Bigravity and Interacting Higgs Fields: A Unified Framework for Mass Generation and Gravitational Dynamics

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Contents

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Abstract

General Relativity (GR), while successful in describing gravitational phenomena at large scales, faces challenges when addressing the accelerating universe, dark matter, dark energy, and black hole singularities. Bigravity theories have been proposed as extensions of GR, introducing two interacting gravitational fields, each with its own metric tensor.

Traditionally, bigravity treats the massless and massive aspects of graviton ripples as fixed features that emerge from the coupling potential between the two metrics.

This paper proposes a possible relationship between bigravity and interacting Higgs fields, offering a broader framework that establishes a physical connection between the massive and massless ripples generated by gravitational fields. This framework also provides a unified scenario in which the four known fundamental forces — gravitational, electromagnetic, strong, and weak — are interconnected.

1 A Dynamic Framework for Gravitational Fields

We introduce a dynamic framework for gravitational fields that diverges from static models, focusing on continuous changes in curvature driven by expansion and contraction over time.

1.1 Static vs. Dynamic Gravitational Fields

In traditional GR, gravitational waves are often treated as perturbations on a static or nearly static background. However, our model conceptualizes gravitational fields as inherently dynamic entities.

As these fields expand or contract, their curvature evolves pulling inward with the negative side of its curvature while contracting or pushing outward with its positive side while expanding, producing ripples that propagate outward or inward at the speed of light. These gravitational waves propagate as disturbances in spacetime.

1.2 Interacting Fields and Bigravity Systems

A single gravitational field undergoing periodic expansion and contraction generates ripples. Expansion produces transverse ripples traveling outward, driven by the field's outward-pushing force caused by its positive (convex) curvature, akin to an expanding universe dominated by a strong cosmological constant. Contraction creates inward ripples resulting from the field's negative curvature pulling inward.

However, a single gravitational field alone cannot fully account for the strong, weak, and electromagnetic interactions. We propose that these phenomena emerge from a manifold structure formed by the interaction of two fields that vary in or out of phase, leading to the interplay of gravitational, strong, weak, and electromagnetic forces.

This model proposes that these interacting fields are two intersecting Higgs-like fields with curvature, alternating in and out of phase. Their intersection forms a coupled nucleus consisting of two transverse and two longitudinal gravitational regions that expand and contract over time.

When the intersecting fields vary out of phase as a result of their periodic expansion and contraction, the contracting dense gravitational regions create inward-pulling ripples interpreted as massive gravitons, while the expanding, less dense regions produce outward ripples corresponding to massless gravitons.

1.3 Gravitational Interactions through Intersecting Higgs Fields

In standard theories, the Higgs field generates mass through the action of Higgs bosons, which are ripples caused by fluctuations in the field that permeates the entire universe. This mass is then thought to curve spacetime according to GR, creating transverse gravitational waves. These gravitational fluctuations are traditionally viewed as massless gravitons, mediating gravitational forces. However, GR does not provide a mechanical explanation for how mass curves spacetime or how such fluctuations emerge from the gravitational field itself.

Bigravity theories Wikipedia contributors [2023a] extend GR by considering two metrics associated with interacting gravitational fields, linked to a massive and a massless graviton. These gravitons are typically conceptualized as ripples generated by gravitational fluctuations, mediating gravitational interactions.

1.4 Double Curvature and Singularities

In the intersecting fields model we propose, each gravitational region (or subfield) exhibits double curvature, coupled by a singularity representing a cusp that creates an abrupt change in curvature direction at the intersection of both fields. The double curvature can be entirely positive, entirely negative, or a combination of both, reflecting the shared subfield created by the intersecting fields.

1.5 In-Phase Dynamics and Symmetry

When the two Higgs fields are in phase, their influence on the longitudinal and transverse subfields differs:

Longitudinal subfields: The massive central longitudinal subfield directly follows the phase of the intersecting Higgs fields. Therefore, when both Higgs fields contract, the central longitudinal subfield in the concave side of the system contracts in unison, moving upwards. This contraction leads to an increase in the density and inner kinetic orbital energy of the subfield, creating a concentrated region. The double compression experienced in this state is consistent with the strong interaction and leads to the emission of a radiation pulse from the increased density and upwards displacement.

Transverse subfields: The transverse gravitational subfields exhibit mirrored symmetry as they contract or expand in phase. This phase is opposite to that of the intersecting Higgs fields. When both intersecting fields contract, the transverse subfields expand instead. During the contracting phase, they experience a compressive force from the bottom section of the intersecting contracting fields that harbour them, pulling inward, along with a decompressive force from the curvature of the opposing intersecting field. This combination of forces results in a balanced yet expanding structure.

During the interval when both Higgs fields are expanding, this behavior is inverted:

The central longitudinal subfield undergoes double decompression, moving downward and expanding, which reduces its density and inner kinetic energy. This phase is associated with a decay of the concentrated state, leading to an expansion and redistribution of density and energy, which then manifests in the convex side of the intersection as the inverted longitudinal subfield.

The transverse subfields now contract. They experience a compressive force from the outer side of the expanding intersecting Higgs field's curvature, which harbors them, and a decompressive force from the curvature of the opposite expanding field.

1.6 Phase Delay and Antisymmetric Dynamics

When the phase of one field lags or advances, a desynchronization introduces an additional time coordinate, represented as a purely imaginary diagonal, resulting in asymmetric states.

For instance, when the right field contracts and the left expands, the longitudinal subfield shifts rightward, following the contracting field.

The transverse subfield in the contracting field undergoes a double force of compression from the convex curvature of the expanding left field and the concave curvature of the contracting right field. An inverted mirror behavior occurs when the left field contracts and the right field expands.

This establishes an antimatter relationship between the left and right gravitational subfields over different time phases.

Regions undergoing double compression represent strong interactions (a strong bond formed by increased kinetic orbital energy), while those with double decompression represent weak interactions. Regions with half-compression and half-decompression correspond to electromagnetic interactions.

Electric charge is reinterpreted as the pushing force arising from the displacement of the longitudinal subfield in the antisymmetric system.

2 Mass, Inner Kinetic Energy, and Interaction Dynamics

In the context of intersecting Higgs fields, mass is represented inside of each gravitational subfield by a combination of density and volume, while energy is understood as the inner kinetic orbital energy within the subfields.

2.1 Mass and Kinetic Energy:

Mass, as a physical property, reflects how much material density is contained in a certain volume of space, and the energy corresponds to the motion of that mass within the gravitational subfields.

A contracting field which receives compression creates inward ripples moving at the speed of light, analogous to how massive gravitons behave as they propagate through spacetime. The pulling force increases the speed of the orbital motions inside the field.

2.2 Double Compression and mc^2

The standard relationship $E = mc^2$ ties mass to energy by multiplying mass by the square of the speed of light. This formula expresses that energy is (equal to) the result of relating the speed of light to the material density and volume.

It does not imply that mass and kinetic energy are identical or interchangeable. Instead, it expresses how kinetic energy is enhanced within the material field. The speed of light serves as a boosting factor for the kinetic energy contained within the mass.

In the framework of the intersecting gravitational fields, multiplying the inner kinetic energy by the speed of light once (mc) provides a measure of the kinetic energy associated with one-half of the curvature of the subfield, representing the energy of the ripple traveling at the speed of light.

To describe the energy caused by the double compression on the transverse subfield, it is necessary to consider the ripples caused by both sectors of the subfield's curvature. Thus, we multiply by c twice, resulting in mc^2.

When mass is multiplied by the speed of light twice (mc^2), it represents a double boost in the speed of the kinetic energy. This corresponds to a double compression in the gravitational subfield, concentrating both mass and energy. The resulting massive gravitons, or ripples caused by the contraction of the field that is gaining mass, are characterized by this intensified concentration of density and energy.

In summary, mc^2 would not simply represent mass converted to energy; it would indicate a state where mass, as a combination of density and volume, experiences a double compression, enhancing its kinetic energy due to the speed of light factor being applied twice. This reflects the nature of strong interactions in this model, where a gravitational subfield contracts with maximal density and energy.

In standard physics, the speed of light c is treated as a constant, the maximum possible speed for any form of information or energy propagation in a vacuum. According to General Relativity (GR), gravitational waves also travel at this speed, and Special Relativity (SR) asserts that nothing can exceed this limit in a vacuum.

However, while Einstein's formula assumes all ripples move at the same speed, in the proposed model the ripples caused by the two sectors of the contracting curvature in the antisymmetric transverse subfield cannot travel at the same speed.

In the antisymmetric system, the inward compression generated by the outer pushing force of the intersecting field that expands creates a lower density region inside the half of the transverse subfield, while the pulling force caused by the negative side of the curvature of the contracting intersecting field creates a higher density region inside of the transverse subfield.

This difference implies that the transverse subfield is divided into two sectors: one generating ripples that travel at the speed of light, and another where ripples propagate more slowly than the speed of light.

Additionally, the mc^2 formula appears incomplete in the context of the topological landscapes of the two intersecting fields model. It does not account for the remaining mass in the double decompressed gravitational subfield — an issue potentially related to the mass gap problem — nor for the electromagnetic mass present in the half-compressed and half-decompressed subfields.

In the symmetric system, the longitudinal subfield located in the concave side does not move leftwards and downwards acting as its own anti-subfield, but it moves upwards (when contracting) or downwards (when expanding) through the central axis of symmetry of the coupled system.

This subfield experiences a double force of compression from the negative sides of the inner curvature of both intersecting fields. The result is a double boost of compression, with equal strength from both sources, and uniform inner density leading to a highly concentrated energy state. The ripples within the subfield rotate in a double helical orbit, emitting a pulsating photon.

In contrast, when the subfield expands losing density and energy in double decompression while moving downwards, the inverted central subfield on the convex side receives a double force of compression from the outer positive curvature of both intersecting expanding fields. However, the compressive forces and the density distribution in this region are significantly weaker, as they arise from expanding fields.

This discrepancy between the concave and convex sides suggests a violation of parity symmetry between the two longitudinal subfields. Since the concave subfield receives amplified energy through double compression, and the convex subfield experiences a weaker, less concentrated compressive force, this asymmetry disrupts the expected balance between the two. In this context, it can be viewed as a potential violation of the parity symmetry between matter and dark antimatter, where the energy density of matter exceeds that of its dark antimatter counterpart.

We consider dark the inverted longitudinal subfield because the convex side of the system is not directly detectable from the concave side.

The excess energy conserved in the concave longitudinal subfield could provide an explanation for the mass gap problem, which in the context of quantum field theory raises the question of why matter, in its lowest energy state, retains some energy rather than having zero energy.

Specifically, it deals with the observation that there is a gap between the vacuum ground state — expected to have zero energy — and the first excited state, rather than a continuum extending from zero mass. Institute [2024]

2.3 Symmetric vs. Antisymmetric Systems and the Emergence of Gravitons

The symmetric and antisymmetric systems may be considered as independent and separate linearly continuous transformations, corresponding to the smooth and gradual continuity of classical wave mechanics.

However, the rotational behavior of the model suggests an interpolation between the symmetric and antisymmetric systems through four successive states of synchronization and desynchronization.

2.3.1 Vector Dynamics in Gravitational Subfields

The periodic transformations of the four gravitational subfields can be represented by the dynamics of four vectors in a complex vectorial space.

Each subfield is characterized by two vectors representing a double force of compression, a double force of decompression, half compression and half decompression, or half decompression and half compression.

These vector pairs account for the behavior of each subfield as it evolves through four different stages:

- Strong Interactions: A subfield experiences double compression, represented by a pair of converging vectors. Each vector symbolizes a compressive force from the curvature, either an inward pull from a contracting field or a pushing force from the outer side of an expanding field. This increases the subfield's density.

- Weak Interactions: A subfield undergoes double decompression, represented by diverging vectors pointing away from each other. This reflects the outward pushing forces of the expanding curvature or the inward pulling forces of a contracting curvature manifested in an adyacent subfield, decreasing the subfield's density.

The transfer of mass and energy is facilitated by the shared curvature, with each subfield experiencing it from opposite sides — one convex and the other concave.

- Electromagnetic (EM) Interactions: Modeled by two diagonally oriented vectors touching at extremities. These two vectors represent a compression and a decompression in the subfield. This balanced state characterizes EM interactions, where forces are neither purely converging nor purely diverging.

2.3.2 Degrees of Freedom in the Nuclear Manifold

To fully describe the evolution of the system, four vectors inverting sign in pairs with each 90-degree rotation are necessary. The rotational behavior interpolates between symmetric and antisymmetric systems, resulting in changes by pairs. Consequently, this structure implies eight degrees of freedom within the nuclear manifold.

The vector evolution reflects a cyclic interplay between the contracting and expanding fields. Initially symmetric, the system shifts to a right-handed contracting subfield and a left-handed expanding subfield as phases desynchronize. This alternates to an expansive state, before reversing dynamics again, returning to the original configuration.

This eight-degree freedom structure, combined with the two additional degrees from the non-intersecting sides of the Higgs fields, leads to a total of ten degrees of freedom, offering a comprehensive framework for gravitational and electromagnetic phenomena.

2.4 Topological Transformations and Singularities

The four subfields possess inner singularities representing abrupt changes in direction. As each subfield undergoes four stages during the rotational evolution, this generates 16 singularities, connecting the nuclear manifold with Kummer-type surfaces and algebraic structures.

The interpolation of symmetric and antisymmetric stages can be described through Hodge cycles, enabling a topological transformation of 16 distinct subfields, each converging at singularities where curvature abruptly changes direction.

The existence of 16 differentiated subfields aligns with the particle count in the Standard Model, plus the Higgs boson. This model presents four particles that transform topologically into one another without requiring a superpartner particle to link bosonic and fermionic particles.

2.5 Fermions, Bosons, and Exclusion Principles

The intersecting fields model is deterministic, whereas the Standard Model is probabilistic. This introduces divergences, particularly because the nucleus derived from the intersecting fields model integrates matter and antimatter through mirror symmetry or antisymmetry.

In two interacting fields, the Pauli exclusion principle operates at the mirror symmetric or antisymmetric level. In the antisymmetric system, one subfield's expansion excludes simultaneous expansion of its mirror subfield. Likewise, the vertical subfield's movement left precludes its simultaneous existence on the right.

However, this exclusion does not apply between the two longitudinal subfields on the convex and concave sides of the intersection.

2.5.1 Spin and Rotational Symmetry

The Standard Model states that a 180-degree rotation changes the phase of fermions, causing a sign change (-1). A 360-degree rotation is needed to return the fermion to its original state, indicating spin-$\frac{1}{2}$. This property is associated with the Pauli exclusion principle.

For bosons, which have integer spins, a 180-degree rotation changes the spin direction but not the wavefunction, which returns to its original state after a 360-degree rotation. This is consistent with our model's symmetric system, predicting two mirror transverse subfields with opposite inner kinetic energies.

In the symmetric system, left- and right-handed transverse subfields exhibit chiral symmetry, interchangeable under a 180-degree rotation and not ruled by the exclusion principle, resembling bosonic behavior.

However, the upward contraction state of the central subfield is exclusive relative to the inverted dark subfield's decaying state on the convex side.

Spin-$\frac{1}{2}$ is interpreted as a state where only half of the vectors of the nuclear system have flipped signs, which occurs in the antisymmetric system's two stages, as opposed to the symmetric system's complete inversion.

2.6 Differential Equations and Systems Integration

While the symmetric system may be described by a linear complex differential equation, and the antisymmetric system by a linear complex conjugate equation, interpolating both functions results in a nonlinear differential equation that combines the symmetric and harmonic antisymmetric systems.

2.7 Observational Implications and Background Radiation Discrepancies

The proposed model, which posits different propagation speeds for ripples within the double-compressed transverse subfield, aligns with discrepancies observed in cosmic background radiation. Specifically, the model predicts that not all gravitational ripples travel at the speed of light; instead, ripples generated by regions of varying density within the subfield propagate at distinct velocities — some at the speed of light, while others move more slowly.

These differing speeds could account for the anomalies observed in the cosmic microwave background (CMB) radiation. Wikipedia contributors [2023b]

Such anomalous differences might arise from the interplay between the two sectors of the curvature in the transverse subfield, each contributing ripples with different propagation characteristics.

By considering the mixed speeds of gravitational ripples, this framework provides a potential explanation for the detected discrepancies in background radiation measurements.

3 Possible Mechanics of Orbital Variation and Solsticial Inertia

General Relativity (GR) is compatible with a massless graviton, which, in the context of intersecting fields, corresponds to an expanding gravitational subfield. This subfield's pushing force is expressed on its outer convex side, moving forward and creating gravitational waves in the adjacent outward region. In this scenario, motion within the inner kinetic orbit is inertial.

In a bigravitational context, masless and massive gravitons are considered.

In the intersecting fields model, the massive graviton corresponds to a contracting transverse subfield, while the massless graviton is associated with a transverse expanding subfield. This occurs within a framework of mirror-symmetric or antisymmetric sectors undergoing periodic expansions and contractions.

In a model of pulsating field mechanics, a phase of no variation occurs once the field reaches its peak expansion or contraction. During this phase, the field does not immediately reverse its dynamics; instead, it briefly maintains its state before beginning the opposite motion—either contracting or expanding. During this period of no variation, the orbital motions are also inertial.

This period of no variation resembles the behavior observed during solstices. At the solstices, the Sun's apparent position relative to Earth remains stationary before reversing its displacement. Once the solstice concludes, the Sun begins its opposite path.

This behavior aligns with the concept of a gravitational field undergoing two complete cycles of expansion and contraction per year.

During the contraction phase (perihelion), Earth would approach the Sun, and orbital motions would accelerate due to the increased gravitational pull. Conversely, during the expansion phase, Earth would move away from the Sun, and the absence of a contracting gravitational force would result in inertial motions, causing them to slow down.

Perihelion occurs around two weeks after the December solstice, and aphelion occurs about two weeks after the June solstice. The difference between these phenomena could be explained within the context of a manifold gravitational system by considering two intersecting gravitational fields curved by two parallel stars.

In this model, the gravitational field orbited by Earth would not be the Sun's gravitational field but rather a "blind" transverse gravitational field situated within the Sun's gravitational field that harbors it.

This transverse field would not be curved by a mass but would be formed by the intersection of the gravitational fields of both stars, having a half-positive and half-negative curvature, with a singularity point representing the abrupt change in curvature at the point of intersection.

In the antisymmetric system, when the intersecting fields vary out of phase, the transverse field and the field that harbors it would vary in phase.

Additionally, the transverse field would experience a pendular displacement of its orbit due to the periodic motions of the intersecting gravitational fields, resulting in two different inclinations during the course of a year, corresponding to the phases of expansion and contraction.

If the transverse subfield undergoes pendular inclinations twice a year during its expansion and contraction phases, this would align with the inclinations observed in the solar orbit. These inclinations would correspond to the maximum contraction and maximum expansion phases of the transverse subfield, matching the solstices where the Sun's path in the sky reaches its peak displacement. Similarly, the transitions from contraction to expansion (contracted-expanding) and from expansion to contraction (expanded-contracting) would correspond to moments of no variation, analogous to the equinoxes when the system's tilt is balanced.

This periodic behavior of the transverse subfield provides a potential explanation for the cyclical nature of solstices and equinoxes.

A dynamic bigravity interaction introduces possibilities for a more complex solar system model, providing a mechanical explanation for asymmetries currently attributed to chance or addressed with ad hoc hypotheses, including differences in orbital inclinations, speeds, and even opposite planetary rotations.

4 Multiverse and nested universes

In this model, the Higgs fields can be interpreted as representing an expanding or contracting universe, but also as a cosmic gravitational field.

In this sense, the intersecting fields framework draws connections with multiverse theories, including parallel and nested universes.

Each phase of expansion or contraction in the coupled Higgs fields may correspond to different states or regions of a deterministic multiverse, suggesting that the gravitational dynamics described here could reflect interactions across multiple, coexisting universes or layers within a nested multiverse structure.

5 Additional considerations

The relationship of the model with black hole singularities and the atomic realm is described in Bueno [2023a]. A broader and more detailed mathematical background is conceptually provided in Bueno [2023b]. Possible connections with other theories are discussed in Bueno [2023c].

Keywords: black holes, singularities, intersecting gravitational fields, bigravity, bi-metric tensors, gravitational waves, mirror symmetry, strong and weak interactions, electromagnetic interactions, supersymmetry, quantum field theory, General relativity, quantum gravity, Gorenstein liaison, Hodge cycles, Kummer surfaces, T-duality, reflection positivity, SYZ conjecture, mass gap problem, equivalence principle, Pauli exclusion principle, cosmological constant, spin.

6 Related diagrams

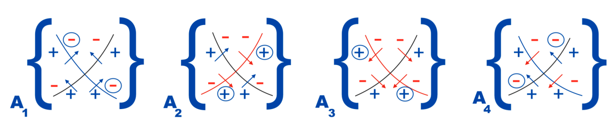

Figure 1: *Rotational system: Singularities represented as abrupt changes of curvature in the four subfields with double curvature*

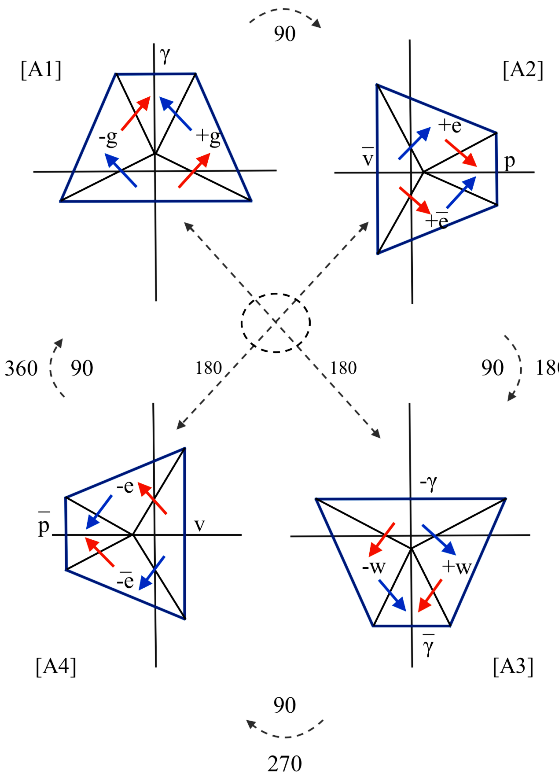

Figure 2: *Illustration of the rotational system*

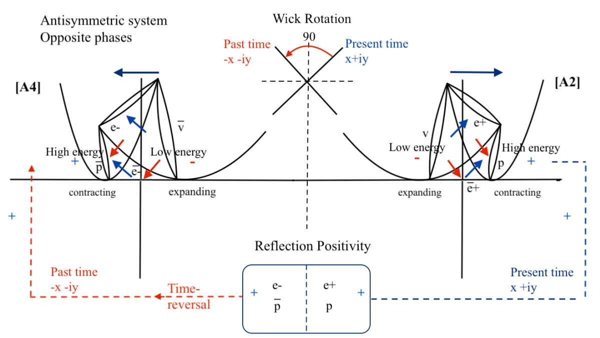

Figure 3: *Depiction of reflection positivity in the antisymmetric system*

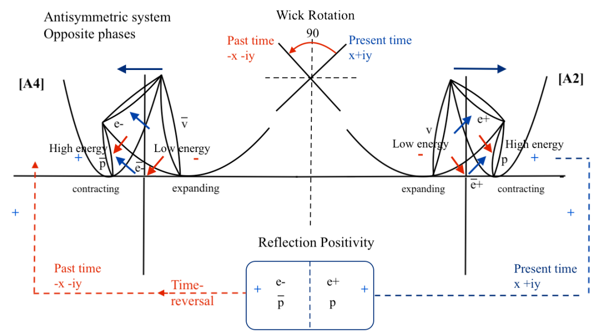

Figure 4: *Depiction of reflection positivity in the symmetric system.*

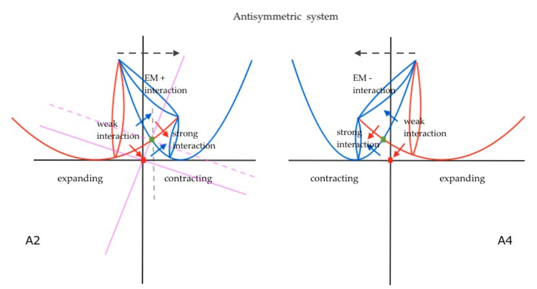

Figure 5: *Mass gap in the antisymmetric system*

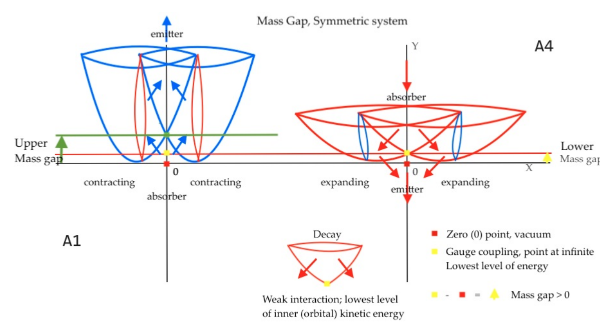

Figure 6: *Mass gap in the symmetric system*

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