Appendix_ New and Refined Predictions of the G-Model for the First Part of the Study

0. Note on source references

Explanation. By the source documents we mean the following eleven PDFs from Part I of the monograph:

- No. 41_23 - (No. 206, page 1104) — strong-field knots: horizon / "near-horizon" structures, shadow, rings, link to metric profiles.
- No. 41_2 — (184, page 982) $R_{\text{eff}}[\Delta H]$ as domain effective curvature and a bridge to GR description; reconstruction logic.
- No. 41_19 —(202, page 1083) matching block (bridge): how parameters and channels from different sections must "fit" into a single system of tests.
- No. 39_10 —(158, page 830) a "map of zones" where the G-model expects qualitatively new signatures (regimes where effects do not reduce to GR).
- No. 40_8_3 — (180, page 957) neutrino "stress channel": extreme sensitivity to the ΔH structure, correlations with mass scales.
- No. 41_32 —(215, page 1152) numerical / profile blocks: 1D / radial simulators of ΔH and lepton profiles; stability of scales.
- No. 40_6 — (174, page 923) "step-like" / discrete levels: $m \leftrightarrow w_n$, ΔH-steps, test procedure.
- No. 41_37 — (220, page 1179) calibration: ΔH_{unit}, L_{corr}, and domain coefficients (a_D, b_D, c_D) as the source of quantitative bands.
- No. 41_3 — (185, page 990) refinements of calibration / parameters, principles of fixing, control of signs / ranges.
- No. 9_3 — (26, page 122) practical notes / simulation modules (1D profiles, radial regimes, stability of numerical schemes).
- No. 16 — (35, page 87) additional strong-field / transitional fragment (contours of deviations in critical regimes and how to read them).

1. Aim and scope of the document

1.1. Aim

Aim. To formulate a clear and at the same time strict map of new / refined predictions of the G-model, based on actual fragments from the eleven PDFs, but presented as a single coherent "test package" in which each effect:

- has a mechanism (what in the model produces the feature),

- has an observable consequence (what is measured),
- has consistency with other channels (one cannot tweak one test without affecting the others),
- provides a falsification criterion (under which data the statement is constrained or rejected).

1.2. Framework principle: one universe without "parallel realities"

Fixation. In the G-model there is no branching into "variants of the universe" as ontologically distinct branches. There is a single reality and a single superposition of domains / superdomains which:

- is unique (not a "choice of branch" but a single structure),
- is projectively given (as part of the structure of the G-field),
- in continuum description appears as different ΔH regimes in domains.

Consequence. In the predictions we do not say "it may be this way or otherwise", but formulate unambiguous signatures: either observations find them, or they impose constraints. (See the matching explanations in document No. 41_19.)

2. Method: how to read predictions as a "package"

2.1. What is a "test package" in physics

Explanation. In modern physics practically no serious model stands on a single "effect". It stands on a bundle of channels which must be mutually consistent:

- weak field (where precision measurements are extremely stringent),
- strong field (where new geometric signatures appear),
- "internal" spectral / mass tests (where the model claims to explain hierarchies),
- numerical experiments (where reproducibility of profiles and scales is tested).

In these eleven PDFs the G-model is presented precisely as a system of consistent channels, not as a "list of ideas". Therefore below we read each section through three questions:

1. What exactly in the model is the source of the effect?
2. What is measured (which data)?
3. With what must it be consistent?

2.2. Three levels of statements: qualitative, semi-quantitative, quantitative

Explanation. These PDFs contain three types of predictions:

- qualitative signatures: “the shape of the profile changes”, “an additional contribution appears”, “a correlation between channels arises”;
- semi-quantitative constraints: “deviations must be small in the weak field but grow in certain regimes”, “the sign of the deviation is determined by the structure of the coefficients”;
- quantitative bands (the most valuable): when ΔH_{unit}, L_{corr}, a_D, b_D, c_D are fixed, and one can then speak of numbers, ranges, scales.

This document brings everything to levels (1)–(2), with prepared slots where (3) will be inserted after final parametrization (see documents No. 41_37, No. 41_3).

3. Weak fields: gravity, astrophysics, navigation

Sources: see documents No. 41_23 (206), No. 41_2 (184), No. 41_19 (202), No. 39_10 (158).

3.1. Main idea of weak-field prediction

Explanation. In the weak field, GR works excellently. Therefore any new model that claims physical relevance must:

- not break the known precision tests,
- but allow structurally consistent micro-deviations which:
  - either accumulate in long, precise integrations,
  - or appear in special configurations (trajectory geometry, domain transitions, etc.).

In the G-model weak-field deviations do not appear as “free parameters for each effect”, but as consequences of the ΔH structure and the domain effective curvature $R_{\text{eff}}[\Delta H]$. This means: if we see a deviation in lensing somewhere, it is not allowed to “fail to show up” in the corresponding timing / orbital tests.

3.2. Post-Newtonian “package”: deflection, Shapiro, orbits

Prediction (structural). The G-model describes weak-field corrections as a package which manifests itself in three classes of tests:

1. light deflection (lensing) — geometry of ray paths;
2. Shapiro-type time delay — additional propagation time in a gravitational field;
3. orbital shifts — perihelion / pericenter, drift of orbital elements, secular effects.

Mechanism. In GR these effects are determined by the metric. In the G-approach the idea is introduced that the "effective geometry" seen by a signal / trajectory may contain an additional domain component encoded via $R_{\text{eff}}[\Delta H]$ and derivatives of the ΔH profile. If $R_{\text{eff}}[\Delta H]$ does not reduce to a "mass parameter", then a profile anomaly appears in lensing. The same structure inevitably contributes to time delays and to orbital integrals.

What is measured.

- In lensing: not only angle / convergence, but the shape of the profile (as a function of impact parameter / radius) and consistency with independent mass estimates.
- In Shapiro delay: ultra-precise radio signals in configurations of close passage near massive bodies; careful control of systematics is required.
- In orbits: long time series of astrometry / radar / pulsar systems.

Falsification criterion. If data are demonstrably reducible to a GR profile with an uncertainty that "swallows" any additional domain contribution, then G-corrections must be strongly constrained (see the "quantitative band" in documents No. 41_37 (222), No. 41_3 (185). (See key formulations in document No. 41_23 (206) and the matching logic in No. 41_19 (202)

3.3. Lensing as a test of domain curvature, not only of "effective mass"

Prediction (qualitative). In typical interpretations of lensing, almost everything is absorbed into the mass distribution. The G-model allows that part of the lensing signal can be geometric (domain effective curvature), not only "mass-like".

Mechanism. $R_{\text{eff}}[\Delta H]$ is introduced: if the domain ΔH profile has a special structure, then optical geodesics experience a curvature different from that reconstructed by a standard GR fit.

Signatures to search for.

- Profile "breaks": systematic deviations in convergence / deflection that do not want to be explained by a smooth mass.
- Coherent deviation: anomalies repeat across a class of objects / configurations and are not a one-off systematic.
- Link to timing tests: if this is domain geometry, there must be small but consistent contributions to time delays.

(See the reconstruction meaning of $R_{\text{eff}}[\Delta H]$ in document No. 41_2 and the "zone map" in No. 39_10.)

3.4. Timing signals: delays and phase-frequency shifts as a "ΔH channel"

Prediction. For signals passing through regions with different ΔH regimes the model expects:

- an additional contribution to travel time (beyond the GR part),

- very subtle phase / frequency shifts in ultra-precise timing systems.

Mechanism explanation. In the weak field, domain contributions may be extremely small in an instantaneous measurement but show up in:

- phase accumulation,
- long time baselines,
- close-passage configurations,
- high stability of reference clocks / pulsars.

Consistency. This must be compatible with what lensing / orbits show in the same class of domains (matching principle: the same parameters — several channels; see No. 41_19 (202).

4. Strong fields: black holes, shadows, rings, ringdown modes

Sources: see documents No. 41_23 (206), No. 16 (37), No. 41_19 (202), No. 41_2 (184).

4.1. Why the strong-field regime is decisive

Explanation. In the strong field GR also has major successes, but precisely there:

- the metric enters in a non-linear way,
- photon regions / rings are highly sensitive to the potential profile,
- observations such as EHT and gravitational-wave events give access to the geometry near the horizon.

Therefore even a small structural deviation in $g_{00}(r)$ or in the effective curvature may produce a bright signature.

4.2. Horizon and "near-horizon" structure: change of the $g_{00}(r)$ profile

Prediction. In the G-model the strong-field region is described such that:

- the horizon conditions (as a "visibility boundary") may undergo structural corrections;
- the profile of the effective potential / metric (schematically $g_{00}(r)$) may differ from the standard GR fit for the same macro-parameters.

What matters. This is not a "free correction" but one that must:

- be consistent with the domain curvature $R_{\text{eff}}[\Delta H]$,
- be consistent with what the weak-field tests permit (the weak field must not be broken).

(See the strong-field knots in No. 41_23 (206) and additional details in No. 16 (35)

4.3. Shadow and photon rings: geometry plus brightness profile

Prediction. For EHT-like observations two distinct layers are important:

- Geometric: size / shape of the shadow, position of the photon ring;
- Radiative: intensity distribution, thickness, contrast.

In the G-model the prediction is structured as follows:

- a shift of the shadow and / or photon ring radius is possible;
- a systematic skew of the brightness profile is possible (not only "where the edge is" but "how the ring shines");
- these deviations must be compatible with what the same object shows in timing / orbits (where available).

Falsification criterion. If after careful calibration of astrophysical systematics (accretion, plasma, source geometry) the data robustly "land" on a GR profile, then G corrections must either:

- be very small, or
- appear not here, but in another "zone of the map" - see No. 39_10 (158).

4.4. Ringdown (quasi-normal modes): frequencies and damping times

Prediction. After mergers of compact objects a ringdown stage is observed where the system is described by quasi-normal modes:

- mode frequencies,
- damping times,
- spectral structure (which modes dominate).

The PDFs state the idea that strong-field corrections of the G-model should manifest as a systematic shift of this spectrum compared with GR predictions for the same macro-parameters.

Why this is a strong test. Quasi-normal modes are a direct spectral "fingerprint" of the geometry near the horizon. If the G-model changes the effective geometry / curvature, this must be reflected in the modes.

Consistency. The shifts of modes are not allowed to be "free": they must correlate with the same parameters that control the weak-field package (see No. 41_19 - № 202).

5. $R_{\text{eff}}[\Delta H]$: domain effective curvature and a bridge to GR

Sources: see No. 41_2 (184), No. 39_10 (158), No. 41_19 (202).

5.1. Why introduce $R_{\text{eff}}[\Delta H]$

Explanation. In GR, geometry is encoded in the metric and curvature tensors. In the G-approach, according to these PDFs, an object $R_{\text{eff}}[\Delta H]$ is introduced which functionally plays the role of:

- an effective domain curvature reconstructed from the ΔH profile,
- a bridge: how the "internal" domain structure (via ΔH) turns into an "external" geometric signature.

The key meaning: $R_{\text{eff}}[\Delta H]$ is not "just another parameter", but a cross-check. If we reconstruct geometry from data, we must have consistency:

- lensing $\leftrightarrow R_{\text{eff}}[\Delta H]$,
- timing delays $\leftrightarrow R_{\text{eff}}[\Delta H]$,
- strong-field shadow / rings $\leftrightarrow R_{\text{eff}}[\Delta H]$.

5.2. Reconstruction as a procedure (not a slogan)

Explanation. The words "can be reconstructed" only make sense when there is a scheme:

- a class of admissible ΔH profiles (within the allowed ΔH-interval for the domain) is fixed;
- the map from ΔH to R_{eff} is specified;
- the consistency of R_{eff} with independent geometric observations is checked.

In the G-model this appears as a requirement: not to "fit" a single channel, but to build a self-consistent profile. (See details in No. 41_2 - №184 and where the maximum gain is expected — in No. 39_10 - №158.)

6. Neutrinos as a "stress channel" of ΔH: an extreme test

Sources: see No. 40_8_3 (180), No. 41_19 (202), No. 41_32 (215).

6.1. Why neutrinos

Explanation. In modern physics neutrinos form one of the most delicate channels:

- masses are small,
- oscillations are sensitive to phases,
- data are accumulated in different media and on different scales.

In the PDFs neutrinos act as a "stress test" of the model: if the ΔH structure is fundamental for mass / frequency scales, neutrinos must display tight relations (or at least strong correlational constraints).

6.2. What exactly is expected to be “rigid”

Prediction contours. In a form suitable for further refinement three types of statements are fixed:

1. ΔH calibration ↔ neutrino mass scales. If ΔH_{unit} and the associated scale are chosen, neutrino masses cannot be “completely independent” — some tying / constraints are expected.
2. ΔH profile ↔ oscillation parameters. In certain domain regimes nontrivial correlations of oscillation parameters may appear.
3. Internal consistency with the steps w_n. If a discrete spectral level description (Section 7) exists, neutrino scales must either lie on these levels or constrain the step parameters.

(The storyline and motivation — No. 40_8_3 (180); links to numerical profiles — No. 41_32 - №215)

6.3. Falsification criterion

Criterion. If after consistent calibration of ΔH_{unit} and of the step parameters (Sections 7–8) neutrino data systematically agree with no reasonable ΔH structure, then:

- either the neutrino channel is “exceptional” (and the model must explain this exception without destroying its general logic),
- or the basic hypothesis of a tight link between neutrinos and ΔH requires revision.

7. Discrete levels and “step-like” structure: testing $m \leftrightarrow w_n$ via ΔH steps

Sources: see No. 40_6 (174), No. 41_32 (215), No. 41_19 (202).

7.1. What “step-like” means in our setting

Explanation. The idea of “step-like” behaviour in these Part I PDFs is neither mysticism nor “playing with numbers”. It is the statement that the model contains discrete levels / regimes which:

- may be read as indices n in spectral frequencies w_n,
- have a correspondence with mass scales (through the model mechanism).

Thus the prediction is formulated as a test procedure:

1. fix ΔH calibration;
2. obtain the expected level structure;
3. compare with masses / frequencies.

7.2. How this differs from “post-factum fitting”

Explanation. It differs from pure “fitting” because two conditions must hold:

- the step parameters are fixed independently (via ΔH_{unit}, L_{corr}, domain coefficients) — see Section 8;
- the check is performed simultaneously on several data classes (neutrinos, lepton scales, other spectral markers), and consistency must be global.

(See the formulation of step-like structure in No. 40_6 (174) and the role of simulations in No. 41_32 - №215, No. 9_3 - №26.)

8. Numerical calibration: ΔH_{unit}, L_{corr}, a_D, b_D, c_D as the source of quantitative bands

Sources: see No. 41_37 (220), No. 41_3 (185), No. 41_19 (202).

8.1. Why calibration is crucial

Explanation. Without numerical fixing of parameters, any prediction remains qualitative. Calibration turns it into a band in which:

- part of the parameters is fixed;
- thereafter the model must accept the consequences in all channels simultaneously.

It is explicitly emphasized that ΔH_{unit}, L_{corr}, a_D, b_D, c_D must not remain mere “symbols”, but must:

- have numerical fixing or at least narrow ranges;
- have a sign structure that determines the direction of deviations;
- be shared by the weak / strong / spectral channels.

8.2. ΔH_{unit} and L_{corr}: their operational meaning

Explanation. In practical terms (not as slogans):

- ΔH_{unit} is the scale of a “unit deviation” through which ΔH regimes are compared between different problems (so that ΔH in simulation and ΔH in physical interpretation refer to the same scale).
- L_{corr} is a correlation / localization scale (determining how quickly “correlation disappears” between distant regions, and thus directly affecting profiles, stability of numerical schemes and spectral estimates).

Matching principle. Once L_{corr} is specified, profiles must be stable (not “drifting” with grid / step changes), and part of the observables must fall into predicted / constrained ranges.

8.3. a_D, b_D, c_D: domain coefficients as a "signature" of deviation

Explanation. The triad a_D, b_D, c_D plays the role of a minimal set of domain coefficients which:

- determine the form / sign of additional terms;
- fix the type of deviation (for example, enhancement vs suppression of an effect);
- must be compatible with the variational formulation (hence not arbitrary).

Practical consequence. Once the sign structure is fixed, the G-model must be able to say: in the strong field we expect a shift in such a direction, in the weak field — another regime, while both remain mathematically consistent. See calibration explanations in No. 41_37 (220), No. 41_3 (185.)

9. Numerical experiments: ΔH profiles, lepton profiles, stability of invariants

Sources: see No. 41_32 (215), No. 9_3 (26), No. 41_19 (202).

9.1. Why simulations here are not "illustrations" but evidential support

Explanation. In the monograph the numerical block is needed not for pictures, but to test three theses:

- reproducibility of profiles (whether a stable form of $\Delta H(x)$ or $\Delta H(r)$ exists under various conditions);
- stability of scales (whether parameters "drift" when the step / grid changes);
- reproducibility of bridges (whether the ΔH profile is consistent with the expected spectral / mass markers).

9.2. "Profile signature" as a prediction object

Prediction. Documents No. 41_32 (215) and No. 9_3 (26) state that for correct L_{corr} and ΔH_{unit} there should exist a class of characteristic profiles:

- 1D ΔH profiles (in a "linear" geometry),
- radial profiles (analogue of the spherical / central problem),
- accompanying profiles for lepton / frequency markers.

This is important: a profile here is not a "random curve", but a compressed information form that later enters into the reconstruction of $R_{\text{eff}}[\Delta H]$ and into testing step-like structure.

9.3. Stability: a criterion against "numerical alchemy"

Criterion. Profiles and invariants must be stable under:

- changing the grid,
- changing the domain size,
- changing initial conditions within the allowed ΔH interval.

If profiles decay or "blow up" depending on minor numerical details, this means either L_{corr} is inconsistent, or the formulation itself requires revision. See methodological notes in No. 9_3 (26), and main claims on reproducibility in No. 41_32 (215)

10. The matching "backbone" of predictions: what must agree with what

Sources: see No. 41_19 (202) and the general context of No. 39_10 (158).

10.1. Main matching rule

Rule. One and the same parameter set is not allowed to give mutually inconsistent answers in different channels.

This means:

- if $R_{\mathrm{eff}}[\Delta H]$ "tunes" lensing, it must produce consistent contributions to timing delays;
- if a strong-field profile changes the shadow / rings, this must show up in quasinormal modes;
- if step-like w_n claims mass levels, it must be compatible with the neutrino channel;
- if L_{corr} is fixed, simulations must be stable.

10.2. "Zone map" as a search strategy

Explanation. Document No. 39_10 (158) states a key idea: not all observations are equally sensitive. One must look for regimes where:

- the GR description becomes insufficiently diagnostic,
- or requires "external" explanations without an internal mechanism,
- while the G-model provides an additional internal marker via ΔH and $R_{\mathrm{eff}}[\Delta H]$.

This is the scientific strategy: not to "explain everything", but to identify zones where the model provides qualitatively new information.

11. Minimal set of critical questions (as strict requirements for the next step)

11.1. Critical questions No. 1–No. 9

1. What exactly is numerically fixed after calibration?
2. Which precise values / ranges for ΔH_{unit} and L_{corr} are adopted as canonical - see No. 41_37 (220), No. 41_3 (185)?
3. What is the sign structure of a_D, b_D, c_D?
4. Which "direction" of deviation is predicted in the strong field, and how is it mirrored in the weak field?
5. What is the minimal set of "golden tests" adopted first? For example:
    - (shadow / ring),
    - (ringdown),
    - (Shapiro / lensing),
    - (neutrinos),
    - (step-like w_n).
6. Which reconstruction procedure for $R_{\text{eff}}[\Delta H]$ is adopted as standard?
    - which input ΔH profiles and which output geometric quantities (No. 41_2 - 184)?
7. How is the consistency of simulations with "physical" scales fixed?
    - which stability criteria for the profile and which invariants must not "drift" - No. 41_32 (215), No. 9_3 (26)?
8. Which statements about neutrinos are considered "rigid" and which are "soft"?
    - where exactly is correlation expected: in mass scales, in oscillation parameters, or both (No. 40_8_3 – №180)?
9. What form of "legal fixation" about one universe is inserted into the monograph so that no interpretation in terms of "multiverses" appears?

11.2. Why this list is necessary

Explanation. Without this package the model remains at the level of survey-like statements. With this package it enters the regime

parameters fixed $\Rightarrow$ channels linked $\Rightarrow$ experiment / observation can either confirm the signature or

12. Conclusion (one-page summary)

Conclusion. The eleven PDF blocks of Part I yield not a “light overview”, but a structured system of predictions, with the following key nodes:

- Weak fields: lensing, Shapiro delay, orbital shifts — as a consistent package No. 41_23 (206), No. 41_19 (202).
- Strong fields: horizon / $g_{00}(r)$ profile, shadow / rings, quasi-normal modes — as a geometric spectral fingerprint - No. 41_23 (206), No. 16 (35).
- $R_{\mathrm{eff}}[\Delta H]$: a bridge from the ΔH profile to effective geometry and mutual cross-check of channels - No. 41_2 (184).
- Neutrinos: an extreme “stress channel” for ΔH logic - No. 40_8_3 (180).
- Step-like w_n: a spectral test procedure $m \leftrightarrow w_n$ via ΔH steps - No. 40_6 (174).
- Calibration: ΔH_{unit}, L_{corr}, a_D, b_D, c_D as the key to quantitative bands - No. 41_37 (220), No. 41_3 (185).
- Simulations: reproducibility of profiles and stability of invariants as an “anti-alchemy” criterion - No. 41_32 (215), No. 9_3 (26).
- Zone map: a search strategy for regimes where the G-model yields qualitatively new signatures - No. 39_10 (158).