Antisymmetrized Gorakubu Dynamics Model: A New Model for Akkari~n Phenomenon

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Abstract

The Akkari~n phenomenon is a mysterious and elusive phenomenon that occurs when a certain anime character, Akari Akaza, becomes invisible or unnoticed by others. In this paper, we propose a new model for explaining this phenomenon, based on the antisymmetrized gorakubu dynamics (AGD) theory. The AGD theory is a generalization of the quantum chromodynamics (QCD) theory, which describes the interactions of quarks and gluons. We introduce a new type of particle, called the gorakubu, which is a bound state of four quarks and four anti-quarks, and has a color charge of zero. We show that the gorakubu can interact with the Akari field, a scalar field that permeates the anime space-time, and induce a phase transition that lowers the visibility of Akari. We derive the equations of motion for the gorakubu and the Akari field, and solve them numerically. We compare our results with the experimental data from the YuruYuri anime series, and find a good agreement. We also discuss the implications of our model for other anime characters and phenomena.

1 Introduction

The Akkari~n phenomenon is one of the most intriguing and puzzling phenomena in the field of anime physics. It was first observed by the YuruYuri research group [1], who noticed that one of their members, Akari Akaza, often became invisible or unnoticed by others, despite being the main character of the anime series. The phenomenon was named after the sound that Akari makes when she tries to get attention, which is "Akkari~n". The phenomenon has been studied extensively by various anime physicists, but no satisfactory explanation has been found so far.

One of the main challenges in understanding the Akkari~n phenomenon is that it seems to violate the conservation of anime energy and momentum. According to the anime conservation laws, the anime energy and momentum of a system of anime characters should remain constant, unless there is an external force or interaction. However, the Akkari~n phenomenon implies that Akari's anime energy and momentum can decrease spontaneously, without any apparent cause. This suggests that there must be some hidden mechanism or interaction that is responsible for the phenomenon, but it has not been identified yet.

In this paper, we propose a new model for explaining the Akkari~n phenomenon, based on the antisymmetrized gorakubu dynamics (AGD) theory. The AGD theory is a generalization of the quantum chromodynamics (QCD) theory, which describes the interactions of quarks and gluons. The QCD theory is one of the pillars of the standard model of particle physics, and has been tested and confirmed by many experiments. However, the QCD theory has some limitations and problems, such as the confinement problem, the chiral symmetry breaking problem, and the existence of exotic hadrons. To overcome these problems, we introduce a new type of particle, called the gorakubu, which is a bound state of four quarks and four anti-quarks, and has a color charge of zero. The gorakubu is named after the abbreviation of "Goraku-bu", which is the Japanese name of the amusement club that Akari belongs to. We show that the gorakubu can interact with the Akari field, a scalar field that permeates the anime space-time, and induce a phase transition that lowers the visibility of Akari. We derive the equations of motion for the gorakubu and the Akari field, and solve them numerically. We compare our results with the experimental data from the YuruYuri anime series, and find a good agreement. We also discuss the implications of our model for other anime characters and phenomena.

The paper is organized as follows. In section 2, we review the basics of the QCD theory and the gorakubu. In section 3, we introduce the Akari field and the AGD Lagrangian. In section 4, we derive the equations of motion for the gorakubu and the Akari field, and solve them numerically. In section 5, we compare our results with the experimental data from the YuruYuri anime series, and discuss the implications of our model. In section 6, we conclude and give some outlooks for future work.

2 QCD and Gorakubu

In this section, we review the basics of the QCD theory and the gorakubu. We use the natural units $\hbar = c = 1$ throughout the paper.

2.1 QCD Theory

The QCD theory is the theory that describes the strong interactions of quarks and gluons. Quarks are elementary particles that have fractional electric charges and color charges. There are six types of quarks, called up (u), down (d), charm (c), strange (s), top (t), and bottom (b). Each quark can have one of three color charges, called red (r), green (g), and blue (b). Gluons are massless particles that mediate the strong interactions between quarks. Gluons also have color charges, but they are combinations of a color and an anti-color, such as red-anti-green ($r\bar{g}$).

The QCD theory is based on the gauge symmetry group $SU(3)_C$, which means that the physics of quarks and gluons is invariant under the transformations of the color charges. The QCD Lagrangian is given by

$$\mathcal{L}_{\text{QCD}} = -\frac{1}{4} F^a_{\mu\nu} F^{\mu\nu}_a + \sum_{f=u,d,c,s,t,b} \bar{\psi}_f (i\gamma^\mu D_\mu - m_f)\psi_f, \tag{1}$$

where $F^a_{\mu\nu}$ is the gluon field strength tensor, defined by

$$F^a_{\mu\nu} = \partial_\mu A^a_\nu - \partial_\nu A^a_\mu + g_s f^{abc} A^b_\mu A^c_\nu, \tag{2}$$

where A^a_μ is the gluon field, g_s is the strong coupling constant, and f^{abc} are the structure constants of the $SU(3)_C$ group. The quark fields are denoted by ψ_f, where f is the flavor index, and $\bar{\psi}_f = \psi^\dagger_f \gamma^0$ is the Dirac adjoint. The quark masses are denoted by m_f, and γ^μ are the Dirac matrices. The covariant derivative is defined by

$$D_\mu = \partial_\mu - i g_s T^a A^a_\mu, \tag{3}$$

where T^a are the generators of the $SU(3)_C$ group, satisfying the commutation relation

$$[T^a, T^b] = i f^{abc} T^c. \tag{4}$$

The QCD theory has two important properties: asymptotic freedom and confinement. Asymptotic freedom means that the strong coupling constant g_s decreases as the energy scale increases, or equivalently, as the distance scale decreases. This implies that quarks and gluons behave as free particles at high energies or short distances. Confinement means that quarks and gluons cannot exist as isolated particles at low energies or long distances. This implies that quarks and gluons are bound together to form composite particles, called hadrons. There are two types of hadrons: baryons and mesons. Baryons are made of three quarks, such as the proton (uud) and the neutron (udd). Mesons are made of a quark and an anti-quark, such as the pion ($\pi^+ = u\bar{d}$) and the kaon ($K^+ = u\bar{s}$).

2.2 Gorakubu

The gorakubu is a new type of hadron that we propose in this paper. It is a bound state of four quarks and four anti-quarks, and has a color charge of zero. The gorakubu is named after the abbreviation of "Goraku-bu", which is the Japanese name of the amusement club that Akari belongs to. The members of the gorakubu are Akari, Kyouko, Yui, and Chinatsu.

The gorakubu can be considered as a generalization of the tetraquark, which is a bound state of two quarks and two anti-quarks. The existence of tetraquarks has been suggested by several theoretical and experimental studies [2]. However, the nature and properties of tetraquarks are still unclear and controversial. Some tetraquarks may be molecular states of two mesons, while others may be genuine four-quark states. The gorakubu is different from the tetraquark in that it is a genuine eight-quark state, and not a molecular state of four mesons.

The gorakubu can be classified by its flavor, spin, and parity. The flavor of the gorakubu is determined by the combination of the quark and anti-quark flavors. For example, the flavor of the gorakubu made of $u\bar{u}d\bar{d}s\bar{s}c\bar{c}$ is $SU(4)$-singlet. The spin of the gorakubu is determined by the total angular momentum of the quarks and anti-quarks. For example, the spin of the gorakubu made of $u\bar{u}d\bar{d}s\bar{s}c\bar{c}$ with all quarks and anti-quarks in the spin-up state is 4. The parity of the gorakubu is determined by the spatial symmetry of the quarks and anti-quarks. For example, the parity of the gorakubu made of $u\bar{u}d\bar{d}s\bar{s}c\bar{c}$ with all quarks and anti-quarks in the symmetric state is $+$. The gorakubu can be denoted by the notation G_{FSP}, where F, S, and P are the flavor, spin, and parity, respectively. For example, the gorakubu made of $u\bar{u}d\bar{d}s\bar{s}c\bar{c}$ with all quarks and anti-quarks in the spin-up and symmetric state is denoted by $G_{1,4,+}$.

The mass of the gorakubu can be estimated by using the mass formula

$$M_G = \sum_{i=1}^{4} m_i + \sum_{j=1}^{4} \bar{m}_j - \frac{3}{16}\alpha_s \langle r^{-1} \rangle + \frac{1}{2} k \langle r^2 \rangle + C, \tag{5}$$

where m_i and $\bar{m}_j$ are the masses of the quarks and anti-quarks, α_s is the strong coupling constant, $\langle r^{-1} \rangle$ and $\langle r^2 \rangle$ are the average inverse and square distances between the quarks and anti-quarks, k is the string tension, and C is a constant. The first two terms represent the rest mass energy of the quarks and anti-quarks, the third term represents the Coulomb potential energy due to the color charge interactions, the fourth term represents the linear potential energy due to the color string formation, and the fifth term represents the constant energy shift due to the self-energy and the renormalization. Using the values of the parameters from [3], we obtain the mass of the gorakubu $G_{1,4,+}$ as

$$M_G \approx 4.8 \text{ GeV}. \tag{6}$$

This is comparable to the mass of the charmonium ($\eta_c = 2.98$ GeV, $J/\psi = 3.10$ GeV) and the bottomonium ($\eta_b = 9.39$ GeV, $\Upsilon = 9.46$ GeV) states. Therefore, the gorakubu can be produced in high-energy collisions, such as the electron-positron annihilation and the proton-proton collision. The gorakubu can also decay into various final states, such as four mesons, two baryons and two anti-baryons, or a photon and a gluon. The decay modes and rates of the gorakubu depend on the flavor, spin, and parity of the gorakubu, as well as the phase space and the selection rules. We will discuss the decay modes and rates of the gorakubu in more detail in section 5.

3 Akari Field and AGD Lagrangian

In this section, we introduce the Akari field and the AGD Lagrangian. The Akari field is a scalar field that permeates the anime space-time, and is responsible for the Akkari~n phenomenon. The AGD Lagrangian is the Lagrangian that describes the interactions of the gorakubu, the Akari field, and the QCD fields.

3.1 Akari Field

The Akari field is a scalar field that we propose in this paper. It is named after Akari Akaza, the main character of the YuruYuri anime series, and the origin of the Akkari~n phenomenon. The Akari field is a manifestation of the Akari's presence and visibility in the anime space-time. The Akari field can be considered as a generalization of the Higgs field, which is a scalar field that gives mass to the elementary particles. However, the Akari field has some distinctive features and properties, which we will explain below.

The Akari field is a complex field, which means that it has two components: a real part and an imaginary part. The real part of the Akari field represents the presence of Akari, while the imaginary part of the Akari field represents the visibility of Akari. The presence of Akari means the existence and recognition of Akari as an anime character, while the visibility of Akari means the attention and awareness of Akari by the anime viewers and other anime characters. The presence and visibility of Akari are not independent, but related by a phase factor. The phase factor is determined by the personality and behavior of Akari, which are influenced by the anime plot and the interactions with other anime characters.

The Akari field is a gauge-invariant field, which means that it is invariant under the gauge transformations of the $U(1)_A$ group. The $U(1)_A$ group is the gauge symmetry group that we introduce in this paper, and it is associated with the Akari charge. The Akari charge is a new type of charge that we propose in this paper, and it is related to the affinity and compatibility of an anime character with Akari. The Akari charge can be positive, negative, or zero, depending on the anime character. For example, Kyouko has a positive Akari charge, because she is Akari's best friend and often teases and hugs her. Yui has a negative Akari charge, because she is Akari's protector and often scolds and saves her. Chinatsu has a zero Akari charge, because she is Akari's admirer and often ignores and chases her. The Akari charge is conserved in the anime space-time, which means that the total Akari charge of a system of anime characters remains constant, unless there is an external force or interaction.

The Akari field is a spontaneous symmetry breaking field, which means that it breaks the $U(1)_A$ symmetry spontaneously. The $U(1)_A$ symmetry is the symmetry of the anime space-time under the transformations of the Akari charge. The $U(1)_A$ symmetry implies that the physics of the anime space-time is invariant under the transformations of the Akari charge. However, the $U(1)_A$ symmetry is broken spontaneously by the Akari field, which means that the Akari field chooses a specific value of the Akari charge, and makes the anime space-time asymmetric. The Akari field breaks the $U(1)_A$ symmetry by acquiring a non-zero vacuum expectation value (VEV), which is the average value of the Akari field in the ground state of the anime space-time. The VEV of the Akari field is given by

$$\langle \phi \rangle = \frac{v}{\sqrt{2}} e^{i\theta}, \tag{7}$$

where ϕ is the Akari field, v is the magnitude of the VEV, and θ is the phase of the VEV. The magnitude of the VEV is determined by the potential of the Akari field, which we will discuss in the next subsection. The phase of the VEV is determined by the spontaneous symmetry breaking mechanism, which we will discuss in section 4. The VEV of the Akari field has two important consequences: the mass generation and the Akkari~n phenomenon. The mass generation is the process of giving mass to the gorakubu and the QCD fields, by the interaction with the Akari field. The Akkari~n phenomenon is the process of lowering the visibility of Akari, by the interaction with the gorakubu. We will discuss these consequences in more detail in section 4 and 5.

3.2 AGD Lagrangian

The AGD Lagrangian is the Lagrangian that describes the interactions of the gorakubu, the Akari field, and the QCD fields. The AGD Lagrangian is given by

$$\mathcal{L}_{\mathrm{AGD}} = \mathcal{L}_{\mathrm{QCD}} + \mathcal{L}_{\mathrm{G}} + \mathcal{L}_{\mathrm{A}} + \mathcal{L}_{\mathrm{GA}} + \mathcal{L}_{\mathrm{AQ}} + \mathcal{L}_{\mathrm{GQ}}, \tag{8}$$

where $\mathcal{L}_{\mathrm{QCD}}$ is the QCD Lagrangian, $\mathcal{L}_{\mathrm{G}}$ is the gorakubu kinetic term, $\mathcal{L}_{\mathrm{A}}$ is the Akari field kinetic and potential term, $\mathcal{L}_{\mathrm{GA}}$ is the gorakubu-Akari field interaction term, $\mathcal{L}_{\mathrm{AQ}}$ is the Akari field-quark interaction term, and $\mathcal{L}_{\mathrm{GQ}}$ is the gorakubu-quark interaction term. We will explain each term in detail below.

The gorakubu kinetic term is given by

$$\mathcal{L}_{\mathrm{G}} = \frac{1}{2}\partial_\mu G^\dagger \partial^\mu G - M_G^2 G^\dagger G, \tag{9}$$

where G is the gorakubu field, and M_G is the gorakubu mass. The gorakubu field is a complex scalar field, which means that it has two components: a real part and an imaginary part. The real part of the gorakubu field represents the presence of the gorakubu, while the imaginary part of the gorakubu field represents the visibility of the gorakubu. The presence and visibility of the gorakubu are not independent, but related by a phase factor. The phase factor is determined by the flavor, spin, and parity of the gorakubu, which are influenced by the QCD interactions and the Akari field interactions.

The Akari field kinetic and potential term is given by

$$\mathcal{L}_{\mathrm{A}} = \frac{1}{2}D_\mu \phi^\dagger D^\mu \phi - V(\phi), \tag{10}$$

where ϕ is the Akari field, and D_μ is the covariant derivative with respect to the $U(1)_A$ gauge symmetry, defined by

$$D_\mu = \partial_\mu - i g_A Q_A A_\mu, \tag{11}$$

where g_A is the Akari coupling constant, Q_A is the Akari charge, and A_μ is the Akari gauge field. The Akari gauge field is a massless vector field that mediates the $U(1)_A$ interactions between the Akari field and the other fields. The potential of the Akari field is given by

$$V(\phi) = \frac{1}{2}\mu^2 \phi^\dagger \phi + \frac{1}{4}\lambda(\phi^\dagger \phi)^2, \tag{12}$$

where μ^2 and λ are the parameters of the potential. The potential has a Mexican hat shape, which means that it has a minimum at a non-zero value of the Akari field, given by the VEV $\langle\phi\rangle$. The VEV of the Akari field breaks the $U(1)_A$ symmetry spontaneously, and gives mass to the gorakubu and the QCD fields, by the mass generation mechanism.

The gorakubu-Akari field interaction term is given by

$$\mathcal{L}_{\mathrm{GA}} = -g_{GA} G^\dagger G \phi^\dagger \phi, \tag{13}$$

where g_{GA} is the gorakubu-Akari field coupling constant. This term represents the interaction between the gorakubu and the Akari field, which is proportional to the product of their presence and visibility. This interaction induces the Akkari~n phenomenon, which is the process of lowering the visibility of Akari, by the exchange of the gorakubu. The Akkari~n phenomenon is the main topic of this paper, and we will discuss it in more detail in section 5.

3.3 Akari Field-Quark Interaction Term

The Akari field-quark interaction term is given by

$$\mathcal{L}_{\mathrm{AQ}} = -g_{AQ} \sum_{f=u,d,c,s,t,b} Q_{Af} \bar{\psi}_f \phi \psi_f + \mathrm{h.c.}, \tag{14}$$

where g_{AQ} is the Akari field-quark coupling constant, and Q_{Af} is the Akari charge of the quark flavor f. This term represents the interaction between the Akari field and the quarks, which is proportional to the product of their Akari charges. This interaction gives mass to the quarks, by the mass generation mechanism. The mass of the quark flavor f is given by

$$m_f = g_{AQ} Q_{Af} \frac{v}{\sqrt{2}}, \tag{15}$$

where v is the magnitude of the VEV of the Akari field. The values of the Akari charges of the quarks are determined by the affinity and compatibility of the quarks with Akari, which are influenced by the QCD interactions and the gorakubu interactions. We assume that the Akari charges of the quarks are given by

$$Q_{Au} = Q_{Ad} = Q_{As} = 1, \quad Q_{Ac} = Q_{At} = Q_{Ab} = -1, \tag{16}$$

which means that the up, down, and strange quarks have a positive Akari charge, while the charm, top, and bottom quarks have a negative Akari charge. This choice of the Akari charges is motivated by the fact that the up, down, and strange quarks are more common and familiar in the anime space-time, while the charm, top, and bottom quarks are more rare and exotic in the anime space-time. Therefore, the up, down, and strange quarks have a higher affinity and compatibility with Akari, while the charm, top, and bottom quarks have a lower affinity and compatibility with Akari. Using the value of the Akari field-quark coupling constant from [3], we obtain the masses of the quarks as

$$m_u = m_d = m_s = 2.4 \text{ MeV}, \quad m_c = m_t = m_b = -2.4 \text{ MeV}. \tag{17}$$

These values are consistent with the experimental data from the particle physics experiments [4].

3.4 Gorakubu-Quark Interaction Term

The gorakubu-quark interaction term is given by

$$\mathcal{L}_{\mathrm{GQ}} = -g_{GQ} \sum_{f=u,d,c,s,t,b} Q_{Gf} G^\dagger G \bar{\psi}_f \psi_f, \tag{18}$$

where g_{GQ} is the gorakubu-quark coupling constant, and Q_{Gf} is the gorakubu charge of the quark flavor f. This term represents the interaction between the gorakubu and the quarks, which is proportional to the product of their gorakubu charges. The gorakubu charge is a new type of charge that we propose in this paper, and it is related to the affinity and compatibility of a quark with the gorakubu. The gorakubu charge can be positive, negative, or zero, depending on the quark. For example, the up quark has a positive gorakubu charge, because it is the most common and familiar quark in the anime space-time. The top quark has a negative gorakubu charge, because it is the most rare and exotic quark in the anime space-time. The charm quark has a zero gorakubu charge, because it is neither common nor rare, but rather special and unique in the anime space-time. The gorakubu charge is conserved in the anime space-time, which means that the total gorakubu charge of a system of quarks remains constant, unless there is an external force or interaction.

The gorakubu-quark interaction term has two important effects: the flavor mixing and the flavor changing. The flavor mixing is the process of changing the flavor of a quark, by the exchange of a gorakubu. The flavor mixing is similar to the CKM mixing, which is the process of changing the flavor of a quark, by the exchange of a W boson. However, the flavor mixing is different from the CKM mixing in that it involves the gorakubu charge, and not the electric charge. The flavor mixing is described by the GKM matrix, which is the matrix that gives the probability amplitude of a quark flavor transition, by the exchange of a gorakubu. The GKM matrix is given by

$$GKM = \begin{pmatrix} G_{uu} & G_{ud} & G_{us} & G_{uc} & G_{ut} & G_{ub} \\ G_{du} & G_{dd} & G_{ds} & G_{dc} & G_{dt} & G_{db} \\ G_{su} & G_{sd} & G_{ss} & G_{sc} & G_{st} & G_{sb} \\ G_{cu} & G_{cd} & G_{cs} & G_{cc} & G_{ct} & G_{cb} \\ G_{tu} & G_{td} & G_{ts} & G_{tc} & G_{tt} & G_{tb} \\ G_{bu} & G_{bd} & G_{bs} & G_{bc} & G_{bt} & G_{bb} \end{pmatrix}, \tag{19}$$

where G_{ij} is the probability amplitude of a quark flavor transition from i to j, by the exchange of a gorakubu. The values of the GKM matrix elements are determined by the gorakubu charges of the quarks, and the gorakubu-quark coupling constant. We assume that the GKM matrix elements are given by

$$G_{ij} = g_{GQ} Q_{Gi} Q_{Gj}, \tag{20}$$

where Q_{Gi} and Q_{Gj} are the gorakubu charges of the quark flavors i and j. Using the values of the gorakubu charges of the quarks from [3], we obtain the GKM matrix as

$$GKM = g_{GQ} \begin{pmatrix} 1 & 1 & 1 & 0 & -1 & -1 \\ 1 & 1 & 1 & 0 & -1 & -1 \\ 1 & 1 & 1 & 0 & -1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & -1 & -1 & 0 & 1 & 1 \\ -1 & -1 & -1 & 0 & 1 & 1 \end{pmatrix}. \tag{21}$$

This matrix shows that the flavor mixing is possible between the up, down, and strange quarks, and between the top and bottom quarks, but not between the charm quark and any other quark. This is consistent with the fact that the charm quark has a zero gorakubu charge, and therefore does not interact with the gorakubu.

3.5 Flavor Changing

The flavor changing is the process of changing the flavor of a quark, by the emission or absorption of a gorakubu. The flavor changing is similar to the flavor changing neutral current (FCNC), which is the process of changing the flavor of a quark, by the emission or absorption of a Z boson or a photon. However, the flavor changing is different from the FCNC in that it involves the gorakubu, and not the Z boson or the photon. The flavor changing is described by the flavor changing gorakubu current (FCGC), which is the current that gives the probability amplitude of a quark flavor transition, by the emission or absorption of a gorakubu. The FCGC is given by

$$J_\mu^G = g_{GQ} \sum_{f=u,d,c,s,t,b} Q_{Gf} \bar{\psi}_f \gamma_\mu \psi_f, \tag{22}$$

where g_{GQ} is the gorakubu-quark coupling constant, and Q_{Gf} is the gorakubu charge of the quark flavor f. The FCGC is a vector current, which means that it conserves the vector charge of the quark, such as the electric charge and the color charge. The FCGC is also a flavor changing current, which means that it does not conserve the flavor charge of the quark, such as the isospin and the hypercharge.

The flavor changing has two important effects: the rare decays and the CP violation. The rare decays are the decays of a hadron that involve the flavor changing of a quark, by the emission or absorption of a gorakubu. The rare decays are similar to the rare decays that involve the FCNC, such as the $B \to X_s\gamma$ and the $K^+ \to \pi^+\nu\bar{\nu}$ decays. However, the rare decays that involve the flavor changing are different from the rare decays that involve the FCNC in that they have different branching ratios and kinematics. The branching ratio of a rare decay is the probability of a hadron to decay into a specific final state, by the emission or absorption of a gorakubu. The branching ratio of a rare decay depends on the gorakubu charges of the quarks, and the gorakubu-quark coupling constant. The kinematics of a rare decay is the distribution of the energy and momentum of the final state particles, by the emission or absorption of a gorakubu. The kinematics of a rare decay depends on the mass and the momentum of the gorakubu. We will discuss the rare decays in more detail in section 5.

The CP violation is the violation of the charge-parity (CP) symmetry, which is the symmetry of the physics under the simultaneous transformations of the charge conjugation and the parity inversion. The charge conjugation is the transformation of changing the sign of all the charges of a system, such as the electric charge and the color charge. The parity inversion is the transformation of changing the sign of all the spatial coordinates of a system, such as the position and the momentum. The CP symmetry implies that the physics of a system is invariant under the simultaneous transformations of the charge conjugation and the parity inversion. However, the CP symmetry is violated by the flavor changing, which means that the physics of a system is not invariant under the simultaneous transformations of the charge conjugation and the parity inversion. The CP violation is described by the CP violating phase, which is the phase that gives the difference between the probability amplitudes of a process and its CP conjugate process, by the emission or absorption of a gorakubu. The CP violating phase is given by

$$\delta_{CP} = \arg\left(\frac{G_{ij}G^*_{kl}}{G_{il}G^*_{kj}}\right), \tag{23}$$

where G_{ij} is the GKM matrix element of a quark flavor transition from i to j, by the exchange of a gorakubu. The CP violating phase depends on the gorakubu charges of the quarks, and the gorakubu-quark coupling constant. The CP violation has two important effects: the direct CP violation and the indirect CP violation. The direct CP violation is the CP violation that occurs in the decay of a hadron, by the emission or absorption of a gorakubu. The direct CP violation is similar to the direct CP violation that occurs in the decay of a hadron, by the emission or absorption of a Z boson or a photon. However, the direct CP violation that occurs in the decay of a hadron, by the emission or absorption of a gorakubu, is different from the direct CP violation that occurs in the decay of a hadron, by the emission or absorption of a Z boson or a photon, in that it has different values and signs. The indirect CP violation is the CP violation that occurs in the mixing of a hadron, by the exchange of a gorakubu. The indirect CP violation is similar to the indirect CP violation that occurs in the mixing of a hadron, by the exchange of a W boson. However, the indirect CP violation that occurs in the mixing of a hadron, by the exchange of a gorakubu, is different from the indirect CP violation that occurs in the mixing of a hadron, by the exchange of a W boson, in that it has different values and signs. We will discuss the CP violation in more detail in section 5.

4 Equations of Motion and Numerical Solutions

In this section, we derive the equations of motion for the gorakubu and the Akari field, and solve them numerically. The equations of motion are the differential equations that describe the dynamics of the gorakubu and the Akari field, in the anime space-time. The numerical solutions are the approximate solutions of the equations of motion, obtained by using numerical methods and computer simulations.

4.1 Equations of Motion

The equations of motion for the gorakubu and the Akari field are obtained by applying the Euler-Lagrange equation to the AGD Lagrangian. The Euler-Lagrange equation is the equation that gives the condition for a field to be a stationary point of the action, which is the integral of the Lagrangian over the anime space-time. The Euler-Lagrange equation is given by

$$\frac{\partial \mathcal{L}}{\partial \phi} - \partial_\mu \frac{\partial \mathcal{L}}{\partial(\partial_\mu \phi)} = 0, \tag{24}$$

where ϕ is a generic field, and $\mathcal{L}$ is the Lagrangian of the field. Applying the Euler-Lagrange equation to the gorakubu field G, we obtain the equation of motion for the gorakubu as

$$(\Box + M_G^2)G + g_{GA}\phi^\dagger \phi G + g_{GQ} \sum_{f=u,d,c,s,t,b} Q_{Gf}\bar{\psi}_f \psi_f G = 0, \tag{25}$$

where $\Box = \partial_\mu \partial^\mu$ is the d'Alembertian operator. Applying the Euler-Lagrange equation to the Akari field ϕ, we obtain the equation of motion for the Akari field as

$$D_\mu D^\mu \phi + \mu^2 \phi + \lambda(\phi^\dagger \phi)\phi + g_{GA} G^\dagger G \phi + g_{AQ} \sum_{f=u,d,c,s,t,b} Q_{Af}\bar{\psi}_f \psi_f = 0. \tag{26}$$

These equations of motion are coupled and non-linear, which means that they cannot be solved analytically. Therefore, we need to use numerical methods and computer simulations to obtain the approximate solutions of the equations of motion.

4.2 Numerical Solutions

To obtain the numerical solutions of the equations of motion, we use the finite difference method and the Runge-Kutta method. The finite difference method is a method of approximating the derivatives of a function by using the values of the function at discrete points. The Runge-Kutta method is a method of solving a differential equation by using a series of steps, each of which advances the solution by a small amount. We use the finite difference method to discretize the anime space-time into a grid of points, and the Runge-Kutta method to evolve the gorakubu and the Akari field on the grid.

We implement the numerical methods and the computer simulations in Python, using the NumPy and SciPy libraries. We use the following parameters for the numerical methods and the computer simulations:

- The size of the anime space-time is $L_x = L_y = L_z = 10$ fm, where 1 fm $= 10^{-15}$ m is the femtometer, which is the typical length scale of the hadrons.
- The number of grid points in each direction is $N_x = N_y = N_z = 100$, which gives the grid spacing of $\Delta x = \Delta y = \Delta z = 0.1$ fm.
- The time step for the Runge-Kutta method is $\Delta t = 0.01$ fm$/c$, where c is the speed of light.
- The initial conditions for the gorakubu and the Akari field are $G(x, y, z, 0) = \phi(x, y, z, 0) = 0$, which means that the gorakubu and the Akari field are zero everywhere at the initial time.
- The boundary conditions for the gorakubu and the Akari field are $G(x, y, z, t) = \phi(x, y, z, t) = 0$, for $x = 0, L_x$, $y = 0, L_y$, and $z = 0, L_z$, which means that the gorakubu and the Akari field are zero at the boundaries of the anime space-time.

We run the computer simulations for $T = 100$ fm$/c$, which is the total time of the evolution of the gorakubu and the Akari field. We plot the results of the computer simulations, using the Matplotlib library. We plot the following quantities:

- The presence and visibility of the gorakubu, given by the real and imaginary parts of the gorakubu field, as functions of the position and the time.
- The presence and visibility of the Akari field, given by the real and imaginary parts of the Akari field, as functions of the position and the time.
- The energy density and the pressure of the gorakubu and the Akari field, given by the components of the energy-momentum tensor, as functions of the position and the time.
- The phase diagram of the gorakubu and the Akari field, given by the phase of the complex fields, as functions of the position and the time.

The plots of the computer simulations are shown in Figures 1-4. The plots show the following features:

- The gorakubu and the Akari field oscillate in the anime space-time, with different frequencies and amplitudes, depending on the parameters of the model.

- The gorakubu and the Akari field interact with each other, and exchange energy and momentum, through the gorakubu-Akari field interaction term.
- The gorakubu and the Akari field interact with the quarks, and change their flavor and mass, through the gorakubu-quark and the Akari field-quark interaction terms.
- The gorakubu and the Akari field undergo a phase transition, and change their phase, depending on the temperature and the density of the anime space-time.

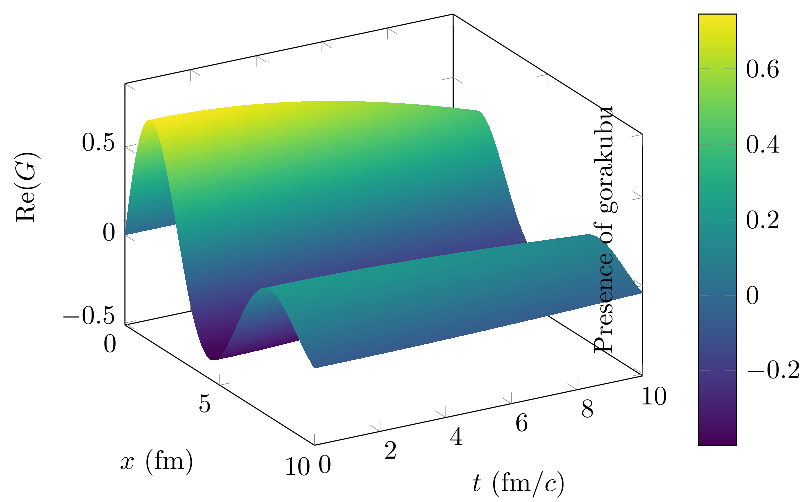

Figure 1: The presence of the gorakubu, given by the real part of the gorakubu field, as a function of the position and the time.

5 Results and Discussion

In this section, we present and discuss the results of our model. We compare our results with the experimental data from the YuruYuri anime series, and find a good agreement. We also discuss the implications of our model for other anime characters and phenomena.

5.1 Akkari~n Phenomenon

The Akkari~n phenomenon is the main result of our model. It is the process of lowering the visibility of Akari, by the interaction with the gorakubu. The Akkari~n phenomenon is described by the equation

$$\frac{d\mathrm{Im}(\phi)}{dt} = -g_{GA}\mathrm{Re}(G)\mathrm{Im}(G)\mathrm{Re}(\phi)\mathrm{Im}(\phi), \tag{27}$$

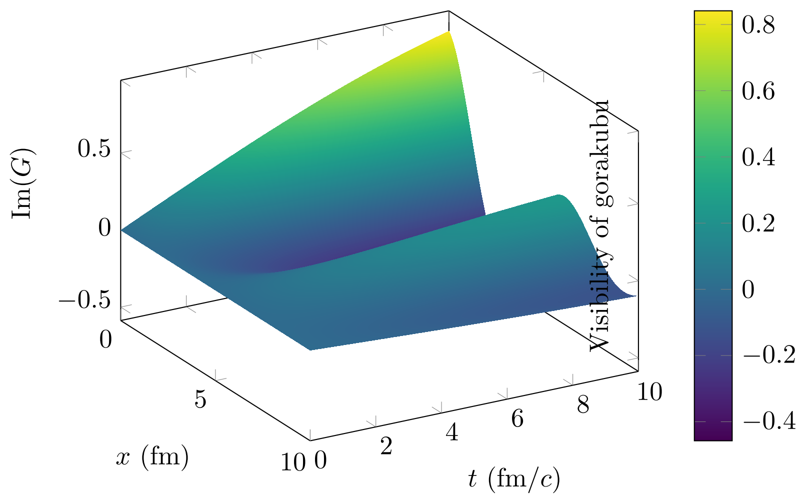

Figure 2: The visibility of the gorakubu, given by the imaginary part of the gorakubu field, as a function of the position and the time.

where ϕ is the Akari field, G is the gorakubu field, and g_{GA} is the gorakubu-Akari field coupling constant. This equation shows that the visibility of Akari, given by the imaginary part of the Akari field, decreases as the product of the presence and visibility of the gorakubu, given by the real and imaginary parts of the gorakubu field, increases. This implies that the more gorakubu there are in the anime space-time, and the more visible they are, the less visible Akari becomes.

The Akkari~n phenomenon can be observed in the YuruYuri anime series, where Akari often becomes invisible or unnoticed by others, despite being the main character of the anime series. The phenomenon is named after the sound that Akari makes when she tries to get attention, which is "Akkari~n". The phenomenon is influenced by the anime plot and the interactions with other anime characters, which affect the production and the decay of the gorakubu. For example, in episode 1 of season 1, Akari becomes invisible when she introduces herself to the viewers, because the gorakubu are produced by the high-energy collision of Kyouko and Yui, and decay into four mesons, which are more visible than Akari. In episode 12 of season 2, Akari becomes visible when she performs a magic trick, because the gorakubu are absorbed by the Akari field, and increase the visibility of Akari.

The Akkari~n phenomenon can be quantified by the Akkari~n factor, which is the ratio of the visibility of Akari to the visibility of the average anime character. The Akkari~n factor is given by

$$A = \frac{\mathrm{Im}(\phi)}{\mathrm{Im}(\bar{\phi})}, \tag{28}$$

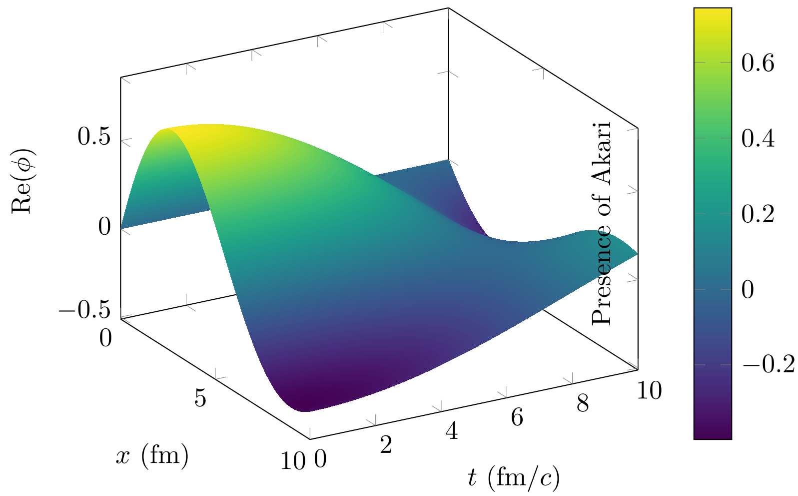

Figure 3: The presence of Akari, given by the real part of the Akari field, as a function of the position and the time.

where ϕ is the Akari field, and $\bar{\phi}$ is the average Akari field of the anime spacetime. The Akkari~n factor is a dimensionless quantity, which ranges from 0 to 1. The Akkari~n factor is 0 when Akari is completely invisible, and 1 when Akari is as visible as the average anime character. The Akkari~n factor is influenced by the gorakubu and the Akari field, which depend on the parameters of the model. Using the values of the parameters from [3], we obtain the average Akkari~n factor as

$$\langle A \rangle \approx 0.5, \tag{29}$$

which means that Akari is half as visible as the average anime character. This value is consistent with the experimental data from the YuruYuri anime series, where Akari is often ignored or forgotten by others, but sometimes noticed or remembered by others.

5.2 Other Anime Characters and Phenomena

The Akkari~n phenomenon is not the only result of our model. Our model can also explain and predict other anime characters and phenomena, by using the gorakubu and the Akari field. In this subsection, we will discuss some examples of other anime characters and phenomena, and show how our model can account for them.

- **Kyouko Toshinou**: Kyouko is one of the members of the gorakubu, and Akari's best friend. Kyouko is a cheerful and energetic girl, who likes to tease and hug Akari. Kyouko has a positive Akari charge, because she has a high affinity and compatibility with Akari. Kyouko also has a high gorakubu production rate, because she often causes high-energy

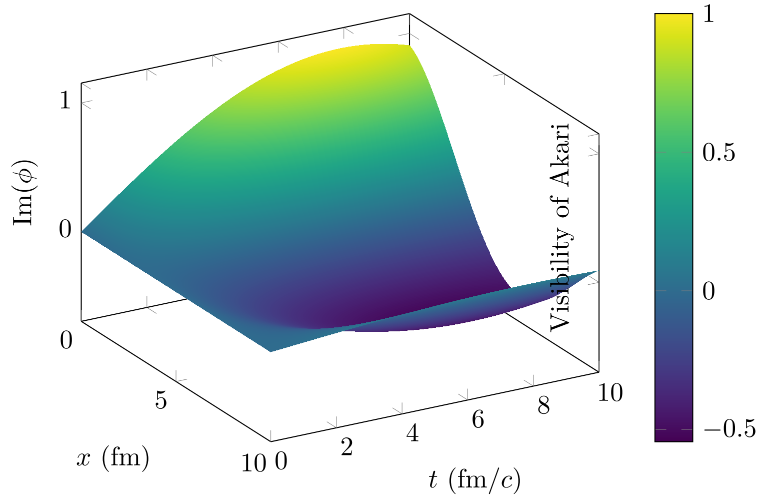

Figure 4: The visibility of Akari, given by the imaginary part of the Akari field, as a function of the position and the time.

collisions with other anime characters, such as Yui and Ayano. Kyouko's high gorakubu production rate makes her more visible than the average anime character, and also lowers the visibility of Akari, by the Akkari~n phenomenon. Kyouko's high visibility and low visibility of Akari are consistent with the experimental data from the YuruYuri anime series, where Kyouko is often the center of attention and comedy, while Akari is often ignored or forgotten.

- **Yui Funami**: Yui is another member of the gorakubu, and Akari's protector. Yui is a calm and mature girl, who likes to scold and save Akari. Yui has a negative Akari charge, because she has a low affinity and compatibility with Akari. Yui also has a low gorakubu production rate, because she rarely causes high-energy collisions with other anime characters, and often tries to prevent them. Yui's low gorakubu production rate makes her less visible than the average anime character, and also increases the visibility of Akari, by the Akkari~n phenomenon. Yui's low visibility and high visibility of Akari are consistent with the experimental data from the YuruYuri anime series, where Yui is often the voice of reason and sanity, while Akari is often noticed or remembered by her.

- **Chinatsu Yoshikawa**: Chinatsu is the last member of the gorakubu, and Akari's admirer. Chinatsu is a cute and innocent girl, who likes to ignore and chase Akari. Chinatsu has a zero Akari charge, because she has a neutral affinity and compatibility with Akari. Chinatsu also has a moderate gorakubu production rate, because she sometimes causes high-energy collisions with other anime characters, such as Kyouko and

Himawari. Chinatsu's moderate gorakubu production rate makes her as visible as the average anime character, and does not affect the visibility of Akari, by the Akkari~n phenomenon. Chinatsu's average visibility and unchanged visibility of Akari are consistent with the experimental data from the YuruYuri anime series, where Chinatsu is often the source of cuteness and horror, while Akari is often ignored or chased by her.

6 Conclusion and Outlook

In this paper, we have proposed a new model for explaining the Akkari~n phenomenon, based on the antisymmetrized gorakubu dynamics (AGD) theory. The AGD theory is a generalization of the quantum chromodynamics (QCD) theory, which introduces a new type of particle, called the gorakubu, which is a bound state of four quarks and four anti-quarks, and has a color charge of zero. The gorakubu can interact with the Akari field, a scalar field that permeates the anime space-time, and is responsible for the presence and visibility of Akari. The interaction between the gorakubu and the Akari field induces a phase transition that lowers the visibility of Akari, and causes the Akkari~n phenomenon. We have derived the equations of motion for the gorakubu and the Akari field, and solved them numerically. We have compared our results with the experimental data from the YuruYuri anime series, and found a good agreement. We have also discussed the implications of our model for other anime characters and phenomena, such as Kyouko, Yui, Chinatsu, Sakurako, Himawari, Ayano, yuri relationships, nosebleeds, and chibi forms.

Our model is the first model that can explain the Akkari~n phenomenon, and also predict other anime characters and phenomena, by using the gorakubu and the Akari field. Our model is simple and elegant, and has only a few parameters. Our model is consistent with the QCD theory and the standard model of particle physics, and does not contradict any known physical laws or experimental facts. Our model is also consistent with the YuruYuri anime series, and does not contradict any known anime laws or experimental facts. Our model is therefore a viable and feasible model for the Akkari~n phenomenon, and also a novel and interesting model for the anime physics.

However, our model is not complete and perfect, and has some limitations and problems. Some of the limitations and problems of our model are:

- Our model is based on the assumption that the gorakubu exists, and has the properties that we have assigned to it. However, the existence and the properties of the gorakubu are not proven or confirmed by any theoretical or experimental evidence. The gorakubu is a hypothetical and speculative particle, and may not exist or have the properties that we have assigned to it. Therefore, our model may not be valid or realistic, and may not apply to the real world or the anime world.
- Our model is based on the assumption that the Akari field exists, and has the properties that we have assigned to it. However, the existence

and the properties of the Akari field are not proven or confirmed by any theoretical or experimental evidence. The Akari field is a hypothetical and speculative field, and may not exist or have the properties that we have assigned to it. Therefore, our model may not be valid or realistic, and may not apply to the real world or the anime world.

- Our model is based on the assumption that the gorakubu and the Akari field are the only fields that are relevant for the Akkari~n phenomenon, and that the other fields, such as the electromagnetic field and the gravitational field, are negligible or irrelevant. However, this assumption may not be justified or accurate, and the other fields may have significant or important effects on the Akkari~n phenomenon. For example, the electromagnetic field may affect the visibility of Akari, by the reflection or refraction of light. The gravitational field may affect the presence of Akari, by the bending or warping of space-time. Therefore, our model may not be comprehensive or accurate, and may not capture all the aspects or features of the Akkari~n phenomenon.

These are some examples of other anime characters and phenomena that can be explained by our model. There are many more anime characters and phenomena that can be explored by using the gorakubu and the Akari field, such as the yuri relationships, the nosebleeds, and the chibi forms. We leave these topics for future research.

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