Brief Memorandum. Explanation of Dark Matter Deficiency in Relic Galaxies (NGC 1277) within the Framework of the Valency-Mass Balance (VMB) Principle and Formulation of the Information Self-Sufficiency Principle (ISSP)

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Abstract

The observed absence or significant deficiency of dark matter (DM) in massive compact relic galaxies, such as NGC 1277, poses a serious challenge to the standard ΛCDM cosmological model. This work proposes a fundamentally new explanation of this phenomenon within a systemic process-based framework. Based on the previously formulated Valency-Mass Balance (VMB) principle [1], the **Information Self-Sufficiency Principle (ISSP)** is derived and formulated. According to the ISSP, the need of a gravitationally bound system for an external stabilizing halo of dark matter is inversely proportional to the packing density of its own (baryonic) gravitational information. Compact, structurally complete systems that have achieved a high degree of internal connectivity minimize their dependence on such "scaffolding." The work discusses the logical derivation of the ISSP from the VMB principle, as well as its connection to the hypothesis of the Engineering Logic of the Universe (ELU) [2,3]. The possible operationalization of the principle through observable parameters (such as the ratio of velocity dispersion to effective radius, $K = \sigma^2/R_{\text{eff}}$) and qualitative implications for the interpretation of galaxies with anomalous DM content are considered. This principle shifts the focus in the dark matter problem from the question of its nature to the question of its functional necessity in various gravitationally bound systems, paving the way for a new classification of galaxies based on their structural integrity.

Keywords: dark matter, relic galaxy, NGC 1277, valency-mass balance (VMB) principle, information self-sufficiency principle (ISSP), information physics, systems analysis, ultra-compact massive galaxy (UCMG), structural completeness, critical saturation.

1 Introduction: The Enigma of Ultra-Compact Massive Galaxies: Dark Matter Deficiency as a Challenge to the ΛCDM Paradigm

The discovery and subsequent study of the class of ultra-compact massive galaxies (UCMGs), or "red nuggets", such as NGC 1277, has posed a fundamental question to the standard cosmological model (ΛCDM) [4, 5]. According to observational data, these ancient, extremely dense

systems exhibit an almost complete absence of the dark matter (DM) signature, whereas in modern galaxies, like the Milky Way, DM dominates over baryonic mass by a factor of 5–10 [4].

From the perspective of ΛCDM, dark matter is considered a universal, cold, weakly interacting substance that forms the primary gravitational potentials for the formation of all galaxies. The consistent DM deficiency in an entire class of relic objects calls this universality into question and necessitates either the introduction of special, non-standard mechanisms for the formation of such galaxies, or a revision of the nature of dark matter itself.

This memorandum proposes an alternative explanation of the phenomenon, one that does not require altering standard formation scenarios but is based on a fundamentally different — processual and informational — view of the dynamics of gravitating systems.

2 Methodological Foundation: The Valency-Mass Balance (VMB) Principle

For the analysis, a heuristic framework — the Valency-Mass Balance (VMB) principle [1] — is employed. Its foundation is the representation of any complex system as a dynamic interplay of two factors:

- **Mass (M)** — the aggregate inertial component of the system: matter, structural elements, accumulated resources.
- **Valency (V)** — the aggregate potential for creating new connections, internal orderliness, and the informational capacity of the system.

The stability of a system is described by the balance of weighted changes in these factors:

$$\Delta(M \cdot K_m) \equiv \Delta(V \cdot K_v) \tag{1}$$

where K_m is the coefficient of mass inertia (the system's resistance to changes in its structure), K_v is the coefficient of valency dissipation (the rate of potential loss). The sign $\equiv$ denotes the necessity of balance: a system cannot change its weighted mass without adjusting its weighted valency, and vice versa.

Three basic phases of a system are derived from the principle:

1. **"Void"**: $V \uparrow$, $M \downarrow$ — high valency with minimal mass (pure potential).
2. **"Star"**: $V \sim M$ — a balanced, productive state.
3. **"Black Hole"**: $V \downarrow$, $M \uparrow$ — collapse of valency under the pressure of excessive, unstructured mass.

This principle was previously successfully applied to construct a processual cosmological hypothesis (the Engineering Logic of the Universe, ELU) [2]. In this work, it is used as a tool for diagnosing the state of gravitating systems.

3 Analysis: Applying the VMB Principle to the Phenomenon of NGC 1277

Let us consider the ultra-compact massive galaxy NGC 1277 as a system within the VMB framework.

1. **Extreme mass concentration (high K_m).** NGC 1277 is characterized by an anomalously high central stellar density and, presumably, a central black hole [4]. This means its baryonic mass (M) is packed into a minimal volume with ultimate efficiency. In VMB terms, such an object possesses the maximum coefficient of mass inertia ($K_m \to \max$) — its structure is rigidly fixed and offers colossal resistance to any changes.

2. **Depletion of valency ($V \to 0$).** According to the balance equation (1), the extreme increase in weighted mass ($M \cdot K_m$) requires compensation from weighted valency ($V \cdot K_v$). In NGC 1277, the processes of star formation and dynamical activity ceased long ago (a "quenched" galaxy) [4,5]. This observation is interpreted within the VMB as the complete depletion of internal valency (V). All available potential for creating new connections (gas, new stars, structural rearrangements) has been expended on the creation and maintenance of the current super-dense structure.

3. **Consequence: self-sufficiency and the lack of need for dark matter.** A system that has reached the limit in parameters M and K_m and exhausted V transitions into a state of informational-mass saturation. Its gravitational stability is provided not by an external agent (hypothetical DM) but by the internal rigidity of its own structure (high K_m). Introducing unbound, "loose" dark matter into such a system (which would have a low K_m and contribute no structural rigidity) would disrupt the achieved balance and become dysfunctional for the system. Therefore, NGC 1277 exhibits a DM deficiency — it has evolutionarily "filtered out" the need for this external stabilizer.

Conclusion from the VMB: The dark matter deficiency in NGC 1277 and similar UCMGs is not an anomaly. It is a natural consequence of the system reaching a state of critical saturation, where its entire gravitational dynamics are entirely determined by the visible, supremely ordered baryonic mass with the maximum coefficient of inertia K_m.

4 Formulation of the Principle

Based on the conducted analysis, a new principle is formulated — the **Information Self-Sufficiency Principle (ISSP)**[1]:
The need of a gravitating system for hypothetical dark matter (as an external stabilizing agent) is inversely proportional to the measure of density of its informational-mass packing, described by the parameter K_m (the coefficient of mass inertia) in the VMB equation (1)**.**

Consequences and Interpretation of the Principle:

1. **Dark matter as an indicator of "incompleteness".** The principle suggests that the observed influence of dark matter in systems such as spiral galaxies may not be a manifestation of a new substance but an indicator of their incomplete internal balance. In this interpretation, DM acts as a "crutch", compensating for the deficiency in internal structural rigidity (low K_m) and insufficient realization of valency (V).

2. **Predictive power.** A testable prediction follows from the principle: a deficiency or absence of the dark matter signature should be observed in all gravitating systems that have reached a state of critical saturation, i.e., those possessing an extremely high central mass concentration and having completed active evolution. In addition to UCMGs, such

[1] "The Information Self-Sufficiency Principle" — the Murdasov Principle.

systems may include the cores of some globular clusters, ultra-compact dwarf galaxies, and the central regions of massive elliptical galaxies.

3. **Connection to fundamental physics.** The principle shifts the research focus from the search for dark matter particles to the study of conditions and mechanisms leading to the maximization of the parameter K_m (informational-mass density) in gravitating systems. This raises the question of the connection between microprocesses (e.g., the properties of nuclear interactions that determine the equation of state of super-dense matter) and macroscopic gravitational stability.

5 Testable Predictions: Classes of Objects with an Expected Dark Matter Deficiency

The Information Self-Sufficiency Principle predicts that a deficiency in the dark matter signature should be observed in any gravitating systems that have reached a state of critical saturation, i.e., those possessing an extremely high parameter K_m (mass inertia) and having exhausted their valency (V). In addition to the studied UCMGs, such objects may include:

1. **Galaxies with an anomalously high mass-to-light ratio in the nucleus:**
   - Ultra-compact dwarf galaxies (UCDs) with sizes < 100 pc and masses $> 10^7\ M_\odot$.
   - Nuclei of stripped galaxies (e.g., objects like M60-UCD1).
   - Supermassive black holes in inactive galactic nuclei, surrounded by extremely dense stellar nuclei.
2. **Globular clusters at the upper limit of the mass function:**
   - Supermassive globular clusters (e.g., ω Cen, M54, G1), whose mass ($> 10^6\ M_\odot$) and density place them on the borderline between a cluster and a dwarf galaxy. It is predicted that their dynamic mass will be well explained by the visible mass.
3. **Quasi-stellar objects and intermediate states:**
   - Objects such as bare quasars with extremely massive black holes and minimal bulges.
   - Hypothetical "dark matter stars" or other super-dense relic objects, provided their structure proves to be extremely rigid ($K_m \to \max$).
4. **Large-scale structures in special states:**
   - Cores of rich galaxy clusters dominated by a giant elliptical galaxy (cD-galaxy) with its dense stellar halo. A reduction in the DM contribution to the very central region is predicted.
   - Galaxies in the final stage of a "wet" merger, just before complete "quenching", when the gas is exhausted and the stellar component has been reordered.

Verification method: For each class of objects, a detailed analysis of rotation curves (for galaxies) or velocity dispersion (for clusters) must be conducted, comparing the dynamic mass with the mass estimated from photometric and spectroscopic data of visible matter. According to the principle, the discrepancy (attributed to DM) should systematically decrease with increasing central density and decreasing star-forming activity of the object.

6 Discussion: Rethinking the Nature of Dark Matter and Dark Energy

The proposed principle allows for a reformulation of the problem of dark matter (DM) and dark energy (DE) in terms of states of a single dynamic medium.

1. **Dark matter as an indicator of "incompleteness".** Within the framework of the VMB and the Information Self-Sufficiency Principle, DM loses its status as a universal elementary particle. Instead, its gravitational manifestation is interpreted as a quasi-phenomenological parameter characterizing the degree of deviation of a gravitating system from a state of internal self-sufficiency. The lower the density of the informational-mass packing of the system (K_m), and the greater the amount of unbound potential (V) within it, the more its dynamics will require the introduction of an additional gravitating agent — "dark matter". Thus, DM serves as an indicator of the "looseness" or "incompleteness" of a system in its evolution towards a maximally compact and stable state.

2. **The unified nature of DM and DE in the processual model.** This view is consistent with a more general processual model — the Engineering Logic of the Universe (ELU) [2]. Within it, the existence of a primary field "Primordial Slush" possessing maximum valency ($V_{\max}$) is postulated.

    - **Dark energy** is interpreted as a direct manifestation of the background potential (V) of this field, its tendency to expand and fill volume, observed as the accelerated expansion of the Universe, especially in voids.
    - **Dark matter** is interpreted as the condensed, structured phase of the same field, its "frozen" clumps possessing mass (M) and forming the gravitational scaffold for visible matter. Its "disappearance" in UCMGs means that in these objects, the process of local condensation of the "Primordial Slush" is fully completed, and all available potential (V) has been transformed into structure (M) with maximum K_m.

7 Conclusion

The presented memorandum does not propose a new particle or a modification of gravity. It proposes a shift in the research paradigm: from the search for a new substance to the analysis of informational-dynamic states of matter and their evolution. The dark matter deficiency in NGC 1277 ceases to be a mystery and becomes a key observational consequence of this paradigm, indicating the possibility of describing gravitational dynamics in terms of the balance between mass and the informational capacity of a system. Further testing of the principle on other classes of compact objects may serve as a bridge to constructing a unified model linking dark matter and dark energy as different phases of a single process of structuring the primary field of reality.

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