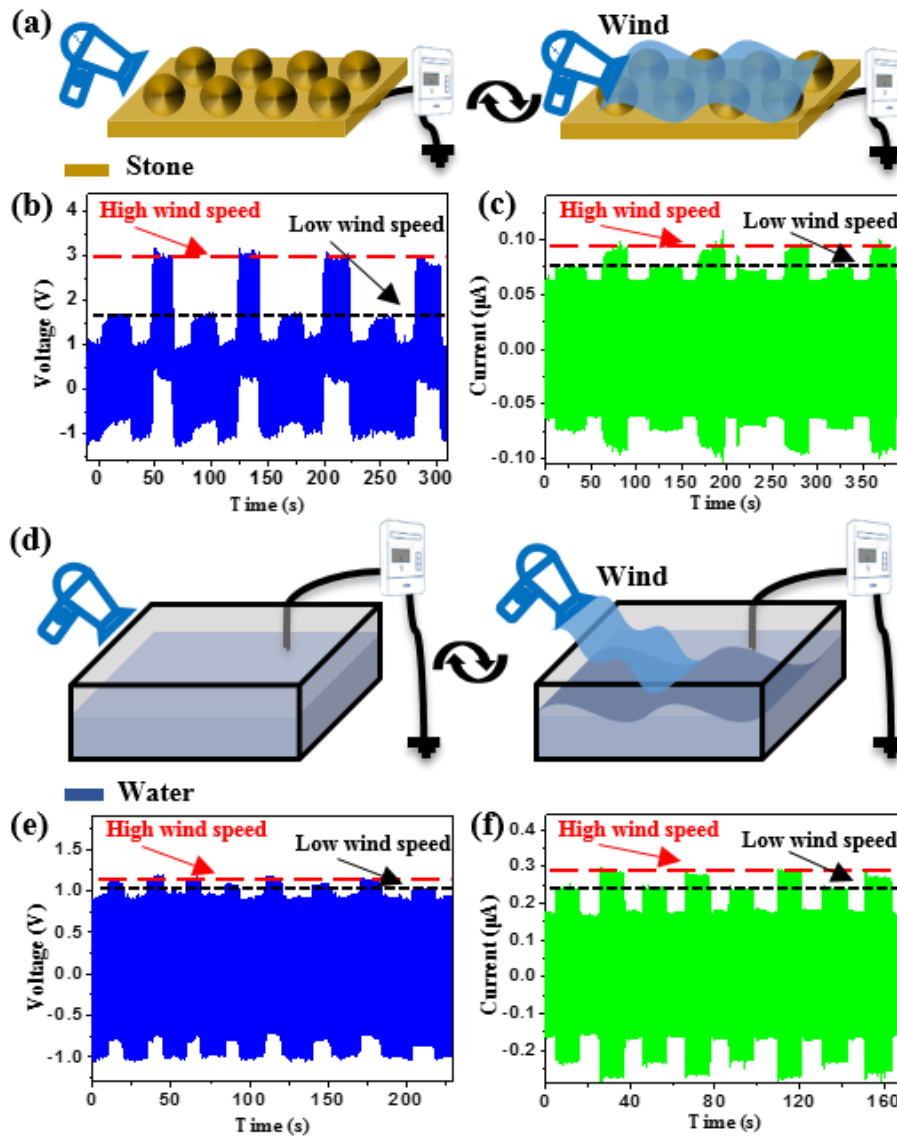


Figure 4. (a) Schematic diagram of the experimental setup of the detection for electromagnetic field generated by the friction between stone and wind; (b, c) The voltage and current detected by the friction between stone and wind at the high wind speed (10 m/s) and low wind speed (5 m/s); (d) Schematic diagram of the experimental setup of the detection for electromagnetic field generated by the friction between water and wind; (e, f) The voltage and current detected by the friction between water and wind at the high wind speed (10 m/s) and low wind speed (5 m/s).

Here is one question: since gravitational waves are around us, why can't we measure them? One reason may be that the instrument for measurement is in this electromagnetic field. In a small range, the intensity of the geomagnetic field is nearly

the same, so the result is relatively zero. It can be assumed that a lamp can be driven by connecting with two wires, when the other ends of two wires are on the ground, and in the high-altitude area or in the place with different geomagnetic fields, respectively. Regarding the formation of the geomagnetic field, it is still in the process of exploration and debate.[33, 34] Based on our latest research findings, it can be inferred that the electromagnetic field is generated when the earth keeps moving and rubs against the atmosphere. The strength of the generated electromagnetic field should be proportional to the air density of the atmosphere. So, the air density of atmosphere should be large in the place where the geomagnetic field is strong. It is known that the largest strength of geomagnetic field is in the South Pole and the North Pole, and the geomagnetic field in the equatorial regions with the small air density is the weakest. The air density in the polar regions is larger than elsewhere due to the extremely high pressure and the low temperature of the lower layer of air, which leads to the shrinkage and subsidence of air column. This is consistent with our inference. In addition, the geomagnetic field is divided into the South Pole and the North Pole, because the flow directions of the polar vortex are different.[35-38] It is also highly consistent with our research findings. It can be concluded that the electromagnetic field generated by the friction between the earth and the atmosphere is changeable and fast enough to generate high-frequency oscillations, and thus the gravitational waves can be generated. The gravitational waves are perpendicular to each point of action and radiate into the air. Therefore, the ring-shaped waves are generated around the earth and radiate into the universe. Furthermore, it is known that the long-wave radiation emitted by the warming of the ground is absorbed by the carbon dioxide and other substances in the atmosphere, thus producing the effect of atmospheric warming. The increase of carbon dioxide, ozone, nitrous oxide, freon and small haze particles leads to an increase in the density of the lower layer of air. Based on the new discovery, the increasing air density leads to an increase of the as formed electromagnetic field generated by the friction between air and the earth. So, the greenhouse effect should be the result of electromagnetic radiation, which can produce the thermal effect. These objective facts in nature are exactly consistent with the conjecture based on the experiments of stones, water and wind.

Furthermore, every planet in the entire solar system moves around the sun. The sun can generate huge electromagnetic fields and the sun's core gravity because of the friction with the atmosphere.[29] While other planets can generate electromagnetic fields by themselves, they are attracted by the gravitational forces from each planet. They finally reach an equilibrium state centered on the sun's centripetal attraction, which is full of the gravitational waves permeating in the entire solar system. The formation of the South Pole and the North Pole in earth is also the result of polarization of the solar magnetic field. What is more interesting is that the auroral phenomenon caused by the unique solar wind in the polar regions is the result of the electromagnetic field enhancement, which is caused by the frictional collision when the solar particles flow through the polar regions. As with the balance of the planets in solar system, there must be other galaxies in the universe that the planets mutually restrict each other and balance each other.

It can be seen from previous studies that the electromagnetic fields exist widely in the environment. And we found that many substances can be used as energy collectors for the electromagnetic fields. Therefore, several substances were used as collectors to collect energy from the electromagnetic field, which was generated by tapping the acrylic sheet with hand. The working principle of the collectors is shown in Figure 5a. The collectors can collect energy within a certain distance, when the hand repeatedly tapped on the bottom of acrylic sheet. And the test instrument was connected between the collectors and the ground to measure the output current of collectors. The results show that copper mesh, leaves, sand, water and wires with insulating layer can be used as energy collectors for electromagnetic field. (Figure 5b-f) Each substance can be used for the wireless energy collection, and each collector can detect and collect the electromagnetic field generated by the tapping at a wireless detection distance of 3 m. The strength of various substances was compared according to their electrical outputs, which shows that the copper mesh (metal) has the strongest ability for wireless energy collection, and the energy collecting ability decreases from sand to water, leaves, and wires with insulating layer. Besides, Figure 5g shows that human bodies can be also used as the energy collectors. These properties can be used to explain the phenomenon

of thunderstorms and lightning strikes in nature.[39-42] Thunderstorms can be generated when the water vapor in the sky reaches a certain level because it can capture a large amount of energy. When two charged clouds collide, the huge electromagnetic field is generated. Buildings made of sand and concrete, trees, human bodies, electric poles and wires can be all used to collect the electromagnetic field and thus hit by the lightning. Metal-made objects are the best energy collectors, so the metal is used to make lightning rods.[43]

As the above mentioned, everything is in the large electromagnetic field of the universe and can collect energy from electromagnetic field. And everything has energy, which proves the validity of gravitation. However, different materials have different energy collecting abilities which lead to different objects have different energy. It is known that the Einstein's equation of mass energy is  $E=mc^2$ , which reflects the relationship between mass and energy.[2, 28, 44, 45] Here, an unexpected amazing discovery is that the fat person and the thin person has different energy collecting ability even though they have the same mass. (Figure 5g) Though they have the same weight of 59 kilograms, the current of the fat and short person is nearly 1.8 times bigger than the thin and tall person when human body was used as the energy collectors. The energy collecting ability of human bodies is complex, which may be affected by the height, weight, body type, constitution, even the eating habit. We can infer that there are many factors affecting the energy collecting ability of various substances, and even the same substance with the same quality can lead to different results. More detailed research focused on the energy collecting ability will be present in our following work. As different materials have different energy collecting abilities, (Figure 5) it is suggested to add a correction factor in the Einstein's equation of mass energy. The correction factor is related to many influences such as the components, contour profile, the internal structure and composition of the object. Therefore, these new discoveries will have a significant impact on the development of physics, astronomy and astrophysics.

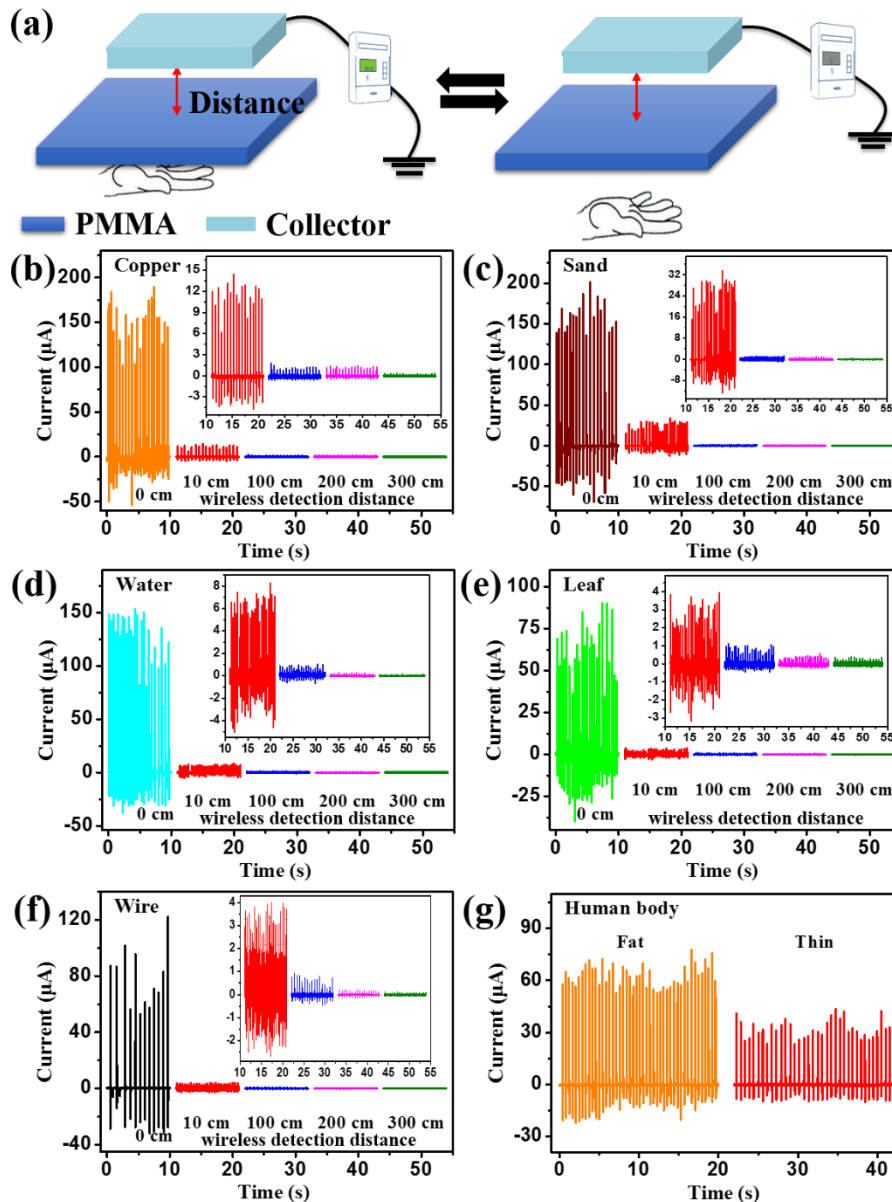


Figure 5. (a) Schematic diagram of the experimental setup for energy collectors; (b) The electrical outputs of copper mesh as energy collectors at different wireless detection distances; (c) The electrical outputs of sand as energy collectors at different wireless detection distances; (d) The electrical outputs of water as energy collectors at different wireless detection distances; (e) The electrical outputs of leaf as energy collectors at different wireless detection distances; (f) The electrical outputs of wire with insulating layer as energy collectors at different wireless detection distances; (g) The electrical outputs of human body as energy collectors with different shapes and sizes.

71% of the earth's surface is covered by water, which has great potential as energy collector for collecting the electromagnetic fields. As shown in Figure 6a-b, the power

generation bucket with water was designed. When the bucket is tapped by hand, the hand does work on the wall of the bucket. The electromagnetic field is generated by the collision and is collected by the water in the bucket to drive the LEDs. As shown in Figure 6c-e, 480 LEDs in series can be driven by the power generation bucket with water, and even more amazing is that the 3 W bulbs on the Christmas tree can be also driven by tapping the bucket with hand. Besides, the electrical outputs generated by each tap were tested, which shows a current of up to 175  $\mu\text{A}$  and a voltage of up to 2989 V. (Figure 6f-g) The maximum power can be up to 0.523 W and the power density is 25.39  $\text{W}/\text{m}^2$ . The as designed power generation bucket with water provides us with new ideas for collecting the abundant hydroenergy. Compared with the traditional hydropower and the harvesting method of blue energy proposed by Zhong Lin Wang, this new idea is more economical, convenient, and efficient.[46, 47] It can easily collect the ocean wave energy and integrate the electricity by wireless transmission, which offers the possibility for power generation by waves, tides, and underwater ultrasound etc.[48] Based on our new findings, more detailed research that is focused on the water energy collecting will be present in our following work.



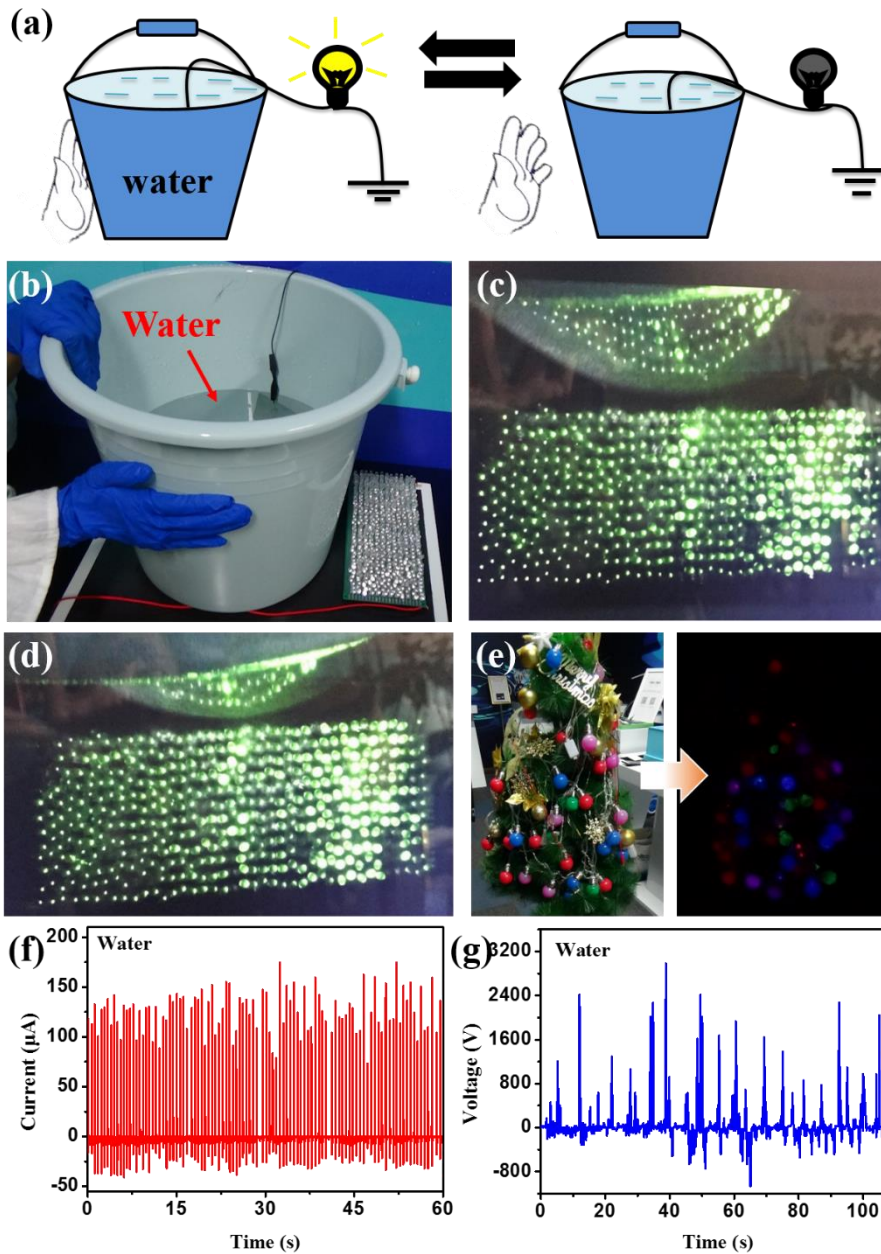


Figure 6. (a) Schematic diagram of the working principle of the power generation bucket with water; (b) Photo of the experimental setup; (c, d) 480 LEDs in series were all driven by the power generation bucket with water; (e) The 3 W bulbs on the Christmas tree were driven by the power generation bucket with water; (f, g) The electrical outputs generated by tapping the power generation bucket with water.

Water is a magical and popular substance. It can collect the electromagnetic field generated by the collision, which should influence the electrochemical reaction in the water. An experiment was designed with a set of copper sheets in a  $\text{CuSO}_4$  aqueous

solution to prove the speculation and analyze the reactional process. As shown in Figure 7a, eight pieces of polished copper sheets were connected in pairs by wires, and then two pairs of copper sheets were placed respectively in two beakers containing the  $\text{CuSO}_4$  aqueous solution. One beaker was placed in the ambient environment, and the other beaker was placed in an environment where the electromagnetic field were generated by the friction. (Figure 7b-c) After two days, the copper sheets were taken out for observation. Figure 7d-f show the contrast of the copper sheets after they were taken out from the solution. The copper sheets placed in the ambient atmosphere were still bright, while the copper sheets placed in the environment with the electromagnetic field were corroded. It can be concluded that the electromagnetic field generated by the friction influences the electrochemical reaction.

The electromagnetic field in the water is collected by two copper sheets at one end of the wire in the copper pairs, so there is a potential difference between the two copper sheets, which is equivalent to an external power source. (Figure 7g) A voltage is applied to the other two copper sheets placed in the  $\text{CuSO}_4$  aqueous solution, causing an electroplating reaction on the copper sheets. Copper crystals are produced on the copper sheets, and the copper crystals are quickly oxidized due to the presence of a large amount of oxygen in the water. Both ends of each pair of copper sheets are mutually power and electrodes, which results in the oxidation of all copper sheets. Human bodies, animals, plants, and organisms can collect energy if they contain water. They can be self-powered by collecting energy from the electromagnetic fields and can drive the chemical reactions in which electrons transfer. The above research has proved that everything on the earth can collect energy from electromagnetic fields, because they are all in the geomagnetic field generated by the earth. Besides, humans, animals, and the other creatures are also affected by the geomagnetic field at any time. It can be concluded that there is a different reaction changed in the body, when the human or animal reach a place where the air intensity of the plateau or other fields changes dramatically. And some creatures can detect the change of signal and thus judge their position due to the changeable electromagnetic field.[49, 50] This explains why there is an altitude sickness, and why some creatures in nature can judge the direction and

position according to the geomagnetic field.[51, 52]

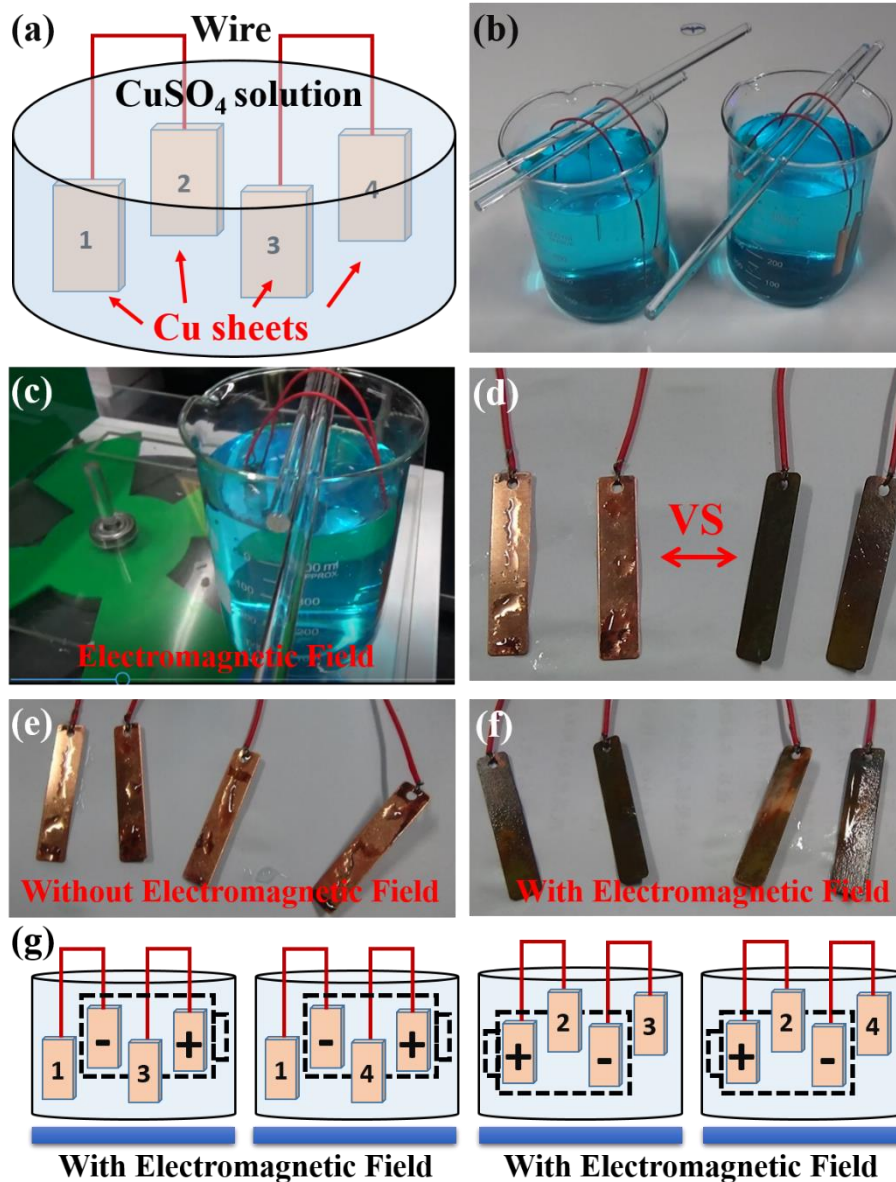


Figure 7. (a) Schematic diagram of the experimental setup for studying the effect of electromagnetic fields on the electrochemical reaction; (b) Photo of the experimental setup; (c) Photo of the copper sheets placed in the environment with the electromagnetic field; (d) The contrast of the copper sheets in different environment after two days; (e) The copper sheets placed in the ambient environment without the electromagnetic field; (f) The copper sheets placed in the environment with the electromagnetic field; (g) Working principle of copper corrosion with the electromagnetic field.

As described above, sand can be also used to collect the electromagnetic field and

generate electricity. Sand can be found anywhere, and every building around us is built on sand. Therefore, the power generation bucket with sand was designed, as shown in Figure 8a-b. The principle of the power generation bucket with sand is the same as that of the power generation bucket with water. The sand can collect the electromagnetic field generated by continuously tapping the bucket. Figure 8c-d show 480 LEDs were driven by tapping the bucket with hands, which reflects the good ability of sand for energy collection. And the current can reach up to 214  $\mu\text{A}$  and the voltage can be up to 3067 V, respectively (Figure 8e-f). The maximum power can be up to 0.656 W and the power density is 42.88  $\text{W}/\text{m}^2$ . Therefore, it has a broad application prospect of power generation in the desert and on the beach.

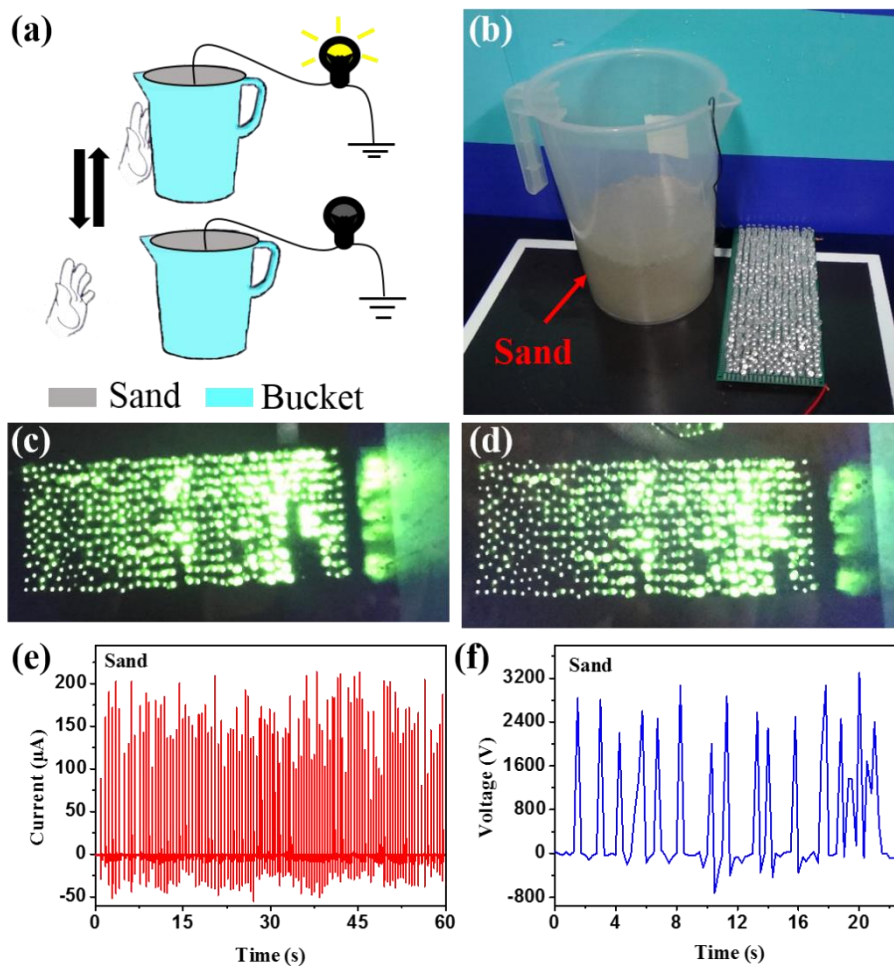


Figure 8. (a) Schematic diagram of the experimental setup for the power generation bucket with sand; (b) Photo of the experimental setup; (c, d) 480 LEDs in series driven by the power generation bucket with sand; (e, f) The electrical outputs generated by tapping the power generation bucket with sand.

According to the principle of the power generation bucket with sand, the power generation floor with sand was designed (Figure 9a-b). The sand under the acrylic sheet can collect the electromagnetic field when people walk on the power generation floor. As shown in Figure 9c-f, the 480 LEDs in series can be all driven by the power generation floor with sand. Besides, Figure 9g-h show the 3 W bulbs were driven by the power generation floor with different forces. The brightness of the bulbs increased with the increasing force, which is consistent with the production of electromagnetic fields. In addition, a foot-controlled switch was also designed to control the bulb in the self-powered mode, as shown in Figure 9i. The bulb can be easy to be controlled by stepping on the foot-controlled switch. There is a lot of sand around people, which provides a good foundation for self-powered systems based on this power generation mode.

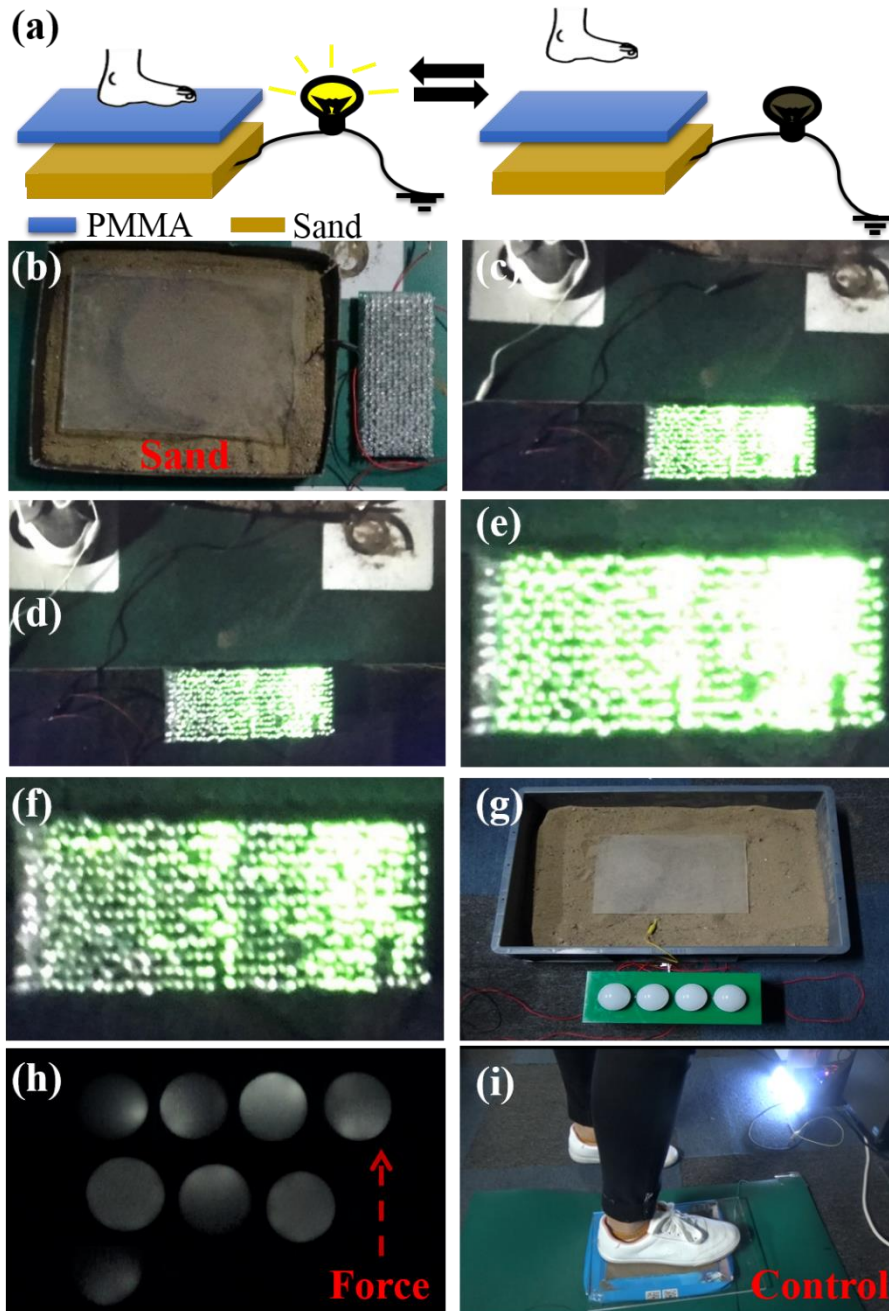


Figure 9. (a, b) Schematic diagram and photo of the experimental setup of power generation floor with sand; (c-f) 480 LEDs in series were all driven by the power generation floor with sand; (g) Photo of the experimental setup of power generation floor with sand for the 3 W bulbs; (h) Photos of the 3 W bulbs driven by power generation floor with different forces; (i) Photos of the foot-controlled switch.

We have found that the electromagnetic field can be generated by the collision of stones. As shown in Figure 10a-b, the power generation stone was designed to collect

the energy from human body motions. Small stones were laid on the carpet, and the medium LED lamp board (480 LEDs in series) was connected to the carpet and the ground. Figure 10c-e shows that the LEDs can be driven by the power generation stone, when the person walked or jumped on the small stones. It can be found the efficiency of energy collection is very high. The whole system is very simple even without the acrylic sheet, and people wearing shoes are free in the movements. Furthermore, Figure 10f-g demonstrates the power generation road, which was discovered to effectively collect the mechanical energy from human body motions. The acrylic sheets need to be placed on the road, which can be connected to the electrical appliances. The roads are very common, so this system has a broad application prospect in life. As shown in Figure 10h-j, 480 LEDs in series were all driven by the power generation road when the person walked or jumped on the acrylic sheet. These new and simple power generation modes can supply for streetlamps, traffic lights, electronic advertising boards, and distributed sensors, etc. Based on our new findings, more detailed research focused on the power generation pavement will be present in our following work.

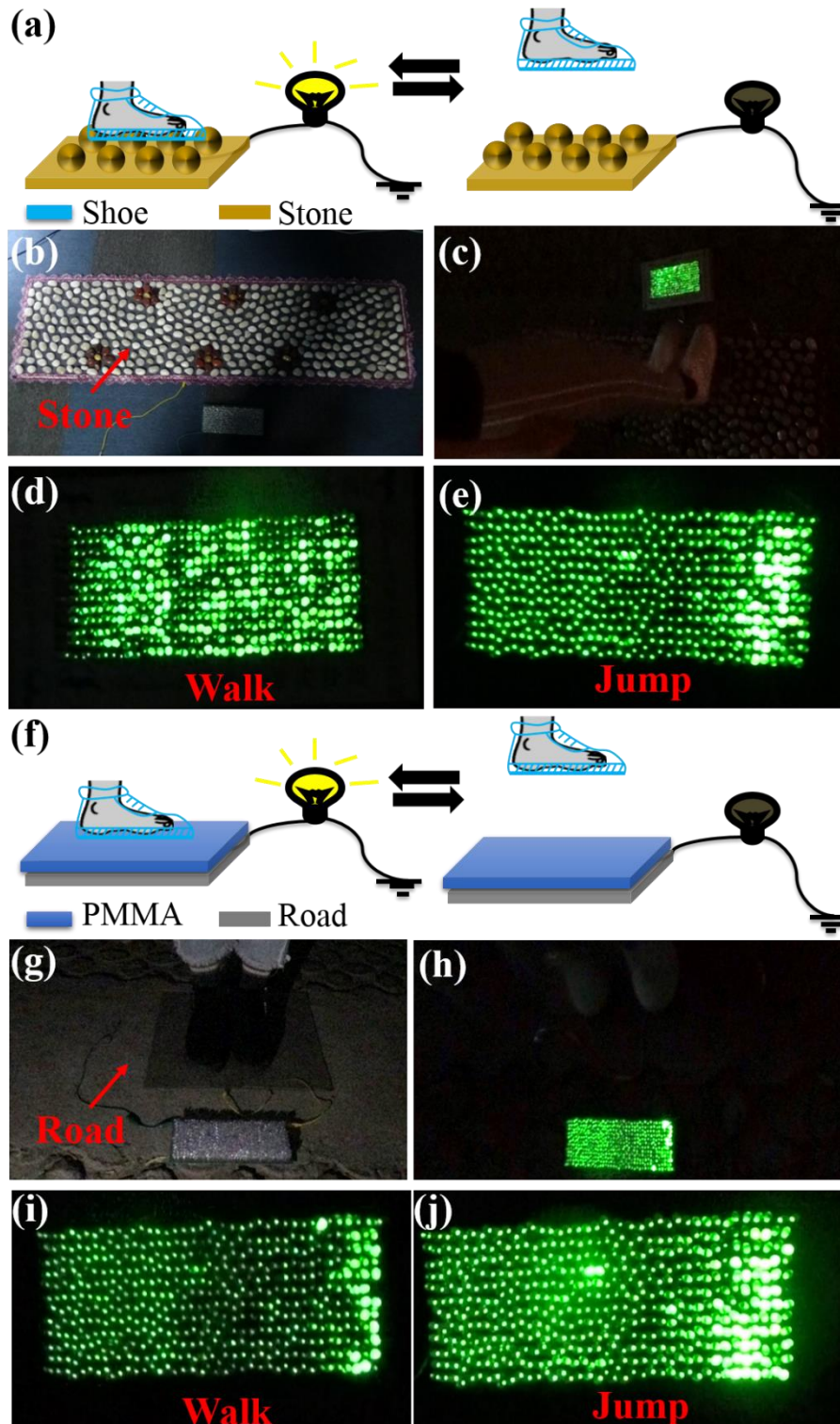


Figure 10. (a, b) Schematic diagram and photo of the experimental setup of power generation stone; (c-e) 480 LEDs in series were all driven by the power generation stone when the person walked and jumped; (f, g) Schematic diagram and photo of the experimental setup of power generation road; (h-j) 480 LEDs in series were all driven by the power generation road when the person walked and jumped.



Human bodies are also good energy collectors. As shown in Figure 11a-c, the methods have been designed to collect the electromagnetic fields generated by the walking of human bodies and the friction of the clothes. When the person walks, the clothes will generate electromagnetic fields due to the friction with the human body or clothes. The electromagnetic fields can be collected by the human body, so that the LEDs and small LED lamp board in the hands can be driven directly. Figure 11d-e show the LEDs driven by human body as the energy collector, which wear different skirts. The same method can be also used to collect the electromagnetic fields generated by the friction between the shoe and the ground when the person walks. Besides, both triboelectric and piezoelectric effect are the gravitational waves generated by two substances under the force.[24, 53] All of these phenomena provide a new way for the generation of new micro-nano energy, which can be used in many fields like wearable devices and self-powered sensing.

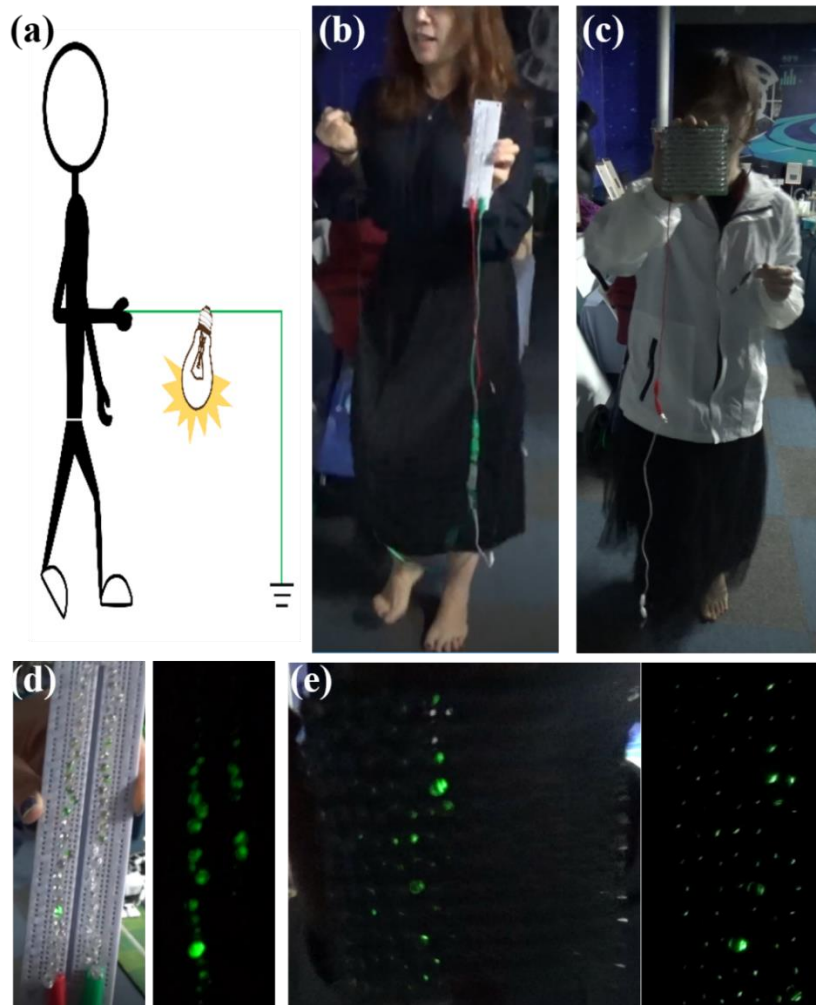


Figure 11. (a) Schematic diagram of human body as the energy collector; (b, c) Photos of the experimental setup of human body as the energy collector; (d, e) Photos of the LEDs driven by human body as the energy collector.

A large LED lamp board was designed for position location driven by the electromagnetic field. As shown in Figure 12a, the LEDs can be driven by the electromagnetic field when the finger touches at the bottom of acrylic sheet. Due to the distribution of the electromagnetic field and the LEDs connected in the series, the brightness of LEDs at the touching point is the strongest, while the brightness near the touching point will gradually weaken. Figure 12b shows the large LED lamp board including 1350 LEDs and acrylic sheet assembled for the position location. By integrating the outputs of collectors, it can be used to power the portable electronic devices such as mobile phones. Figure 12c-e show the column of LEDs driven by the electromagnetic field when the lamp board was touched on the left, in the middle, and on the right position. The brightness of three columns of LEDs was different, because it was affected by the forces of touching in different positions. As demonstrated in Figure 12f, this discovery can be used for the screen location by the digital and miniaturized design. This simple way of position location has a wide range of applications in the fields of man-machine interactive devices and portable devices.

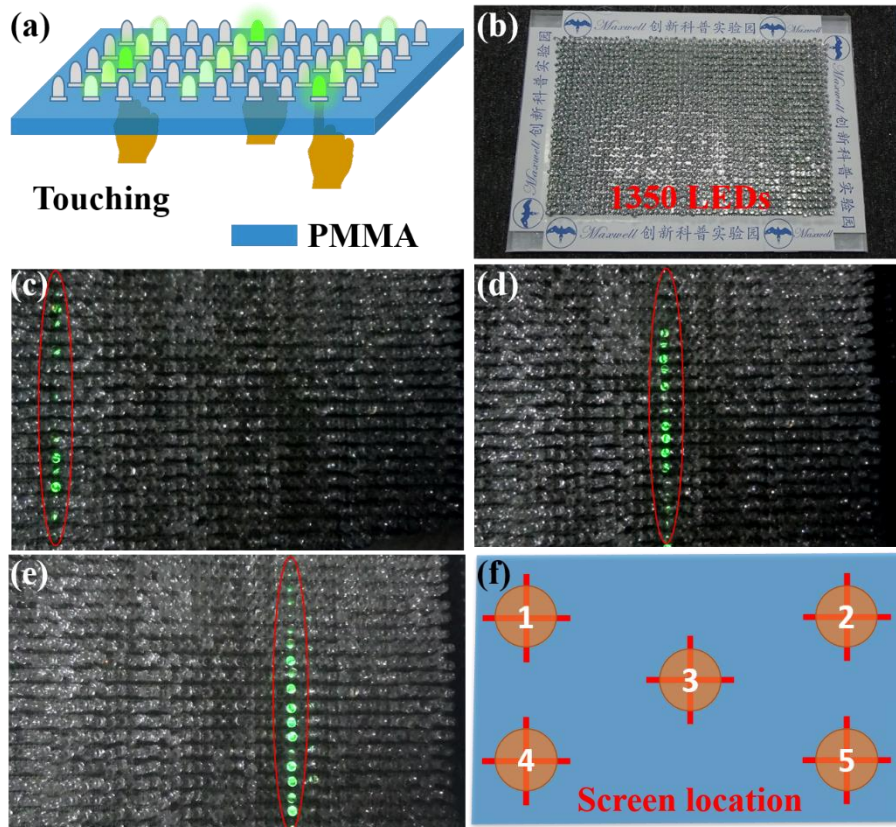


Figure 12. (a) Schematic diagram of the position location for touching based on the LEDs driven by the electromagnetic field; (b) Photo of the large LED lamp board (1350 LEDs in series) for position location; (c-e) Photos of the LEDs driven by the electromagnetic field when touching the left, the middle, and the right position; (f) Schematic diagram of the screen location for man-machine interactive devices.

### 3. Conclusions

In conclusions, it was found that the interaction between two objects under force, such as collision and friction, can generate the electromagnetic field. The 1350 LEDs in series could be lit by the electromagnetic field generated by tapping. High-frequency interaction can generate the oscillating electromagnetic waves (gravitational wave). The formation mechanism of earth's circular gravitational waves was deduced and confirmed that is related to the friction between the earth and the atmosphere. Furthermore, a series of discoveries and studies provide ideas and evidences for the discovery of gravitational waves, the generation of geomagnetic field, the orientation and navigation of creatures by the geomagnetic field, the phenomenon of lightning and

altitude sickness, the complement of Einstein's equation of mass energy, and the proof of Newton's law of universal gravitation.

Besides, it was found that the electromagnetic field generated by tapping can be collected by multiple substances as energy collectors like metals, sand, water and leaves etc. Several power generation devices and self-powered systems were designed for collecting mechanical energy. The power generation bucket with water or sand can be easily used to collect energy in the ocean or in the desert. The power generation stone, and the power generation road can supply for streetlamps, traffic lights, electronic advertising boards, and distributed sensors, etc. The power generation by human body provide a new way for wearable devices, portable devices and self-powered sensing. These research findings provide a new way of thinking about the emergence of new power generation and power transmission, as well as the phenomenon of gravitational waves.

The results of this study will have far-reaching and immeasurable impact on a range of research fields such as new energy, physics, astronomy, biology, and self-powered electrochemistry. As the limitation to the length of the article and the research time, many models are only briefly presented to fully explain the latest findings of gravitational waves and related natural phenomena. A systematic study of gravitational waves and applications is underway, and we will continue to report relevant research results.

#### **4. Experimental section**

**Materials:** Polymethyl methacrylate (acrylic board, PMMA), small LED lamp board (10 cm\*10 cm, 216 LEDs in series), medium LED lamp board (20 cm\*10 cm, 480 LEDs in series), large LED lamp board (30 cm\*20 cm, 1350 LEDs in series), bulbs (3 W, 12 V), leaves on branches (805 cm<sup>2</sup>, picked from campus), plastic bucket (206 cm<sup>2</sup>, 153 cm<sup>2</sup>), beaker (400 ml), copper sheets (4 cm\*0.8 cm), copper mesh (27.5 cm<sup>2</sup>), copper sulphate (CuSO<sub>4</sub>, AR, Tianjin Damao Chemical Reagent Factory), water, sand, stone, LEDs (3.2 V).

**Experimental methods:**

**LEDs lamp boards for collecting the electromagnetic field:** The medium LED lamp board and large LED lamp board were placed on the fixed acrylic sheet, and the acrylic sheet was tapped from the bottom by the hand wearing latex gloves.

**Stones for generating the electromagnetic field:** A stone was put on the floor and connected to the test instrument. Another stone was used to constantly collide the stone on the floor. And a LED can be driven after connecting to the circuit. Then several small stones were laid on the floor, and an electrode was connected at the bottom of stones. When the wind from the air blower blows, the LEDs connected to the electrode can be driven.

**Water for generating the electromagnetic field:** Water was put in an open tank and connected to the test instrument by wire. When the wind from the air blower blows, the electrical signals can be detected.

**A variety of materials as collectors for collecting energy:** Copper mesh, sand, water, leaves, wires and human body are used as collectors in turn to collect electromagnetic field generated by tapping the acrylic sheet. Taking copper mesh as an example, the copper mesh was placed on a fixed acrylic sheet. And it was connected to LEDs lamp board by wire. Next, tap the acrylic sheet from the bottom by hand wearing latex gloves.

**The power generation bucket with water:** The bucket (206 cm<sup>2</sup>) with a liter of water was placed on the table. One end of a wire was put in the water as an electrode. The other end of the wire was connected to the LEDs lamp board. Tap the bucket with hand and observe the phenomena.

**The experiment of copper sheets:** Four polished copper sheets were divided into two groups, and each group was connected by one wire. And the two groups of copper sheets were placed into the same concentration of copper sulfate solution in two beakers. One beaker was placed in the environment with the electromagnetic field generated by continuously tapping the acrylic sheet, and the other was placed on a stationary table. Two days later, take out the copper sheets and observe the phenomena.

**The power generation bucket with sand:** The bucket (153 cm<sup>2</sup>) with sand was

placed on the table. Like the bucket with water, one end of a wire was placed into the sand as the electrode, and the other end of the wire was connected to the LEDs lamp board. Tap the bucket with hand and observe the phenomena.

**The human body as collector:** The two ends of the LEDs were separately connected to wires. The other end of one wire was connected to hand, and another wire was connected to ground. Then the person walked and observed phenomena.

**The power generation stone:** Small stones were laid on the horizontal ground, and an electrode was connected at the bottom. The electrode was connected to the LEDs, and the LEDs were connected to the ground. When the person walked, jumped or ran on the small stones, the LEDs can be driven.

**The power generation road:** The electrode was directly placed on the road, and acrylic sheet was laid on the electrode. The electrode was connected to the LEDs, and the LEDs were connected to the ground. When the person walked, jumped or ran on the acrylic sheet, the LEDs can be driven.

**Electrical measurement:** The current was measured by an electrometer (Keithley 6514) with computer measurement software written in LabVIEW. The voltage was measured by a digital storage oscilloscope (DSO-X 2014A). Electromagnetic field was measured by electromagnetic field tester (Pudibei 620).

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