Higgs-Englert boson and vacuity: A parallelism between the vision of physics and Zen.

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Introduction

During the cooling down of our universe only 4% of the energy has been transformed in observable mass. We are living in a situation where we ignore the composition of the 96% of our universe. 20% would be formed by some unknown mass whose effects are observed through gravitational interactions; such effects could not be explained only by the action of the apparent masses. Unknown, this mass is called dark matter, as it stays invisible to any observation. All the rest – 70% - would be diffuse energy, called dark energy. This one represents a great enigma: Is it responsible for the acceleration of the expansion of the universe due to its positive potential, source of a centrifugal force? Although astrophysics and particle physics have done tremendous progresses and have opened long hidden horizons of observations and knowledge, it remains a fact that still today we ignore the quasi-totality of the composition of our universe. 70% has remained under the form of energy. This part, in Buddhist language, could be called the vacuity, a latent and potential form of all appearances and phenomenon's. In that sense, vacuity is not nothingness: It is not empty according to the common sense of the word, but quite the contrary, it is inhabited by a field of energy called the Higgs field.

This notion is close to the one developed in the old Buddhist sutras called *sunyata*, or *ku* in Zen, both terms alluding to a vacuity filled with all potentialities, physical as well as psychic. The word nothingness is reserved to an absence of everything, including the absence of space-time. Nothing can appear suddenly

from nothingness, whereas space-time and matter can appear from a vacuity full of potentialities. Concerning the psyche, such a vacuity would be represented by our unconsciousness, the potential universe of all our conscious thoughts. And what about the physic side? Such process, the apparition of matter from vacuity, is described by the mechanism of Higgs-Englert along with its associated particle: The Higgs boson (below, the simplified term of Higgs boson will be used. Higgs and Englert got conjointly the Nobel price for their theoretical prediction experimentally verified at the LHC accelerator at CERN).

The next paragraphs do not pretend to form a scientific article but are an attempt to bring closer the vision of Zen concerning reality, on the forms and phenomenon's issued from the vacuity, and the Standard Model of the particle physics where matter, mass, appears thanks to the coupling of some "flavors" (the quarks) with the energy of the Higgs field. This energy, extracted from this field, localized, is equivalent to the mass given by the well-known Einstein equation E = mc2.

I then propose to you a vulgarized journey into the current model of particle physics, the Buddhist Sutra and the Zen vision of the phenomenons' world, with a detour in what stays unknown to us. The apparent conclusion is that everything is born from the vacuity as it is populated by perturbations and energy. Energy, big bang, space-time, pre-universes or not, the puzzle is not complete but numerous pieces are still missing to such extend that we may ask ourselves if we are trying to understand and to assemble the correct puzzle, or if we are not in the process of conceptualize a wrong understanding of our universe.

The model of particle physics

Our actual understanding of particle physics is based on a model that is not only capable of reproducing and understanding the experimental results, but is also capable of making predictions It is however only a model, as precisely verified as it is. It contains quantities extracted from the experiments and not only fundamental variables of our universe such as the speed of light, for example. It is more like a grid that allows us to understand the link between the various quantities that generate matter and the forces responsible for their mutual interactions. Does it correspond to the unique truth? No one knows for the time being. As a reading grid it allows us to advance in our understanding of the particles of matter, and of the forces leading their interactions. This integrated model includes at the same time the constituents of matter, called quarks and leptons, and the interactional forces.

The constituents of the standard model

The constituents of the standard model have all intrinsically a zero mass; the model must be able to explain the generation of mass on one side, and the differences between the masses of the observed particles on the other side. In nature only three families of quarks and leptons exist. Why three? Why these three families have different internal characteristic although they have no mass, so no reality? A single family has survived until our time, the mother family of the protons, neutrons and electrons; the two others have disappeared although they have existed in a time close to the big bang when the temperature of the universe was extreme. When we call these elements quarks, we automatically think about some ultra microscopic and material objects. But they are not. It is the reason why these families are called “flavors”. This term alludes to a scent, a taste, detached from its material source. We do not have any idea what they really are, neither where they come from. Do they have some source or are they “flavors” inherent to our universe? To give a definition seems to be beyond our language.

The problem arises: How do these “flavors” acquire a mass? If they do not possess any intrinsic mass, where are the observed masses in nature coming from and why the elementary particles have different masses? And why visible matter does represent only 4% of total energy and matter? The rest is energy, and dark matter: where are they coming from? If we accept the presence of these “flavors”, and of a form of energy filling out the vacuity, then we know how the masses have been formed: Through the action of the Higgs mechanism and its associated boson. But this one is by no means the God particle, as it does not explain the origin of all things: Energy and “flavors” remain for us mysteries as we ignore where they would come from.

Let us recall once more that there is no difference between mass and energy. The mass can be considered as a form of very localized energy. If the energy would be compared to some water, then the mass would have to be compared to crystals of ice, all different from each other, as agglomerates of water locally concentrated.

The forces

It would be illusory here to try to propose an absolute definition of the forces that regulate the interactions between the elements of our universe, as these can be visualized in two different ways.

Let us take for example two persons playing tennis. They are linked by an interaction: the fact to play tennis. This interaction can be seen as an attractive force between these persons: An interactive field that binds them. In the same way two magnets are attracted by the force of the magnetic field that binds them, their electromagnetic waves interpenetrate each other and tend to minimize the distance that separates them. This is seen from a wave-like perspective where the forces carry some quantity of energy, much like the electromagnetic waves, the radio, radar, X rays, ultraviolet or infrared light.

But this interaction between the two tennis players can also be seen as the exchange of a tennis ball. What binds the players is the tennis ball. It is the same thing in physics: Every interaction can be visualized either as due to the force of a wave field, or to the exchange of a particle. This one is not a material particle but a virtual one that can only be observed in particular energetic conditions and during an extremely short time. So light or any wave-like phenomenon can also be seen as the exchange of a photon, a grain of light. The inner interactions in the atomic nuclei responsible of the radioactivity can be visualized either by the action of an interactive field, or by the exchange of virtual particles: The intermediate bosons. When the produced energy in a collision in between nuclei of matter in a particle accelerator, as the one at the CERN in particular, is capable of concentrating locally the field of force in a sufficient quantity of energy corresponding to the “size” of the exchanged particle (the tennis ball), this one can then be really observed during a short time.

This way of seeing things is not new but take its origin in the duality wave-particle expressed in the 20’s. We are effectively in the zone of validity of the quantum physics, right around the border between energy and mass. In that fringe of energy, these two states are not defined independently, but will take a form determined by the observation. In physics the notion of field has become an autonomous concept, expressing at the same time the interactive wave and the exchanged particle, as the third included overpassing the duality wave-particle.

Grosso modo two domains of forces exist in our universe: The ones governing the atomic interactions, nuclear or sub-nuclear, which are all very

strong, and the gravitational force which is infinitely small. The more modern physics has great successes in an integrated understanding of the unification of the forces of the infinitely small, the more it stays unconceivable theoretically to accommodate a theory unifying at the same time gravitation and nuclear forces: Their difference in scale is too big.

Something was missing in the standard model: The Higgs field and its associated particle, the Higgs boson. The Higgs field would be the equivalent, in our tennis example , of the interaction linking the two players, and the Higgs boson would be the equivalent of the ball exchanged. So then what is the Higgs field and the Higgs boson?

The Higgs boson

Visualize space, or vacuity, entirely filled up by a field of energy called the Higgs field. What is it really, where does it come from, is it permanent? We do not have any answer to this kind of questions. Let us recall that the notion of field in quantum theory generalizes the ones of waves or particles, it is an independent entity. We can naively visualize the Higgs field as energy waves filling out the vacuity of our universe. It would be a wave-like representation of the field. We can also visualize the Higgs field like myriads of virtual Higgs bosons. These have not acquired enough quanta of localized energy to appear under the form of a defined mass. When a strong perturbation acts on them as a magnet, they stick to each other and become observable under the form of a boson having a real mass for a short time: THE Higgs boson.

At the time of the big bang, or during a frontal interaction between two protons in an particle accelerator like the LHC at the CERN, quarks, called also “flavors” are produced. These three families of “flavors” have such internal characteristics that they will couple in a different way to the ocean of virtual Higgs bosons, to the point where the locally accumulated energy will give a mass. Some “flavors” will attract a lot of virtual bosons and will create particles with a great mass; some will only attract few of them and give particles of small mass. We do not know why some “flavors” have a strong coupling or not to the Higgs field. We only observe that it is the case. For example the photon does not attract any virtual Higgs. It is then not slowed down by the heaviness of the virtual particles that stick to it, and so it travels at the speed of light.

Let us take a parallel to explain this phenomenon. Instead of a quark, or of a “savor”, let us consider, a ball of magnetized iron so small that it has no mass and is totally invisible. If you throw it in a field of filings, it will quickly become visible due to the filings that it attracts: It will take a mass that will depend on its attraction to the filings, on the amplitude of its magnetic field. Our world is made as if the number of families of such invisible balls would be three, and three only. Internally they carry a magnetic field: weak, medium or strong. The ball with a weak internal field will travel at high speed in the filings because it will not be

slowed down by its accumulation of grains around it. The one carrying an intense internal magnetic field will at the contrary be strongly slowed down by its accumulation of filings that makes it bigger and slower. Some balls like the photon, not carrying any characteristic of inner field, pass straight at the maximal speed. By replacing the iron filings by the Higgs field and the invisible balls by the quarks or the “flavors”, you have what is called the Higgs mechanism, generating the various visible masses.

How can we know that all that is due to the Higgs field? We must observe it. That means that we should produce locally a sufficient accumulation of energy of the Higgs field, or of virtual Higgs bosons, so that it can be observed. This ball of energy is called THE Higgs boson. It is detectable under the form of an unstable particle. Its mass is linked to the force binding the virtual Higgs bosons in between them, a bit like the size of a water drop is linked to the surface tension of the liquid.

With the observation of the Higgs boson, the standard model of the particle physics is complete. So what then? If our understanding of nature is totally coherent and if this model is so well adapted to all our observations, it become more and more hazardous to think that it could exist anything else. The particle physics would then be facing an immense desert where nothing new would appear taking into account all the world possibilities of accelerators, even if they would be build around the earth.

Having approached on a popularized way the world of the Higgs, vacuity and dark energy, it is time to come to the question if anything of that could be close to Buddhism and Zen, close to their vision of our universe.

The concept of the universe from the Mahayana Buddhism and Zen

It is mentioned in the Sutra of the Great Virtue of Wisdom, the Prajnaparamita sutra of Nagarjuna: " *The matter is empty from the character of matter. All dharma's are empty of intrinsic dharma. It is the absolute vacuity.*" It means that all the phenomenon's are devoid of any intrinsic existence. And in the Phenasutra, Buddha said: "*The matter born from causes and multiple conditions does not have any solidity. On water, the waves produce a ball of foam that, as soon as seen, disappears; with the matter it is the same.*" Nagarjuna adds: "*When the elements of the present existence and the causes and karmic conditioned of the previous existences are gathered together, they produce a matter, but as soon as these causes and conditions disappear, matter disappears with them.*" The Mahayana Buddhism states then that the vacuity is a common character to every phenomenon, to the beings and the things. Everything comes from the vacuity and goes back to it. However this vacuity itself does not have any existence: To hypostatize the vacuity would be a great mistake in the understanding of the Buddhist philosophy.

This entire thought is born in a reaction to the Brahmanism beliefs in the eternal soul, in the ego. The treaty of the Abhidharma considered then the vacuity as the absence of the self and stated then the vacuity of the beings to liberate its adepts from any attachment to the self or to the mine. In the Hinayana Buddhism however the vacuity of the beings had the dharma itself as a substrate. That has been abandoned in the Mahayana perspective. How to understand vacuity in such a context? By which logic is it possible to envisage that every being and every thing have no intrinsic existence and cannot justify of any existence? Following this thought, no particle can merit the adjective of elementary. For that we must invoke three fundamental notions in Buddhism: Impermanence, interdependence and the world of forms.

Impermanence

In Buddhism and Zen nothing is permanent, no being, no thing; nothing is eternal. As everything changes at each instant, it is impossible to define any permanent reality of whatever. No existence can be defined in itself. Let us take for example a pot in clay. How to define it in itself? At the beginning it was only some humid clay, it had to be formed and cooked. Maybe later on, the pot brakes in pieces; the clay stays but the pot disappears. No noumenon can be attributed to this pot as the impermanence makes its form to change continuously. However in the present the pot exists, that means that it has a form of a pot and that its form is real. In Zen the forms are real, it is not that nothing exists: the forms exist but no intrinsic existence can be defined for anything. In such a sense the beings and the things are empty. It come from vacuity, and goes back to vacuity.

Interdependence

Our planet is limited by few kilometers of atmosphere and we live on it all together, beings, nature, water and available energy. It is obvious that we are in complete interdependence, everyone with everything. Nobody can pretend to live only by himself or to be fully autonomous. When we were born we only weighted between three and four kilos and as adults 15 to 20 times more. Where does such a difference comes from? Of what are we principally constituted? First we are made of water, which means made of the evaporation of the oceans, of the rain, the melting of the glaciers, and of an entire cycle generator of life. Already with that, we cannot justify an intrinsic and singular being, we are fully dependent of that life. Then, we are made of what we eat: Earth, sun, humidity. The cycle of nature feeds us. To define ourselves by ourselves is not possible; we do not have any noumenon, everything that we are comes back to the totality of the world.

We are empty from any proper existence: only a gathering, an accumulation of everything that surrounds us, in full interdependence. How could we isolate our existence purely by itself when it is really made of the totality? However, our human form is well real.

The world of forms

A koan says: "*What was your face before the birth of your grandparents?*" Before our birth we were already here but under a scattered form. All the potential ingredients of our conception, at the time of our birth, were already present in the world, like the pot was already potentially contained in the clay of the earth. But we did not have any identified existence, no individuation. In that sense we were part of the vacuity, of the world of potentialities. At our birth the world embodied us, under a defined form. And after our death we will join again the world of before our birth, the world of *sunyata* or *ku*.

Most people see their birth, their life and their death under an angle that is totally individual, as if they were autonomous. It is the world of suffering. Birth is suffering. Life is suffering and death is also, we never get out of it.

In the universe, from its apparition, nothing gets born, nothing disappears, but everything transforms itself. The forms of all things modify themselves, like agglomerates that form and undo themselves: Atoms, molecules. Ourselves are issued from this indistinct vacuity and we will go back to it. That does not mean that we do not exist when we are alive. Our human form is well real, although we are simply form by the interdependence and the impermanence.

The Heart Sutra (Hannya Shingyo Sutra)

In this sutra the bodhisattva Avalokitesvara explains to Sariputra what is the vacuity:

The bodhisattva of the true freedom and compassion, by the deep practice of the Great Wisdom, understands that the body and the five skandas (sensation, perception, thought, activity, consciousness) are only vacuity, ku, and through that understanding, he helps all the ones who suffer.

Phenomenon's become ku, ku becomes phenomenona (form is emptiness, emptiness is form), and the five skandas are phenomenon's also.

O Sariputra, every existence has the character of ku, there is no birth, no beginning, no purity, no dirtiness, no growth, no decreasing.

This is why, in ku, there are no forms, no skandas, no eye, no ears, no nose, no tongue, no body and no consciousness

There are no colors, no sounds, no smell, no taste, no touch, and no object of thought.

There is no knowledge, no ignorance, no illusion of decline and death.

There is no origin of suffering, no cessation of suffering.

There is no knowledge, no profit, and no no-profit.

…

All the Buddha's of the past, of the present and of the future, by this incantation (mantra) matchless and unsurpassable that allows to find the authentic reality, ku, can attain the understanding of this Supreme Wisdom that delivers from any suffering.

…

Everything is *ku*, vacuity: No noumenon. Physical as well as psychic phenomenon's , come from *ku* and go back to it, like the elementary "flavors" couple to the Higgs field to give masses. Our thoughts, our ideas as well, spring out of our unconsciousness and go back to it.

In Buddhism, the first reflection on the vacuity has been linked to the vacuity of the ego, and of all thoughts; these are said to come from nowhere and to go nowhere. A particular sense has been asserted by the Mahayana Buddhism: The vacuity of the self, and so the vacuity of the beings, vacuity of everything. Going back to the primary cause of everything, we only find the vacuity: It is the only one that can pretend to be permanent. In summary, the origin, the essence of everything, of all forms of matter, of beings or thoughts, for the Buddhism and the Zen in particular is *ku*, the vacuity. The vacuity is not the emptiness. Nothing can appear from the emptiness, no geometry, no space, no time and no existence. The vacuity contains everything that has not yet appeared in the existence, or everything that has disappeared from the existence, everything that is not part of the real forms. In that sense *ku* is not entirely empty, it is only empty of any

particular forms. One could say that it is similar to the dark energy of the astrophysics, or to the Higgs field present in the whole space.

However an unknown remains: The question of the quarks, called also “flavors”. In the standard model they have a zero mass and then no material existence, but however they possess properties that allow them to couple to the Higgs field. It is an enigma. Why what we call vacuity in Buddhism would posses such properties and would not be a fuzzy without any characteristic? In fact nothing in Buddhism characterizes the vacuity: quite the contrary, it is said without any characteristic at all. Where are these “flavors” coming from? Are they themselves phenomenon’s, namely possessing no proper identity? Do they have causes or are they resulting from conditions? We reach the limit of the model, that represents a classification, as well as the limit of the actual observation

Another fundamental question subsists: What is the universal dynamical process that gave birth to all these manifestations? Does a fundamental noumenon exist?

Are these two paradigms, physics and Zen, complementary?

In Zen, the intuition of the vacuity, of the impermanence of everything as well as of the interdependence, nourished by the observation of the relation between our conscious and unconscious thoughts, bring us more easily to conceive the non-existence of any singular essence of the beings and the things. Instead of a reality, material, permanent and existential; instead of a noumenon, the zen brings forward that the reality is only constituted by forms: Material or alive. Everything only takes a particular form of vacuity, of the Tao, of the dharma that constitutes its primary origin, its fundamental source. No noumenon, everything is vacuity.

From this knowledge of zen, it is then easier to envisage a universe inhabited by 70% of invisible energy, by energetic fields, virtual particles, from that are born and disappear the constituents of matter. According to Einstein and quantum physics, the matter is only a particular from of the energy. The matter exists of course but only as a localized form of energy at rest.

The observation of the Higgs boson verifying the Higgs mechanism has allowed to establish that the origin of the mass and the diversification of the masses come from the coupling of the quarks with the energy contained in the Higgs field. This one is not observable in itself, but the forms that it takes, particles, bosons, matter, are real. They are born from this energetic background and go back to it. This physical mechanism is similar to the one described in the Heart Sutra, where phenomenon's (the particles) are born from the vacuity (the Higgs field) and go back to the vacuity. Their primary essence is then the vacuity itself, unobservable, inconceivable and outside time.

One can deduce from that: The paradigm of Zen, its vision of the world, of the vacuity, forms and phenomenon's, its intuitive paradigm, is corroborated in the last discoveries of physics.

That opens for us the hope that the worlds of science and spirituality will meet more and more, giving us an integrated vision of our universe and of ourselves, a vision that will contribute to peace and the blossoming of everyone as well as to the disappearing of obscurantism. Our freedom and our survival are probably at that price.