Appendix — Minimal Condition for a Local Repulsive Term Canceling Weight in the HGR Framework

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Purpose of this appendix

The purpose of this appendix is to examine, within the spirit of Hypercomplex General Relativity (HGR), the minimal conditions required for the appearance of a *local repulsive term* capable of canceling the weight of a test mass m placed above a source mass M.

The goal here is not to propose a realistic experimental device, but rather to fix a minimal theoretical architecture for *local antigravity*, understood as an activated, anisotropic, and spatially confined geometric correction.

1 Formulation of the local problem

Consider a source mass M and a test mass m placed at a fixed altitude r_0 above M. In the non-relativistic limit, the standard gravitational acceleration is

$$\mathbf{a}_M(r) = -\frac{GM}{r^2}\,\hat{\mathbf{r}}. \tag{1}$$

To cancel locally the weight of m at the point r_0, one must introduce a local repulsive contribution such that

$$\mathbf{a}_{\text{eff}}(r_0) = \mathbf{a}_M(r_0) + \mathbf{a}_{\text{rep}}(r_0) = 0. \tag{2}$$

The minimal condition is therefore

$$\boxed{\mathbf{a}_{\text{rep}}(r_0) = +\frac{GM}{r_0^2}\,\hat{\mathbf{r}}.} \tag{3}$$

2 Geometric translation in terms of an effective connection

In the weak-field approximation and for a slow particle, the spatial acceleration is related to the effective connection by

$$a^i \simeq -c^2\,\Gamma^i_{00,\text{eff}}. \tag{4}$$

We then introduce an effective connection of the form

$$\Gamma^\rho_{\mu\nu,\text{eff}} = \Gamma^\rho_{\mu\nu}(g) + \Delta\Gamma^\rho_{\mu\nu}(H), \tag{5}$$

where $\Delta\Gamma^\rho_{\mu\nu}(H)$ represents the correction induced by the hypercomplex sector.

The local weight-cancellation condition then becomes

$$\boxed{-c^2\,\Delta\Gamma^r_{00}(r_0) = +\frac{GM}{r_0^2}.} \tag{6}$$

In other words, the hypercomplex sector must locally correct transport in such a way as to produce a radial acceleration opposite to that generated by the source mass.

3 Minimal affine hypercomplex ansatz

In the spirit of the strong affine extension of HGR, one may take as a minimal model

$$\Delta\Gamma^\rho_{\mu\nu}(H) = \frac{\lambda}{2}\left(A^I_\mu \Sigma^\rho_{\nu I} + A^I_\nu \Sigma^\rho_{\mu I}\right), \tag{7}$$

where:

- A^I_μ is an internal hypercomplex connection;
- $\Sigma^\rho_{\nu I}$ is a base–fiber projection tensor;
- λ is an effective geometric coupling.

In this case, the local compensation condition reads

$$\boxed{-c^2\,\frac{\lambda}{2}\left(A^I_0 \Sigma^r_{0I} + A^I_0 \Sigma^r_{0I}\right)_{r=r_0} = +\frac{GM}{r_0^2}.} \tag{8}$$

Equivalently,

$$\boxed{-c^2\,\lambda\,(A^I_0 \Sigma^r_{0I})_{r=r_0} = +\frac{GM}{r_0^2}.} \tag{9}$$

4 Need for local activation and a spatial domain

A repulsive term useful for local antigravity cannot be merely cosmological. It must be *locally activated* within a spatial region D.

We therefore introduce a domain function

$$\mathcal{A}_D(x) \in [0,1], \tag{10}$$

which is approximately 1 inside the weight-cancellation region and 0 outside.

A possible smooth form is

$$\mathcal{A}_D(x) = \exp\left(-\frac{d(x,D)^2}{L^2}\right), \tag{11}$$

where L sets the characteristic thickness of the domain.

The local effective connection then becomes

$$\Gamma^\rho_{\mu\nu,\text{eff}} = \Gamma^\rho_{\mu\nu}(g) + \mathcal{A}_D(x)\,\Delta\Gamma^\rho_{\mu\nu}(H). \tag{12}$$

The local condition at the center x_0 of the domain is

$$\boxed{-c^2\,\mathcal{A}_D(x_0)\,\Delta\Gamma^r_{00}(x_0) = +\frac{GM}{r_0^2}.} \tag{13}$$

5 Need for directional anisotropy

A simple isotropic scalar correction is insufficient to cancel weight in a given direction. To compensate the gravitational field of M above the source, one needs a structure capable of selecting the radial direction $\hat{\mathbf{r}}$.

The local repulsive term must therefore be at least:

- either vectorial,
- or affinely anisotropic,
- or a mixed base–fiber tensorial structure.

In the ansatz (7), this anisotropy is carried by the projection $\Sigma^{\rho}_{\nu I}$ and by the internal orientation of the sector A^I_μ.

6 Local stability condition

Canceling the weight at a single point is not sufficient to obtain a useful static levitation. One must also require stability under small radial perturbations.

If $a_{\text{eff}}(r)$ denotes the effective radial acceleration, the minimal conditions are

$$a_{\text{eff}}(r_0) = 0, \tag{14}$$

and

$$\left.\frac{\mathrm{d}a_{\text{eff}}}{\mathrm{d}r}\right|_{r=r_0} < 0. \tag{15}$$

The second condition ensures that a small deviation near r_0 does not turn the equilibrium into an explosive instability.

7 Minimal radial toy model

A minimal effective form for the acceleration is

$$\mathbf{a}_{\text{eff}}(r) = -\frac{GM}{r^2}\,\hat{\mathbf{r}} + \mathcal{A}_D(r)\,a_H(r)\,\hat{\mathbf{r}}. \tag{16}$$

The compensation condition at the target altitude r_0 is

$$\boxed{a_H(r_0) = \frac{GM}{r_0^2}.} \tag{17}$$

A simple form for the local repulsive profile is

$$a_H(r) = a_0\,f(r), \tag{18}$$

where $f(r)$ is centered on r_0 and decays rapidly outside the domain.

For instance,

$$f(r) = \exp\left(-\frac{(r-r_0)^2}{\ell^2}\right), \tag{19}$$

with the adjustment condition

$$a_0 = \frac{GM}{r_0^2} \tag{20}$$

if $f(r_0) = 1$.

8 Effective tensorial writing

At the level of the field equation, the idea may be summarized by

$$G_{\mu\nu} = 8\pi G\, T^{(m)}_{\mu\nu} + \mathcal{A}_D(x)\, \Theta^{\mathrm{rep}}_{\mu\nu}(x). \tag{21}$$

But if one wants an oriented local compensation of weight, the tensor $\Theta^{\mathrm{rep}}_{\mu\nu}$ should not be assimilated to an ordinary isotropic fluid. It must contain anisotropic components capable of locally correcting the component Γ^r_{00} of the effective connection.

In other words, the correct physical language is no longer merely that of a "repulsive density", but that of an *activated anisotropic geometric domain.*

Conclusion

Within the HGR framework, the appearance of a static local antigravity effect above a source mass would require at minimum:

- a local affine correction of the type $\Delta\Gamma^\rho_{\mu\nu}(H)$;
- a spatial activation confined within a domain D;
- a directional anisotropy capable of selecting the radial axis;
- an exact compensation condition,

  $$-c^2\, \Delta\Gamma^r_{00}(r_0) = +\frac{GM}{r_0^2},$$

  or, with an activated domain,

  $$-c^2\, \mathcal{A}_D(x_0)\, \Delta\Gamma^r_{00}(x_0) = +\frac{GM}{r_0^2};$$

- a local stability condition on the radial profile of the repulsive term.

The minimal formulation therefore suggests that a *local cancellation of weight* would not result from a simple homogeneous cosmological term, but from a genuine *local, activated, and oriented geometric bubble* producing an affine correction opposite to the gravitational field of the source mass.