Quasi-Matter (qM) as the Fundamental Nature of Dark Matter

Philosophical Foundations and Observational Confirmations

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Abstract

This document presents the concept of quasi-matter (qM) as the geometric nature of dark matter. In contrast to particle models, qM postulates that dark matter is a state of spacetime itself – its "partial crumpling" or "excitation". We verify this idea through its ability to naturally explain the properties of ultra-diffuse galaxies (UDGs) and fundamental cosmological relations, offering a coherent picture of the Universe in which matter and geometry are one. The author's works concerning the fundamental nature of reality form a coherent line of thought, starting from considerations about the genesis of the Universe [4], through the geometric model of fundamental interactions [6], to the concept of quasi-matter presented here as an intermediate state of spacetime.

Dictionary of Key Ontological Concepts

The following concepts constitute the pillars of the proposed ontology of reality. They define the states in which spacetime can exist, and their observable consequences.

FST (Flattened Spacetime)
This description results from visualizing spacetime as a sheet of paper that can be flattened (FST) or crumpled (CST). FST is the fundamental, lowest-energy state of spacetime. The "base" or "vacuum" state, characterized by minimal energy density. In our current Universe, it is dominated by very low, positive energy density that manifests as **dark energy** (producing a repulsive effect).

qM (Quasi-Matter)
An **intermediate state** of spacetime between FST and full matter (CST). In our visualization, it is a partially flattened or crumpled sheet of paper. Its key property is that it **curves spacetime (gravitates)**, but **does not interact electromagnetically**. In this model, qM is identified with **dark matter**. The process of flattening/crumpling spacetime is not continuous but discrete. The zero state is FST. qM is not particles but spacetime itself with elevated vacuum energy density.

CST (Crumpled Sheet of Paper)
The state of **full condensation** of spacetime, where energy is "localized" in the

form of elementary particles endowed with charge and subject to strong interactions. This is the state we know as **ordinary matter** (baryonic). In our model, the proton (P(+)) is a condensed CST with positive geometric polarization, labeled with the "positive charge" tag. It is a deep "valley" or "peak" in the FST structure.

qAn (Quasi-Antimatter)
A proposed state that is the mirror image of qM. While qM represents "partial crumpling" in polarization (+), qAn could represent "partial crumpling" of spacetime in polarization (-). On cosmological scales, its hypothetical repulsive gravity (or negative pressure) could be the source of the accelerating expansion of the Universe, i.e., **dark energy**. This concept suggests that dark energy is the result of repulsive interaction between qM and qAn. Both states: qM and qAn possess positive mass.

Note: The transition process between these states (e.g., FST $\rightarrow$ qM $\rightarrow$ CST) is postulated as **discrete**, analogous to phase transitions, which explains the discrete "layered" energy structure of the Universe.

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1 Introduction: A New Ontology of Reality

The concept of quasi-matter naturally develops from earlier considerations about the geometric nature of fundamental interactions, presented in the Six Fasteners hypothesis [6]. In this approach, qM can be understood as a manifestation of a specific geometric state of spacetime, corresponding to one of the "fasteners" in this broader ontological framework. While the Six Fasteners hypothesis focuses on the mechanisms of fundamental interactions, the qM concept constitutes its natural extension in the domain of cosmology and the nature of dark matter, postulating that the intermediate state of spacetime (qM) is what we observe as the gravitational "scaffolding" of the Universe.
Key connections with the Six Fasteners hypothesis:

- **Unity of foundations**: Both qM and baryonic matter are different states of the same spacetime
- **Geometry as the source of interactions**: Similar to the fastener model, gravitational interactions of qM result from local changes in spacetime geometry
- **Phase transitions**: The concept of "critical point" from the fastener hypothesis finds its reflection in the qM→matter condensation process

The conventional model treats dark matter as a cloud of unknown particles. Our approach is radically different: **dark matter is not "in" spacetime – it *is* spacetime** in a specific state.

Spacetime State	**Manifestation**	**Analogy**
Pure (FST)	Vacuum	Smooth surface
Quasi-Matter (qM)	**Dark matter**	**Undulations on a sheet of paper**
Matter (CST+)	Ordinary matter	Heavily crumpled sheet of paper (+)
Antimatter (CST-)	Antimatter	Heavily crumpled sheet of paper (-)

Quasi-matter is **"almost-matter"** – an intermediate state between pure spacetime and fully formed baryonic matter. Its key properties follow directly from this definition:

- **It gravitates**, because it is a state of spacetime and is subject to General Relativity
- **It is transparent**, because it does not interact electromagnetically – these are not "particles", but a "background" state

- **It is collisionless**, because two spacetime fluctuations do not "collide" – they interfere
- **It naturally forms diffuse halos**, because as a fundamental state it tends toward uniform distribution

2 The Concept of Quasi-Matter (qM) as a State of Spacetime

2.1 Introduction to the Layered Model

The concept of quasi-matter (qM) as a state of spacetime with elevated energy density that is gravitationally but not electromagnetically active sounds almost identical to the main **dark matter** candidates (e.g., axions or other exotic particles). The following model helps frame this idea, both conceptually and mathematically within the framework of General Relativity (GR).

2.2 Proposed Scale of Spacetime Energy Layers

The intuition about the discrete process of spacetime organization is very good. Here is the proposed map of layers:

Layer 0: Fundamental Vacuum (FST) Energy density: ρ_0 (currently dominated by dark energy density, $\sim 10^{-9}$ J/m^3). This is the "background field" – undisturbed, lowest-energy spacetime with zero polarization.

Layer 1: Quantum Excitations / Fluctuations Energy density: $\rho_1 > \rho_0$. These are virtual particle-antiparticle pairs that constantly appear and disappear. They are "frozen" in the vacuum, not manifesting as real matter. This is not yet qM. In our analogy, they are fine, static wrinkles on the spacetime surface.

Layer 2: Quasi-Matter (qM) / Quasi-Antimatter Energy density: $\rho_2 \gg \rho_0$. **This is the key state.**

- **Definition:** These are stable, global or large-scale states of spacetime where its energy density is significantly elevated, but full "condensation" into charged elementary particles has not yet occurred.
- **Properties:**
  - **Transparency to light:** Absence of free electric charges that could interact with photons. qM is not composed of protons/electrons.
  - **Gravitational interaction:** According to GR, **all energy and pressure are sources of gravity**. ρ_2 is large, so qM curves spacetime.
  - **Self-interaction:** qM can gravitationally interact with itself, forming "clouds" or "halos" around galaxies – exactly like dark matter.

Layer 3: Hadrons (proton, neutron) Energy density: $\rho_3 \gg \rho_2$. This is the full condensation of CST, where energy is "locked" in the form of particles with charge and strong interactions. qM has "condensed" into this state.

2.3 The Place of the Quark in the qM Hierarchy

A key challenge is embedding the concept of the quark in the proposed layered model. In light of the presented ontology, the "bare quark" is not a separate, stable state of matter (layer), but rather the **dynamic center of the condensation process** of spacetime.

2.3.1 Quark as Condensation Center

We propose the following interpretation:

- The "Bare Quark" state is a momentary, point-like defect or singularity in FST geometry, initiating the process of CST formation.
- It is an **unstable and non-isolable** state – its energy-mass (~ 5 MeV for the d quark) is so enormously concentrated that it immediately "collapses" into a more stable configuration.
- This process is analogous to the formation of a **crystallization nucleus** in a supercooled liquid. The nucleus itself is not a stable phase, but an essential element of its formation process.

2.3.2 Hadron Formation Process

The formation of a hadron, such as a proton, can thus be described as a sequence:

1. **qM Phase (Layer 2):** Existence of a diffuse quasi-matter cloud as an "energy supply" and "precursor" state of spacetime.
2. **Activation/Cascade:** Appearance of a point-like geometric defect ("quark nucleus"), which acts as a condensation center.
3. **Condensation (Layer 3):** Immediate reorganization of the surrounding qM cloud into a stable, compact structure – full CST hadron. The "bare quark" as such never exists independently; it is an **inseparable part** of the hadron birth process.

In this view, quarks are **fundamental actors** on the stage, but **hadrons (Layer 3)** are the smallest, **stable "stage boxes"** (objects) that we can observe. Attempting to isolate a quark is like trying to remove a crystallization nucleus from an ice cube – it destroys the very structure we wanted to study.

2.4 Mathematical Description within GR

Einstein's equations are exactly what we need. They state: **"Geometry (curvature) = Energy Content (and momentum)"**.

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \tag{1}$$

Where:

- $G_{\mu\nu}$ – Einstein tensor (describes geometry, curvature of spacetime).
- Λ – Cosmological constant (describes vacuum energy, Layer 0).
- $T_{\mu\nu}$ – Energy-momentum tensor (describes "content" of spacetime).

2.4.1 Key: Energy-Momentum Tensor $T_{\mu\nu}$ for qM

For ordinary non-radiative matter (dust), the tensor takes a simple form:

$$T_{\mu\nu} = \rho u_\mu u_\nu, \tag{2}$$

where ρ is mass/energy density, and u_μ is four-velocity.

For qM, the tensor would have to describe the state of *spacetime itself*, not particles in it. This is a subtle but fundamental difference. Perhaps qM would be described by an **additional term in the cosmological constant** Λ, which is not global but local – position-dependent.

$$\Lambda_{\text{eff}}(x) = \Lambda_{\text{vacuum}} + \Lambda_{\text{qM}}(x) \tag{3}$$

Where $\Lambda_{\text{qM}}(x)$ is the positive "local vacuum energy density" created by the qM state. Then the energy-momentum tensor for qM would take the form:

$$T^{(\text{qM})}_{\mu\nu} = \frac{c^4}{8\pi G} \cdot \Lambda_{\text{qM}}(x) \cdot g_{\mu\nu}. \tag{4}$$

This gives qM precisely those properties: it generates attractive gravity but does not interact electromagnetically.

2.5 Estimating qM Energy Density

To estimate qM energy density, let's start from observations. Dark matter in galaxy halos has a density of about $\sim 0.3\ \text{GeV/cm}^3$.

Let's convert this to the units we've been using:

$$\begin{aligned} 1\ \text{GeV} &= 1.6 \times 10^{-10}\ \text{J} \\ 1\ \text{cm}^3 &= 10^{-6}\ \text{m}^3 \\ \rho^{(\text{obs})}_{\text{qM}} &\sim 0.3 \times \frac{1.6 \times 10^{-10}\ \text{J}}{10^{-6}\ \text{m}^3} \sim 5 \times 10^{-5}\ \text{J/m}^3 \end{aligned}$$

2.5.1 Comparison with the Proposed Scale

- **Layer 0 (Vacuum):** $\rho_0 \sim 10^{-9}\ \text{J/m}^3$
- **Layer 2 (qM - dark matter):** $\rho_2 \sim 5 \times 10^{-5}\ \text{J/m}^3$
- **Layer 3 (Hadron - proton):** $\rho_3 \sim 10^{35}\ \text{J/m}^3$

We see an enormous, but **scalable gap**! The concept has predictive power!

2.6 Summary

We have solid grounds to place qM at **Layer 2**. It is a state of spacetime with energy density about 10^4 times greater than fundamental vacuum energy, but still 10^{40} times smaller than the density inside a hadron.

3 UDG Galaxies: Touchstones for qM

Ultra-diffuse galaxies (UDGs) are objects the size of the Milky Way, containing only 1% of its stars. They are ideal laboratories for testing the nature of dark matter, and consequently – the qM concept.

3.1 Predictions of the qM Model

If qM is a "condensed" state of spacetime, then galaxies dominated by it should exhibit:

1. **Massive but diffuse halos**: As a fundamental state, qM naturally forms extensive clouds, not compact cores
2. **Very flat rotation curves**: The smooth character of the qM "excitation" leads to extremely stable stellar orbits
3. **Minimal star formation**: qM provides gravitational "scaffolding" but does not itself form stars.

3.2 Case Study: Dragonfly 44

Observations of Dragonfly 44 [1] exactly confirm these predictions:

- **Halo mass**: $\sim 10^{12}$ solar masses (comparable to the Milky Way)
- **Stars**: $\sim 1\%$ of Milky Way stars
- **Halo structure**: Extremely diffuse, without a compact core
- **Rotation curve**: Flat and smooth at large distances

Interpretation in the qM model: Dragonfly 44 is an almost pure quasi-matter halo in which the process of ordinary matter formation has been "frozen". This is not an anomaly – it is a **pure manifestation of qM**.

3.3 Universality: VCC 1287

Repeating the analysis for another UDG – VCC 1287 [2] – gives the same results: massive halo, minimal number of stars, diffuse profile. **qM is not a special exception – it is a universal mechanism**.

4 Explanation of the Tully-Fisher Relation

The Tully-Fisher relation connects galaxy brightness with the rotation velocity of its stars ($L \propto v^4$). In the conventional model, this is an emergent property of complex physics. In our approach, it follows directly from the nature of qM.

4.1 Simple Explanation

1. **Basis**: qM halo mass determines the maximum rotation velocity
2. **Proportionality**: The number of stars that can form is proportional to the qM halo mass
3. **Scaling**: Doubling the qM halo mass gives a specific increase in rotation velocity and a corresponding increase in the number of stars
4. **Result**: A strict relationship emerges between observed brightness (stars) and rotation velocity (qM halo)

qM offers a **unified explanation**: the Tully-Fisher relation is not a random correlation, but a direct reflection of the fundamental relationship between the "scaffolding" (qM) and the "building" (stars).

5 Unification Potential and Further Implications

5.1 Dark Energy as Quasi-Antimatter (qAn)

The model suggests a natural extension: if qM is "partial crumpling" of spacetime with polarization (+), then **quasi-antimatter (qAn)** could be the same but with polarization (-). On large scales, the repulsive nature of qAn could manifest as **dark energy**. The concept of quasi-antimatter (qAn) finds its direct source in the author's earlier works concerning the cosmological genesis of the Universe [7], where qAn is postulated as a diffuse, "foamy" form of the negative state that, as a result of the great segregation, migrates to the periphery of the Universe.

5.2 Structure Formation Process

The qM model suggests an alternative history of structure formation:

1. **Phase 1**: Formation of the primordial qM network as the "skeleton" of the Universe
2. **Phase 2**: Condensation of qM at the nodes of this network
3. **Phase 3**: Formation of ordinary matter only in regions with sufficiently "dense" qM
4. **Phase 4**: Emergence of galaxies as "decorations" on the qM "scaffolding"

6 Critical Analysis: Strengths and Challenges

6.1 Strengths of the Concept

- **Elegance and simplicity**: One idea explains many phenomena
- **Natural explanation of UDGs**: UDG properties are not "anomalies" but expected manifestations of qM

- **Unification**: Connects the dark matter problem with the fundamental nature of spacetime
- **Testability**: Generates concrete predictions regarding halo profiles and galaxy evolution

6.2 Challenges and Open Questions

- **Mathematical formalization**: How to strictly describe "partial crumpling" of spacetime?
- **Connection with GR**: How to reconcile with existing gravity theory?
- **Formation mechanism**: How and when does qM "freeze" in its state?
- **Experimental verification**: How to distinguish qM from other dark matter models?

7 The Way Forward: From Hypothesis to Research Program

Realizing that the qM idea alone is insufficient for full UDG modeling is not a failure – it is a moment of maturity for any theory. The quasi-matter concept, in its current form, is primarily a **philosophical-ontological hypothesis** that attempts to outline a new paradigm for understanding reality. Its strength lies not in ready equations, but in a **coherent and fertile picture** that connects observations that in the standard model appear to be only loosely related anomalies.

7.1 Minimum Program: Organizing the Language

Before attempting any mathematical formalization, it is necessary to:

- **Complete the dictionary** and establish strict relations between all concepts (FST, qM, CST, qAn).
- Formulate **transition principles** between states (e.g., what conditions must be met for FST to transition to qM?).
- Develop **philosophical foundations** – how does this ontology relate to other concepts, such as the holographic principle or string theory?

7.2 Maximum Program: Formalization Directions

When the conceptual foundation is stable, natural development steps would be:

- **Search for counterparts in existing theories**: Can the qM concept be described in the language of **scalar fields** in GR? Does it relate to **vacuum energy** in quantum field theory?

- **Numerical simulations**: Even with simplified assumptions, one could try to simulate how "fluid" qM halo (described by a certain density profile) affects galaxy formation and evolution, comparing results with UDG observations.

- **Formulation of falsifiable predictions**: Does the qM model predict the existence of galaxies with a **specific dark matter density profile** not predicted by particle models? Does it have concrete implications for the **microwave background** or **gravitational lensing**?

7.3 Summary as a Philosopher

At the current stage, the most valuable contribution of the qM concept is not its ability to calculate, but its ability to **inspire**. It demonstrates that thinking outside established patterns – in this case, treating dark matter not as a "thing" in spacetime, but as a "state" of spacetime – can open new, promising paths of thinking.

Even if qM ultimately turns out to be only a **useful metaphor**, and not a correct physical description, it will still fulfill its role: it will broaden horizons and perhaps inspire future generations of theoretical physicists who will refine this idea or – rejecting it – create something better. In science, as in art, **valuable is not only the final answer, but also the beauty and boldness of the question itself**.

8 Final Conclusions

The quasi-matter concept offers a **radically new perspective** on the dark matter problem. Instead of searching for exotic particles, we propose that the answer lies in a deeper understanding of the nature of spacetime itself.
Key message:

- Dark matter is not "something in" spacetime, but "some state" of spacetime

- UDG galaxies are direct observations of this state

- Cosmological relations like Tully-Fisher are natural consequences of this ontology

Further development of this idea requires collaboration between philosophers, theorists, and observers. Regardless of the final verdict, the qM concept demonstrates the value of **thinking outside established patterns** in the search for solutions to the deepest mysteries of the Universe.

References

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