Saturday, March 30, 2019

The interactions of Electrons and Positrons.

I woke up amused on March 18th when I saw my last pages open so,

Oops .. I did it again tonight

A fog chamber is a particle detector that shows in the form of contrails the passage of nuclear particles into the material.

This is an enclosure (waterproof or not) in which a water vapor phase or supersaturated alcohol is present. Supersaturation is created via two different physical principles.

Wilson chambers operate "pulsed", that is to say that they show radiation only once or twice a minute because of the need to perform relaxation cycles via the piston.

The solvent used may be steam or a water-alcohol mixture.

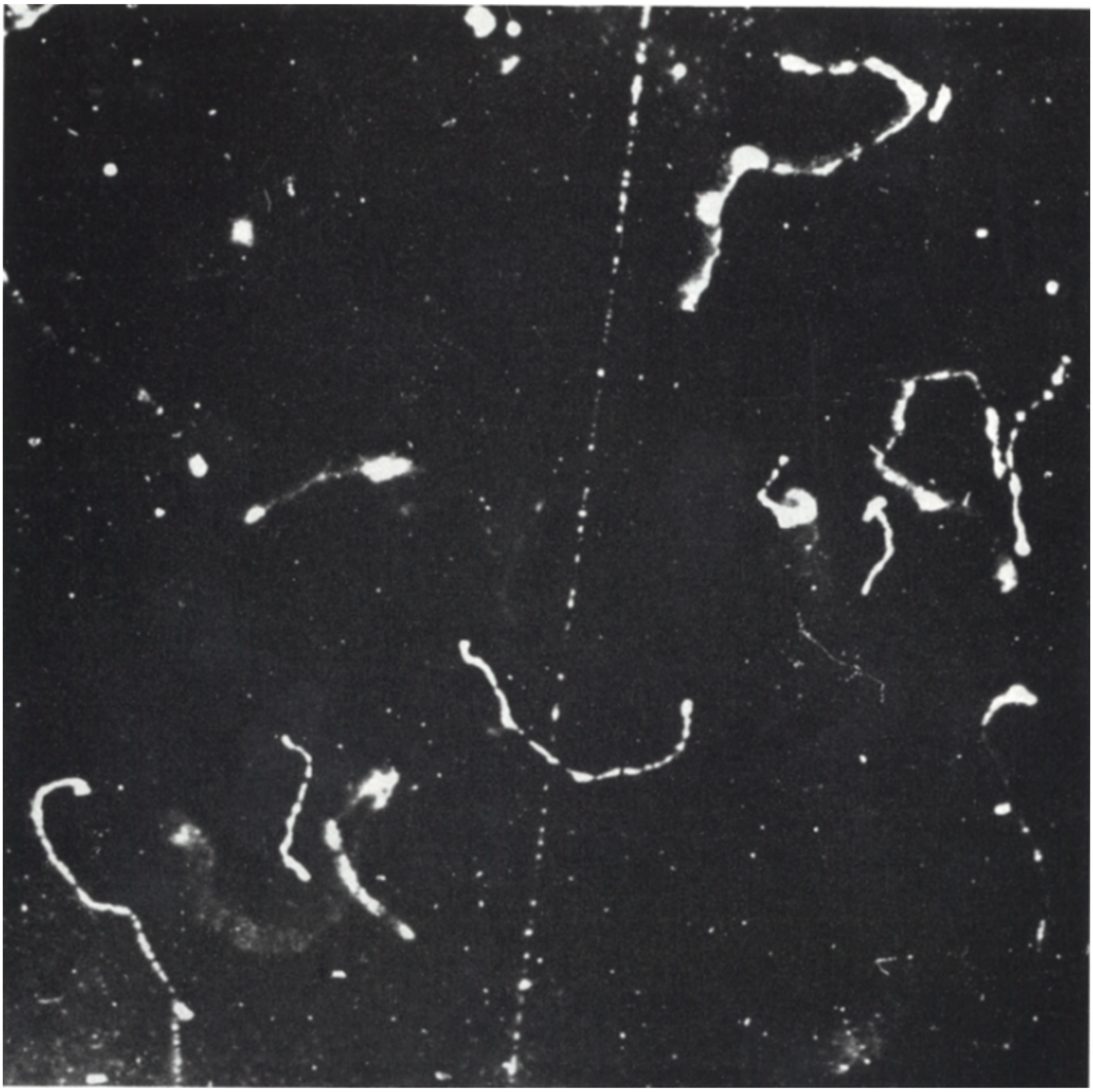
However, they can operate in a vertical plane to see particles from above which explains their use until the 1950s for the study of cosmic radiation.

The white marks observed in these machines consist of thousands of droplets of water or alcohol that have condensed where a nuclear particle has passed.

Depending on the shape of the plots (length, trajectory, droplet density), we can identify the particle that has passed through the detector.

Only charged nuclear particles (capable of ionizing matter) are detectable in fog chambers. At our altitude, four particles are commonly observable: alpha particles, protons, electrons and muons.

Although the latter are very discrete given their weak interactions in matter due to their relativistic speed.



Electrons slow and fast. C. T. Wilson, 1923.

The first fog chamber was created in 1911 by the Scottish physicist Wilson.

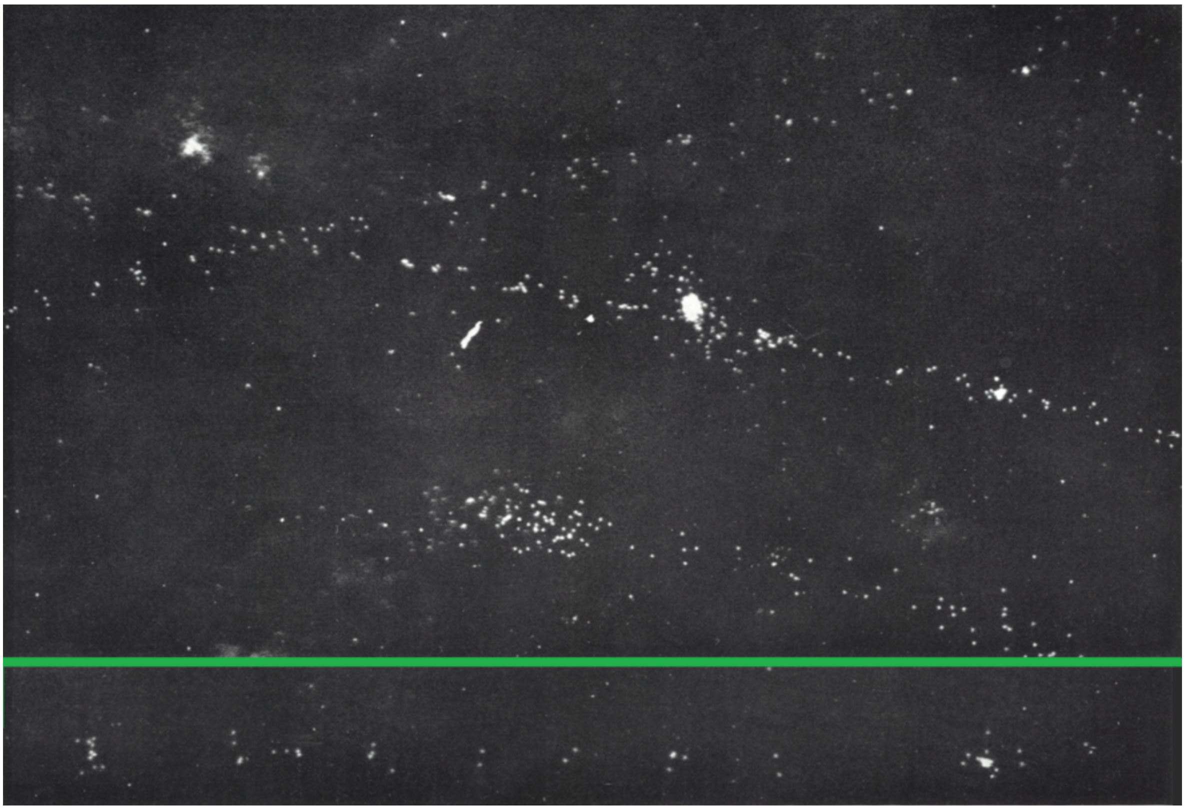
Fascinated by the spectacle of Brocken's Specter on the fog while working at the meteorological laboratory at the summit of Mount Ben Nevis, he wanted to understand their mechanism of formation by seeking to reconstruct them in the Cavendish laboratory (University of Cambridge)

To verify his theory, he shows as early as 1896 that X-rays have the ability to create large quantities of fog by the formation of ions in his enclosure, but he abandons his investigations until 1910.

It was in 1910 that he saw for the first time the traces of nuclear particles in his expansion chamber.

By introducing a sample of radium into the chamber, he saw streaks of water droplets that had formed where ions had been created by the passage of the particles emitted by the sample.

He received the Nobel Prize in 1927 for his discovery.

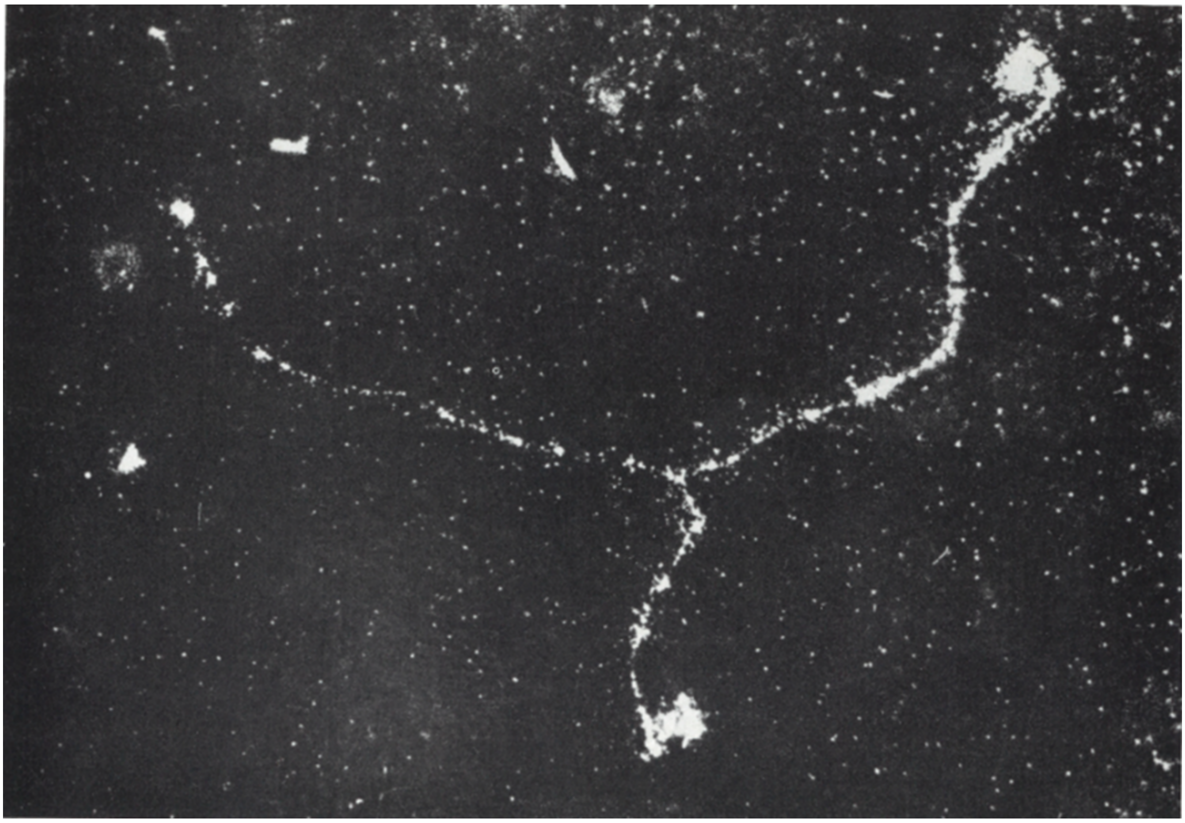


Close-up view of the trajectory of a beta ray below 400 mm Hg.

An accumulation of ions in the middle of the trajectory is visible (1932)

Bottom photo: 3x magnification of the trajectory of an electron at 200 mm Hg

The ion pairs are visible (1923)



Shock of an electron on an atomic electron.

The ejected electron becomes a "delta ray".

No magnetic field (1935)

Patrick Blackett took the experience of Wilson and improved it in 1921 so as to achieve relaxation automatically, with a camera to photograph nuclear events.

In 1925, he photographed the first transmutation of nitrogen into oxygen, induced by an alpha particle, as well as examples of scattering of alpha particles on nuclei.

The expansion fog chamber was mainly used for the study of cosmic radiation because it allowed to operate vertically (cosmic radiation being much more numerous with a zenith angle of 0 °).

Until 1951, the fog chamber made it possible to build nuclear physics by discovering (in part) cosmic radiation (Skobeltzyn 1927), positron

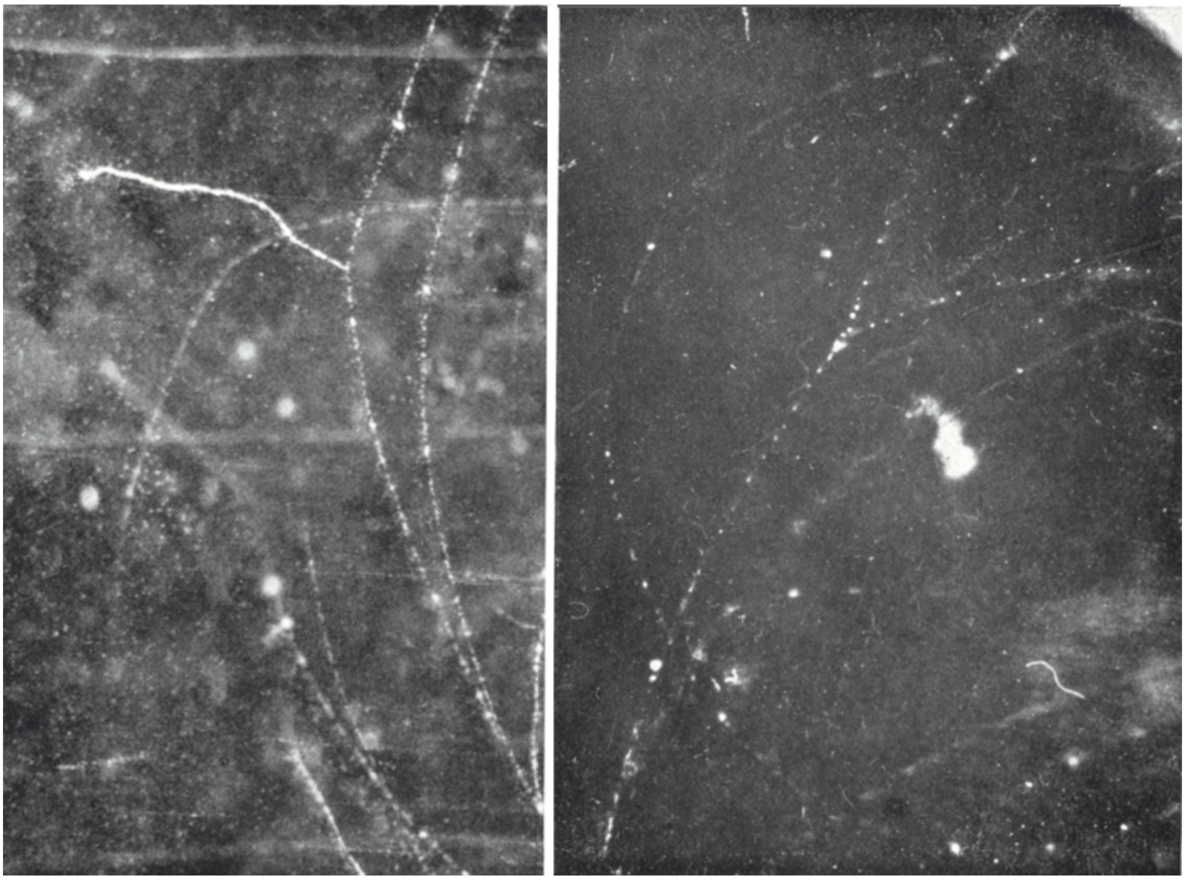
(Anderson, 1932), electromagnetic cascades with the process of pair creation (1933) , muon (Anderson, 1936), kaon (Rochester, 1947), baryons lambda (1951) and xi (1952)

In 1939, Langsdorf proposed another detection technique by creating a supersaturated state from the constant cooling of a black plate.

The diffusion fog chamber of his invention allowed the radiation to be seen continuously. Historically some machines were used to observe nuclear reactions from particle accelerators, but its delicate design prevented it from competing with the automated expansion chambers that produced clichés, until 1950, of better quality (especially by the control of the degree of expansion of the droplets)

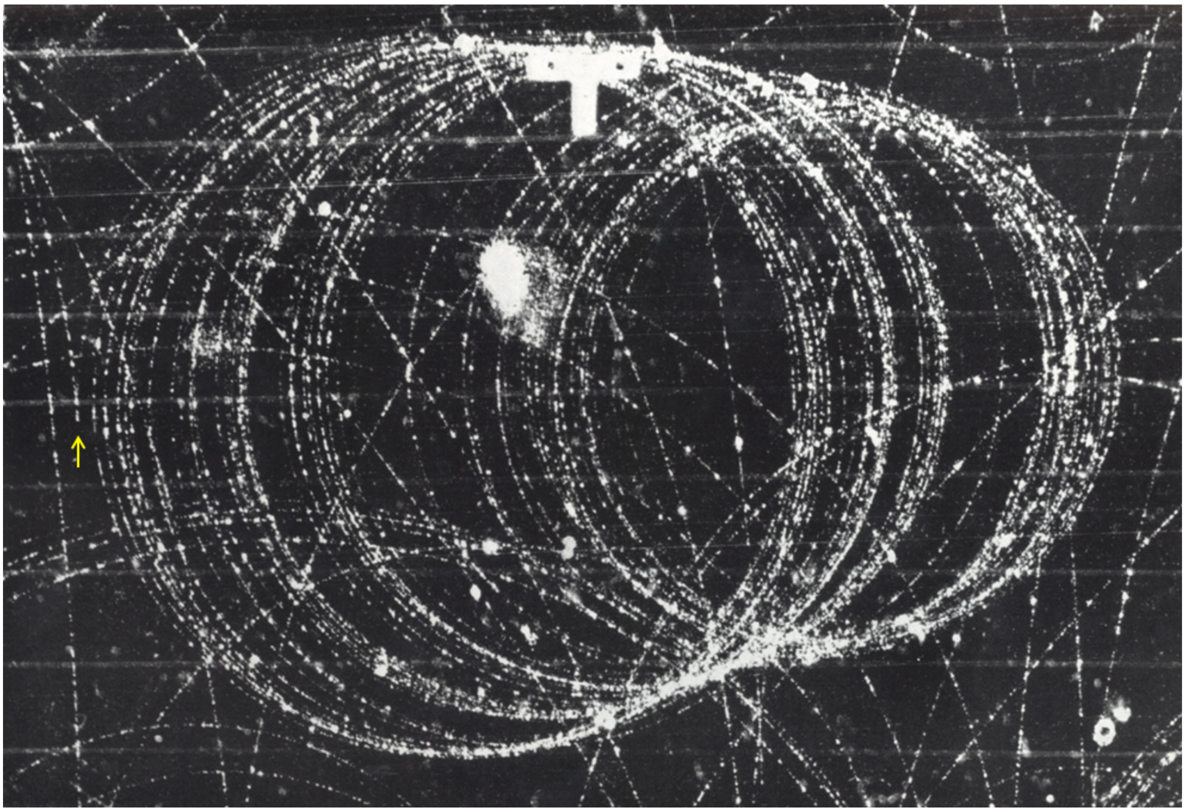
Nowadays, expansion fog chambers have completely disappeared. Only diffusion chambers are used for scientific popularization because their construction has become easier with the improvement of current cooling techniques.

The fog chamber gradually disappeared from the laboratories from the 1950s, when other methods of detection of particles were discovered (always in the form of traces in a solid, liquid or gaseous medium)



Left: a 40 keV delta radius released by an electron of 300 keV, coming from below, with a magnetic field of 300 Gauss.

Right: shock of an electron of 1.6 MeV (1935)



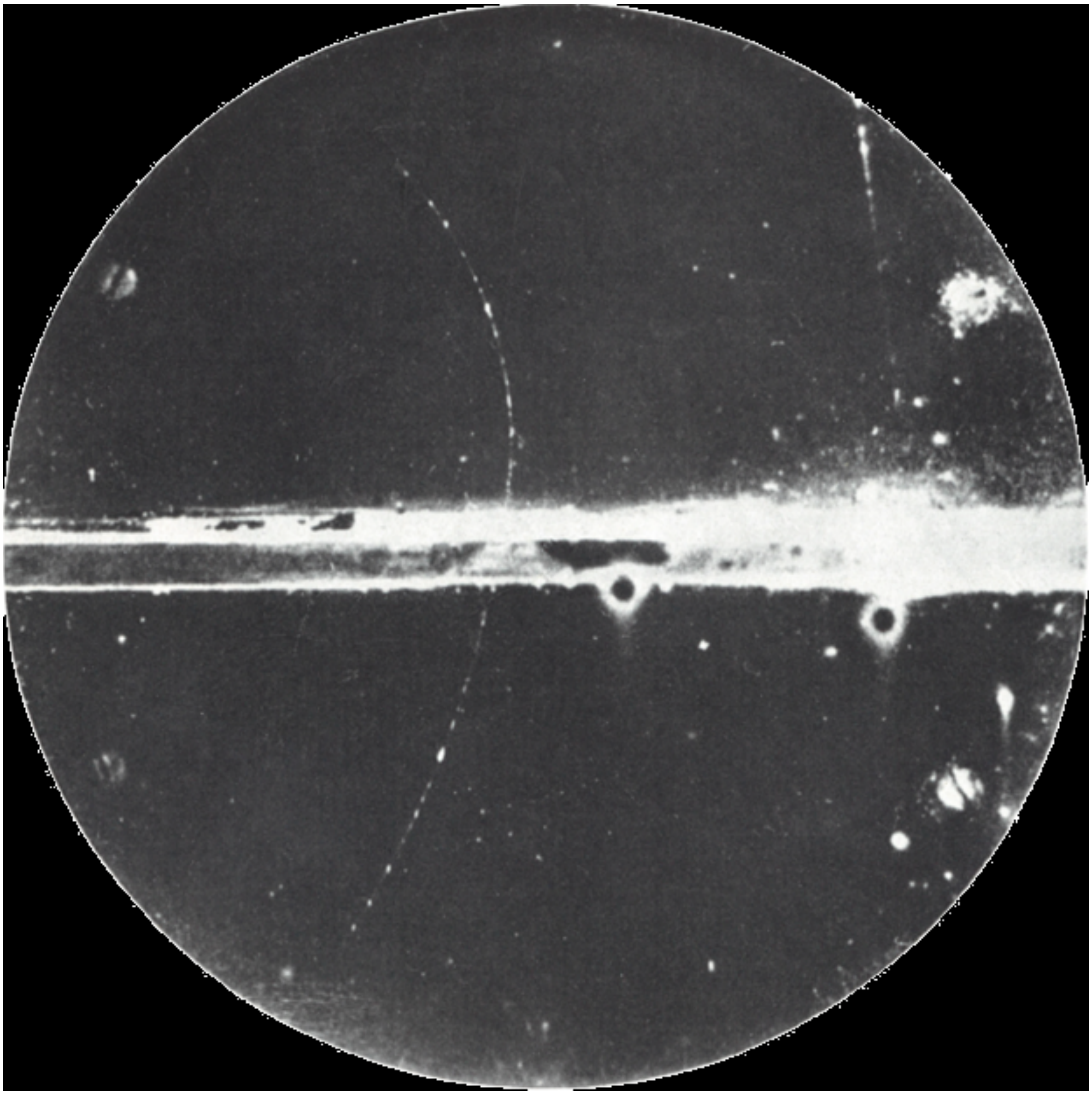
Fast electron losing its energy by ionization and radiation (Bremssthralung)

Magnetic field 1T, Argon 50%, Helium 50%.

Parallel lines are the wires for the electric field.

The chamber is 41 cm in diameter and 15 cm deep.

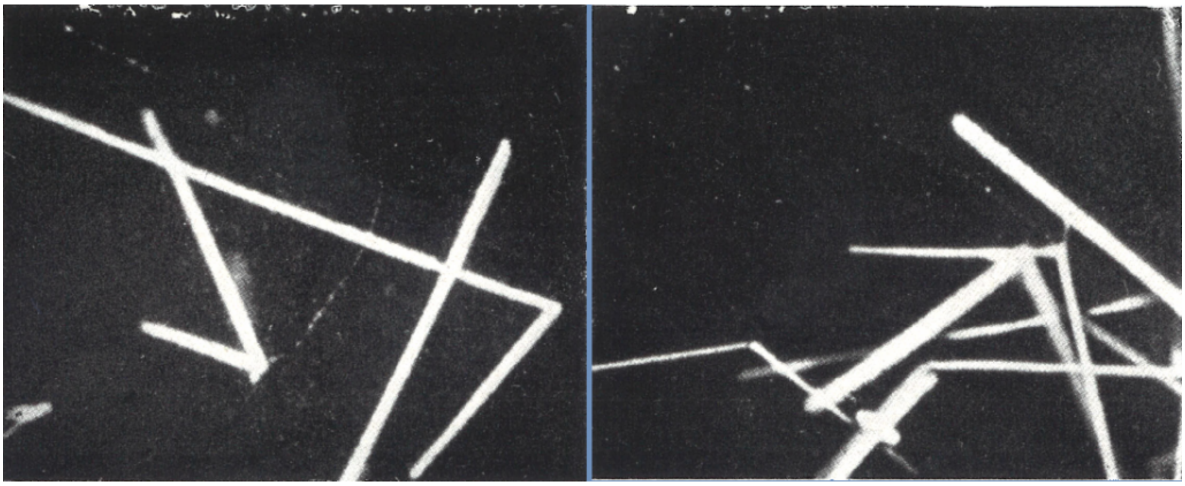
The size of the largest turn is about 12 cm in diameter. Radiation Laboratory, Berkeley



Discovery of the positon.

Magnetic field of 1,5T, diameter of the chamber 15 cm.

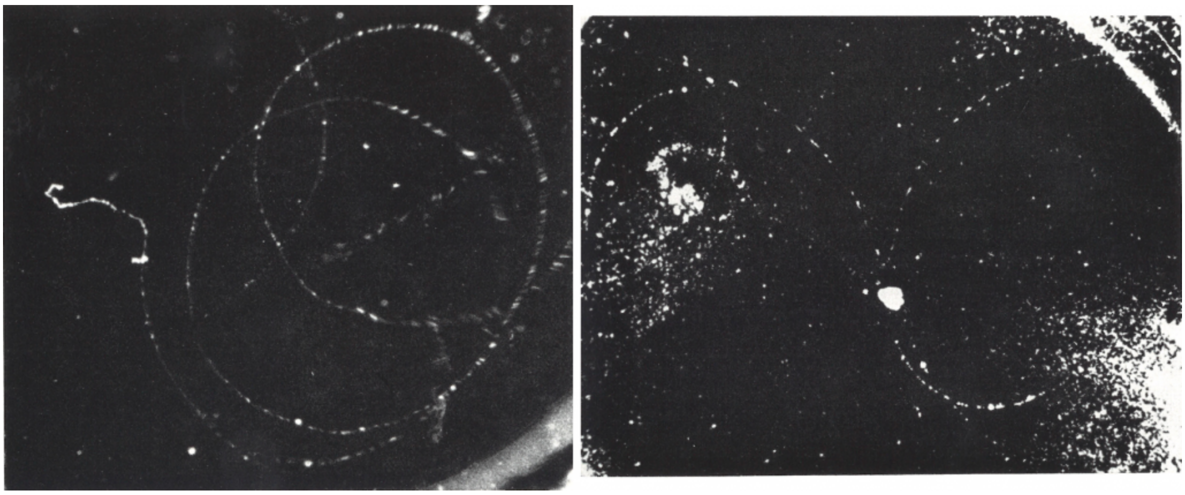
A 63 MeV positron crosses a 6 mm lead screen and comes out with an energy of 23 MeV



Electron of internal conversion of γ rays from radon 219 gas.

Auger electrons are also visible.

Magnetic field 380 gauss (1938)



Left: Internal conversion during beta decay of Xenon 135 or 133, with Auger electron emission, 530 Gauss magnetic field.

Right: Electron-positron pair resulting from the deexcitation of an Arsenic nucleus by gamma emission (2.2 MeV)

Magnetic field 714 gauss, diameter of the chamber 18 cm

The electron, one of the components of the atom with neutrons and protons, is an elementary particle that has an elementary charge of negative sign.

It is fundamental in chemistry because it participates in almost all types of chemical reactions and is an essential element of the bonds present in molecules.

In physics, the electron intervenes in a multitude of radiations and effects
The concept of an indivisible amount of electric charge was developed from 1838 by British naturalist Richard Laming to explain the chemical properties of atoms.

The electron is identified as the corpuscle envisioned by Joseph John Thomson and his team of British physicists in 1897, as a result of their work on cathode rays.

It was at this time that Thomson proposed its atomic model.

In 1905, Albert Einstein offers an explanation of the photoelectric effect-electrons emitted by matter under the influence of light.

In 1912, Niels Bohr explains the spectral lines by postulating the quantification of the orbit of the electrons of the hydrogen atom, another argument supporting this theory.

In 1914, the experiments of Ernest Rutherford and others solidly established the structure of the atom as a positively charged nucleus surrounded by electrons of lower mass.

In 1923, Arthur Compton's experimental results convinced a majority of physicists of the validity of quantum theory.

In 1924, Wolfgang Pauli defined the Pauli exclusion principle, which implies that electrons have a spin.

The same year, Louis de Broglie hypothesizes, verified later, that electrons have a wave-particle duality.

In 1928, Paul Dirac publishes his model of the electron which will lead him to predict the existence of the positron then antimatter.

Other studies of the properties of the electron have led to more complete theories of matter and radiation

During the nineteenth century, German physicists Julius Plücker and Johann Wilhelm Hittorf studied the electrical conductivity of gases in sealed glass ampoules with a cathode and anode that allow the gas to be subjected to electric current.

In 1869, Hittorf observed the emission, by the cathode, of charged "bundles of particles" if the bulb contains a gas at low pressure.

In 1876, the German physicist Eugen Goldstein shows that the rays of this glow cause a shadow, and he calls them cathode rays.

During the 1870s, the English chemist and physicist William Crookes developed the first cathode ray tube with a high vacuum inside, later called Crookes tube.

Then it shows that the light rays appearing in the tube transmit energy, and move from the cathode to the anode.

In addition, by applying a magnetic field, it is able to deflect the rays, thus showing that the beam behaves as if it were loaded.

In 1879, he proposes to explain these properties by what he calls: radiant matter.

He believes that this is a fourth state of matter, consisting of negatively charged molecules, projected at high speed from the cathode.

In 1896-1897, the British physicist Joseph John Thomson and his colleagues John Townsend and Harold A. Wilson perform experiments indicating that cathode rays are actually individualized particles, rather than waves, atoms or molecules as specialists believe at the time.

His considerable work on the deflection of cathode rays in an electric field is probably the reason why he is credited with discovering the electron.

The name of electron is proposed again by the Irish physicist George F. Fitzgerald, this time with success.

Historically, the electron is the first elementary particle highlighted.

In 1900, Paul Drude proposes to consider all the electrons of a metal as a perfect gas.

He then theoretically justifies an experimental conclusion that good electrical conductors are also good thermal conductors.

Even if its hypothesis is false according to current knowledge, this concept of: perfect gas of electrons, is still used in quantum mechanics.

By studying naturally fluorescent minerals, the French physicist Henri Becquerel discovers that they emit radiation in the absence of any external energy source.

These radioactive materials are provoking the enthusiasm of scientists, including that of the New Zealand physicist Ernest Rutherford, who discovers that they emit particles.

It gives them the name of alpha, beta and gamma particles, according to their penetration of matter.

In 1900, Becquerel shows that the beta rays emitted by radium are deflected by an electric field, and that their mass-to-charge ratio is the same as that of cathode rays.

This result reinforces the idea that electrons exist as components of atoms.

At the beginning of the twentieth century, physicists discovered that, under certain conditions, a fast particle caused on its trajectory the condensation of supersaturated water vapor.

In 1911, Scottish physicist Charles Thomson Rees Wilson, one of Thomson's collaborators, uses this effect to develop his fog chamber, which allows photographing traces of charged particles, such as fast electrons, which makes it easier to their study.

In his publication Recherches sur la théorie des quanta, in 1924, the French physicist Louis de Broglie hypothesizes that all matter possesses a L.De Broglie wave similar to light.

That is, depending on the conditions, the electrons and other material particles show the properties of either particles or waves.

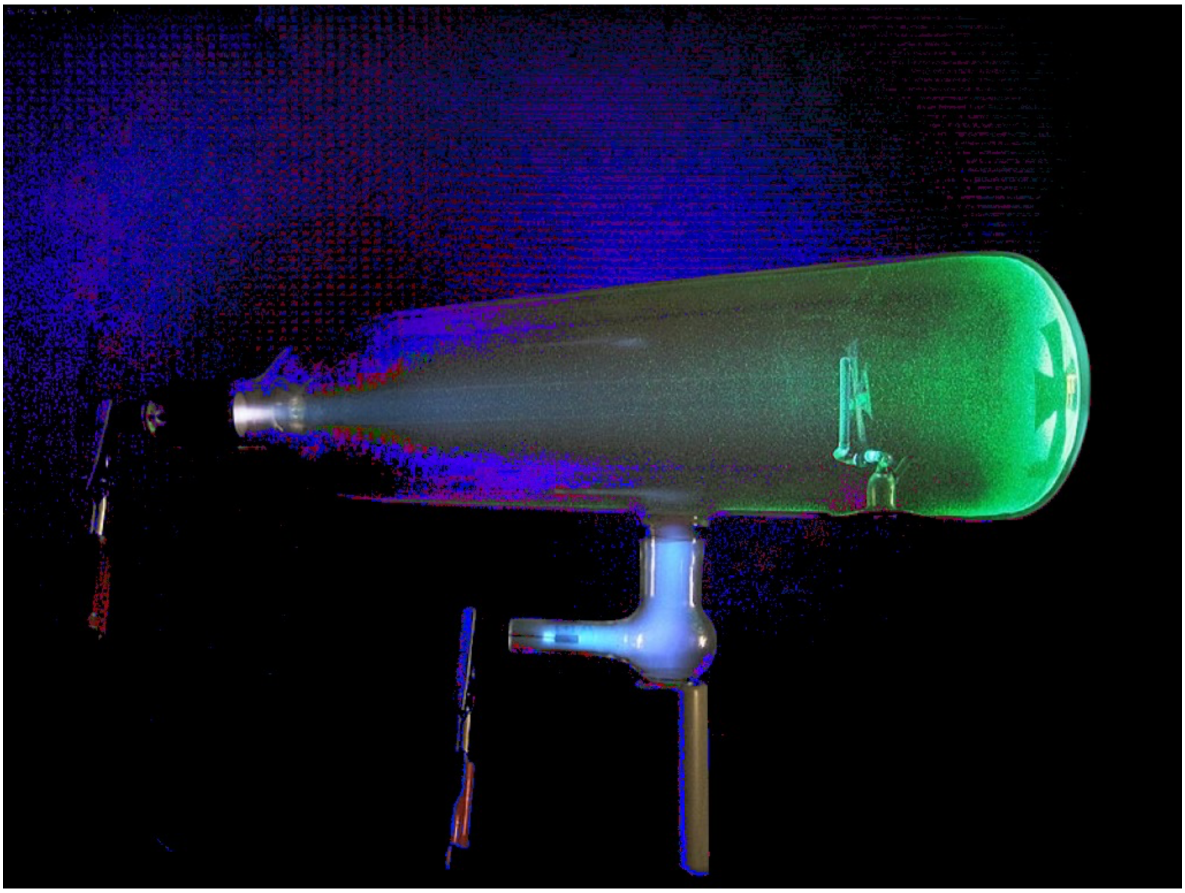
The corpuscular properties of a particle are patent when it appears at any time located at a point in space along a trajectory.

The wave nature is observed, for example, when a beam passes through parallel slots and creates interference patterns.

In 1927, the effect of interference with an electron beam is shown by the British physicist George Paget Thomson, using a thin metal film, and by American physicists Clinton Davisson and Lester Germer using a nickel crystal.

The electron has a wave-particle duality, which can be demonstrated by the experiment of Young's slits.

This property allows it to pass through two parallel slots simultaneously, rather than just one slot, as would be the case for a conventional particle.



Electrons are indistinguishable particles because they can not be distinguished from each other by their intrinsic physical properties.

In quantum mechanics, this means that a pair of electrons present must be able to invert their position without causing any observable change in the state of the system.

The wave function of fermions, especially electrons, is antisymmetric, that is to say that it changes sign during the exchange of two electrons When free electrons move-whether in a vacuum or in a metal, they produce a net charge current, called electrical current, which generates a magnetic field.

Similarly, a current can be generated by an electric field, possibly caused by a variable magnetic field.

At a given temperature, each material has an electrical conductivity which determines the value of the electric current when an electric potential is applied.

Examples of good conductors include metals like copper and gold, while glass and Teflon are bad conductors (they are insulators)

In any dielectric material, the electrons remain bound to their respective atoms, and the material behaves like an electrical insulator.

Most semi-conductors have a varying degree of conductivity between the extremes of the conductor and the insulator.

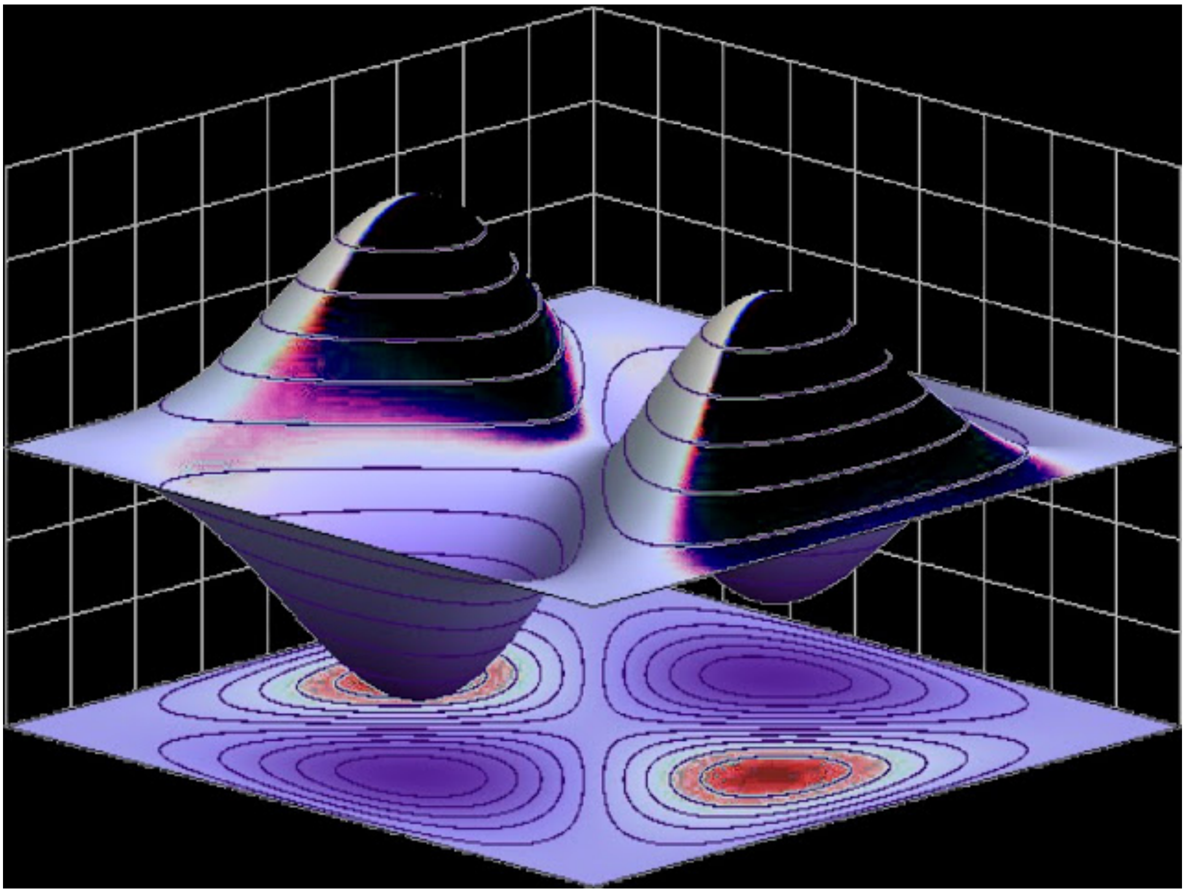
In addition, the metals have a structure in electronic bands, some of which are only partially filled.

The presence of this type of band allows the electrons to behave as if they were free or delocalized.

When an electric field is applied, they can move like the molecules of a gas (called Fermi gas) through matter, much like free electrons. These phenomena are the basis of all electricity: electrokinetics, electronics and radio.

A lightning bolt consists primarily of a stream of electrons.

The electric potential required for lightning can be generated by a triboelectric effect.



Example of an antisymmetric wave function for a quantum state of two identical fermions in a one-dimensional box.

If the particles exchange their position, the wave function changes sign.

Incandescence, which appears in heated materials, is caused by the orbital changes of the electrons in the atom.

Luminescence is an emission of light that occurs at relatively low temperatures and is also a consequence of the orbital changes of the electrons in the atom.

When an electron is accelerated, it can radiate energy in the form of photons.

This electromagnetic radiation is manifested as radio waves, microwaves, infrared, visible light, ultraviolet, X-ray or gamma rays.

Optical scattering, an interaction between light and electrons, explains optical reflection.

Rayleigh diffusion helps to explain the color of the sky.

The Big-Bang is the most widely accepted scientific theory to explain the early stages of evolution of the Universe, whose age is estimated in 2011 at about 13.75 billion years.

During the first millisecond after the Big Bang, the temperatures reach 107 K, and the photons have an average energy higher than 1 MeV.

They therefore have sufficient energies to react together and form electron-positron pairs.

In the stars:

About a million years after the Big-Bang, the first generation of stars begins to form.

In a star, stellar nucleosynthesis results in the production of positrons by fusion of atomic nuclei and β + decay of the nuclei thus produced, which transforms the excess of protons into neutrons.

The positrons thus produced annihilate immediately with the electrons, producing gamma rays.

The net result is a constant reduction in the number of electrons, and the conservation of the charge by an equal number of proton transformations into neutrons.

However, the stellar evolution process can lead to the synthesis of unstable heavy nuclei, which in turn can undergo β- decays, which recreates new electrons.

An example is the cobalt 60 nuclide (60Co), which decays to 60 (60Ni) nickel.

At the end of its life, a star heavier than 20 solar masses can undergo a gravitational collapse to form a black hole.

According to classical physics, these massive stellar objects exert a gravitational attraction strong enough to prevent any object, including electromagnetic radiation, from escaping from the Schwarzschild radius.

However, astrophysicists believe that quantum effects allow the black hole to emit low Hawking radiation at this distance and that electrons (and positrons) are created on the horizon of black holes.

When pairs of virtual particles: such as an electron and a positron, are created near the horizon, their random spatial distribution may allow one of them to appear on the outside: this process is named effect quantum tunnel.

The gravitational potential of the black hole can then provide the energy that transforms this virtual particle into a real particle, allowing it to spread into space.

In exchange, the other member of the pair receives a negative energy, which results in a net loss of energy-mass of the black hole.

The rate of Hawking's radiation increases as the mass decreases, eventually causing complete evaporation of the black hole.

Observation:

Polar auroras are mainly caused by energetic electrons from the Sun, entering the atmosphere.

Remote observation of electrons requires the detection of the energy they radiate.

For example, in environments rich in energetic phenomena such as the star ring, free electrons form a plasma and transmit energy by continuous braking radiation.

The electron gas can undergo a plasma wave, which consists of waves

caused by synchronized changes in electron density, which causes detectable energy emissions with radio telescopes.

The first images of the energy distribution of an electron were made by a group at the University of Lund in Sweden, in February 2008.

Scientists used very brief pulses of light (from 1 attosecond to 10-18 s), which allowed for the first time to observe the movement of the electron.

The distribution of electrons in solids can be visualized by UV photoelectron spectrometry analyzed at an angle.

This technique uses the photoelectric effect to measure the reciprocal network.

Applications:

The properties of the electron are exploited in the electron microscope, the cathode ray tube, the welding, the laser effect, the photographic-sensor and the particles accelerator.

It was so exciting to write those data.

It unveil the relationship between my research and my first exposure.

Video-art creator:

The appearance of television had changed the world.

Marcel Duchamp did everything except the video.

He made a big entrance door and a very small exit door.

“Marcel Duchamp has already done everything there is to do except video. It is only through video-art can we get ahead of Marcel Duchamp”

Nam June Paik.

Interview with Irmeline Lebeer. in: Chroniques de l’art vivant nr. 55 (February 1974), p. 35, quoted in: Marcel Duchamp: The Most Influential Artist of the 20th Century? p. 27

Work marked by the Fluxus artistic group that mixes music, performance, art and writing with heterogeneous, transdisciplinary and experimental influences.

I'am happy to write that my projects was approved for the Karostas festival.

Artwork 1:

I'll be able to create a giant camera obscura.

There are a lot of different rooms in Redan (Old Forts) so, I will be able to use this space.

This i can do on the last day of festival when there will be public event.

Artwork 2:

MAGNETEEVEE

A video arts installation.

which will allow me to delight with an artwork dedicated to video Art and Sciences.

A participative artwork where people will be able to interact with the installation and learn something that can be really fun and in a rather psychedelic situation, impressive.

Artwork 3:

Visual: Fish-eye-workshop.

I will personally bring few fisheyes devices and tripods.

I will create an event that my host can share to invite people to brings their fisheye.

Taking photos in different fish-eye cameras including instant camera.

I will devellop photos in a workshop.

Allowing visitors to devellop images during the event with me in groups of 2. With an option to work with local labo-photo.

The photos will be published in a special edition of the magazine May+June.

I obtained, last night: that my artworks are also presented in the Prison of Karostas just before the public event.

This is a added by my host, enjoying my artworks proposal.

Also i got that: Some students of media in Liepaja University, who could to take part in the project by interest.

People will come back to Prison on Saturday and they will see artworks as well.

My host will advertise this event in media, before.

I am really happy.

Video-arts installation:

I have asked for 6-8 TV plus 6-8 video-recorders in state of operation and connection to power supply.

And asked to create this installation in nature or atypical place and I got it:

Between Forts: there is a lot of green and nature or in the tunnels of Forts so please see pictures attached in Patreon

patreon.com/posts/25544487

patreon.com/posts/25702071

patreon.com/posts/25724697

Courtesy:

To Karostas cietums and to the city council.

To Artrvl

The Camera Obscura events got sponsored by Bonfoton

This post will be available physically in the May magazine with all the photos.

The images in black and white are from the remarkable book Bothe, Gentner and Maier-Leibniz, published in 1940: The Atlas of Typical Cloud Chamber Images.

They are all taken in a Wilson expansion chamber.

Posted by Veronica IN DREAM at 8:52 PM