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I-B-VP-CR A Local Ward Gate and a Positive-Core Obstruction on a Prescribed Conical Product

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Abstract

Smooth operator realizability does not by itself select an apex boundary condition. We formulate one source-test Ward demand in the exceptional scalar Bessel channel associated with the curvature-regular prescription of I-B-G-S, keeping its Friedrichs target fixed. Among all nonnegative self-adjoint realizations in this one-channel chart, the demand holds exactly for the singular nonnegative realization E_0. In an explicitly declared local class of smooth rotational metric–curvature–flux cores with nonnegative energy densities, however, every transported operator converges to Friedrichs. Consequently no selected limit in that class meets the Ward demand. The obstruction is visible to fixed exterior sources and tests: an explicit rank-one resolvent defect stays uniformly separated from zero, and one fixed smooth spectral packet also witnesses failure for every sufficiently small admissible core. A hypothetical local realization of the demanded branch must instead develop negative, critically tuned radial impedance. The useful refinement is this quantitative compatibility gate, not a new cap construction or a new Friedrichs convergence theorem. It separates idealized Ward selection from physical core-limit claims and identifies a precise hypothesis that must fail in any successful extension. Angularly nonlocal finite-mode caps are excluded. Locality without the stated positivity and channel hypotheses is not covered; no tensor-core theorem, Einstein source law, state selection, or spacetime-emergence conclusion is derived.

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Book expansion: Ward gate before positive-core obstruction

Present the Ward gate before the positive-core obstruction. The gate is an *additional source-test demand*, not a consequence of scalar conservation and not a physical selection principle. Keep the fixed exterior resolvent witness alongside the Mosco result. Conclusions are restricted to the declared positive local core class.

The local class comes first

Locality and the excluded cap

Work in units $c = 1$. The prescribed exterior is

$$\begin{aligned} M &= \mathbb{R}_t \times (0,\infty)_r \times S^1_\varphi \times \mathbb{R}_z, \qquad \varphi \sim \varphi + 2\pi, \\ g_0 &= -\mathrm{d}t^2 + \mathrm{d}r^2 + \alpha^2 r^2\,\mathrm{d}\varphi^2 + \mathrm{d}z^2, \qquad 0 < \alpha < 1. \end{aligned}$$

Its completion has defect

$$\mathscr{W} = \mathbb{R}_t \times \{o\} \times \mathbb{R}_z.$$

Thus the defect is a worldsheet, not a worldline.

Definition (Local smooth core). A family belongs to $\mathfrak{Q}_{\mathrm{loc}}$ if, for every $\varepsilon > 0$, its spatial operator on the completed smooth product is a scalar second-order metric–curvature–flux differential expression, with smooth coefficients, an explicitly declared self-adjoint realization, and exterior coefficients exactly equal to the prescribed conical coefficients for $r \geq \varepsilon$. All multiplication and differential couplings are local. An angular integral interaction, including an interaction obtained by projecting onto finitely many angular modes and coupling those modes, is excluded.

In particular, the smooth-coefficient finite-rank cap in I-B-VP-9-Ex1, thm:core, is not admitted: its angularly nonlocal interaction is precisely the issue recorded there as warn:core [8]. We neither reprove that realization theorem nor use it as a premise. A local multiplication coefficient may couple angular Fourier coefficients after expansion; that observation does not turn an angular projection operator into a local differential operator.

The declared class for the obstruction

Locality alone gives no sign estimate on the core energy. The obstruction below is therefore stated for a specified subclass, rather than asserted for every member of $\mathfrak{Q}_{\mathrm{loc}}$.

Definition (Positive rotational metric–curvature–flux class). Fix $\alpha \in (0,1)$, $\beta \in [0,1)$, and $\xi \geq 0$. A family belongs to $\mathfrak{Q}_+(\alpha,\beta,\xi)$ if its completed spatial manifold is $\mathbb{R}^2 \times \mathbb{R}$, its metric and connection are

$$q_\varepsilon = P_\varepsilon(r)^2\,\mathrm{d}r^2 + \alpha^2 r^2\,\mathrm{d}\varphi^2 + \mathrm{d}z^2, \qquad A_\varepsilon = a_\varepsilon(r)\,\mathrm{d}\varphi,$$

and

$$P_\varepsilon \in C^\infty, \qquad \alpha \le P_\varepsilon \le 1, \qquad P_\varepsilon' \ge 0,$$
$$P_\varepsilon = \alpha \text{ near} 0, \qquad P_\varepsilon = 1 \quad (r \ge \varepsilon),$$
$$a_\varepsilon \in C^\infty, \qquad a_\varepsilon = 0 \text{ near} 0, \qquad a_\varepsilon = \beta \quad (r \ge \varepsilon).$$

There is no uniform derivative bound unless one is separately imposed. The profiles may depend on ε.

The operator is

$$B_\varepsilon = -\Delta_{q_\varepsilon, A_\varepsilon} + \xi R_\varepsilon, \qquad R_\varepsilon = \frac{2P_\varepsilon'}{rP_\varepsilon^3} \ge 0,$$

defined by the ordinary smooth-center finite-energy form

$$q_\varepsilon[u] = \int \Big(P_\varepsilon^{-2} |\partial_r u|^2 + \frac{|(\partial_\varphi + i a_\varepsilon) u|^2}{\alpha^2 r^2} + |\partial_z u|^2 + \xi R_\varepsilon |u|^2 \Big) P_\varepsilon \, \mathrm{d}V_0, \qquad \mathrm{d}V_0 = \alpha r \, \mathrm{d}r \, \mathrm{d}\varphi \, \mathrm{d}z.$$

Its domain is the closure of smooth compactly supported functions on the completed smooth manifold. No independent inner boundary condition is appended.

For fixed ε, the metric is smooth at the center: near $r = 0$, the transverse metric is $\alpha^2(\mathrm{d}r^2 + r^2 \, \mathrm{d}\varphi^2)$. The connection vanishes there. Its coefficients and the curvature potential are bounded for that fixed core, although their bounds need not be uniform as $\varepsilon \text{downarrow} 0$. Consequently the form is closed and nonnegative.

The unitary identification must be fixed before convergence is discussed:

$$\mathscr{H}_\varepsilon = L^2(P_\varepsilon \, \mathrm{d}V_0), \qquad \mathscr{H}_0 = L^2(\mathrm{d}V_0),$$
$$U_\varepsilon u = \sqrt{P_\varepsilon}\, u, \qquad Q_\varepsilon[v] = q_\varepsilon[P_\varepsilon^{-1/2} v].$$

Remark (What positivity means here). The hypothesis is positivity of the complete local energy density in , not merely nonnegativity of the final self-adjoint operator. An attractive local potential can invalidate the proof even when the complete operator remains nonnegative. The theorem does not silently include such potentials, magnetic-moment interactions, or tuned resonant wells.

The scalar chart and the existing branch name

After normalized angular decomposition, the exterior n-th transverse channel acts on

$$\mathscr{H}_r = L^2((0,\infty), r\,\mathrm{d}r)$$

by

$$\ell_{\nu_n} = -\partial_r^2 - r^{-1}\partial_r + \nu_n^2 r^{-2}, \qquad \nu_n = \frac{|n+\beta|}{\alpha}.$$

Longitudinal Fourier transformation adds k^2.

For the Ward gate fix

$$\frac{1}{2} < \alpha < 1, \qquad \beta = 2\alpha - 1, \qquad n = 0, \qquad \nu = 2 - \alpha^{-1} \in (0,1), \qquad \mu = 1 - \nu.$$

This is a genuine scalar flux channel in Definition . It is not an assertion that the scalar connection is a tensor spin connection.

Write the two endpoint coefficients as

$$f(r) = A(f) r^{\nu} + B(f) r^{-\nu} + o(r).$$

The Friedrichs and singular nonnegative realizations are

$$h_{\nu,\mathrm{F}} : B(f) = 0, \qquad h_{\nu,\mathrm{E}_0} : A(f) = 0.$$

The construction and relevant properties are verified below.

The terminology is kept attached to its source. I-B-G-S defines the *curvature-regular branch* by taking vector channels Friedrichs and, for $\alpha > 1/2$, replacing precisely the two exceptional tensor channels $(\sigma, n) = (2,-1), (-2,1)$ by E_0; the threshold uses the no-logarithm endpoint [6, def:geo]. Here h_{ν,E_0} denotes only that prescription's exceptional scalar radial restriction. We do not rename a scalar field strength as a tensor curvature, and we do not prove a spin-2 core-selection theorem.

One additional demand: source-test Ward restoration

The target is declared, not selected afterwards

The fixed target is $h_{\mu,\mathrm{F}}$. Define the radial ladder and its formal adjoint in $L^2(r\,\mathrm{d}r)$ by

$$D_\nu = \partial_r + \frac{\nu}{r}, \qquad D_\nu^\dagger = -\partial_r - \frac{\mu}{r}.$$

As differential expressions,

$$D_\nu \ell_\nu = \ell_\mu D_\nu.$$

The angular phase and factor 1/2 in the developed-coordinate version of the exceptional ladder do not affect whether the source-test defect vanishes.

Definition (The Ward demand W**).** Let h be a nonnegative self-adjoint extension of ℓ_ν initially defined on $C_c^\infty(0,\infty)$. It satisfies W if, for every $f, g \in C_c^\infty(0,\infty)$ and every $\chi \in C_c^\infty((0,\infty))$,

$$\mathfrak{W}_\chi(h; f, g) := \left\langle D_\nu^\dagger g, \chi(h) f \right\rangle - \left\langle g, \chi(h_{\mu,\mathrm{F}}) D_\nu f \right\rangle = 0.$$

The inner product is conjugate-linear in its first entry. The associated resolvent defect is

$$\mathfrak{W}_\kappa^{\mathrm{res}}(h; f, g) := \left\langle D_\nu^\dagger g, (h+\kappa^2)^{-1} f \right\rangle - \left\langle g, (h_{\mu,\mathrm{F}} + \kappa^2)^{-1} D_\nu f \right\rangle, \qquad \kappa > 0.$$

This is the exceptional scalar source-test identity, with Friedrichs target, that occurs in the I-B-G-S domain obstruction [6, thm:spin2, eq:explicitdefect]. In this paper it is an *additional hypothesis*. It is not deduced from scalar gauge covariance, stress conservation, or smoothness of the core.

Sources and tests have compact radial support away from the apex. The produced spectral packets need not have compact radial support. No incompatible simultaneous compact spatial and compact spectral support requirement is imposed.

Only W is used. Finite local curvature is not imposed as a second demand, and no local source tensor is supplied as a third one. Compatibility with a complete ghost tower or a complete tensor system would require additional declarations and proofs.

The non-sourcing warning belongs beside the demand

Proposition (Conservation and trace do not imply sourcing). *A symmetric, conserved, traceless tensor need not source a prescribed background through an Einstein equation.*

Proof. In Minkowski coordinates let

$$\eta = \mathrm{diag}\,(-1,1,1,1), \qquad T_{\mu\nu} = \mathrm{diag}\,(3e,e,e,e), \qquad e > 0.$$

This tensor is constant, symmetric, divergence-free, and $\eta^{\mu\nu}T_{\mu\nu} = 0$. Nevertheless $G_{\mu\nu}(\eta) = 0$, whereas $\kappa_{\mathrm{grav}}T_{\mu\nu} \neq 0$ for $\kappa_{\mathrm{grav}} \neq 0$. Thus the Einstein equation with zero cosmological constant fails.

This is the warning of I-B, prop:not-source, reproduced with its elementary argument rather than imported as a premise [2]. Ward restoration in Definition is a domain demand; it is not an Einstein source law.

The gate: ideal selection or local obstruction

Theorem (The scalar Ward gate and its positive-core obstruction). *Use and the fixed target* $h_{\mu,\mathrm{F}}$.

1. *Among all nonnegative self-adjoint extensions of the single expression* ℓ_v*, the Ward demand* W *holds if and only if*

$$h = h_{v,\mathrm{E}_0}.$$

No dilation-invariance hypothesis is needed for this assertion.

2. *Every family in* $\mathfrak{Q}_+(\alpha,\beta,\xi)$*, with the parameters in , has Friedrichs strong-resolvent limit after . In particular its distinguished transverse channel converges to* $h_{v,\mathrm{F}}$*, not* h_{v,E_0}*. Therefore no selected limit in this declared local class satisfies* W.

3. *The failure has a fixed exterior witness. There are real* $f,g \in C_c^\infty(0,\infty)$*, a real nonnegative* $\chi \in C_c^\infty((0,\infty))$*, and constants* $d_0,\varepsilon_0 > 0$*, all independent of the admissible profiles, such that the transported distinguished core channel* $\widehat{\sim}_\varepsilon$ *satisfies*

$$\mathfrak{W}_{\chi}(\widetilde{h}_{\varepsilon}; f, g) \geq d_0 \qquad (0 < \varepsilon < \varepsilon_0).$$

At each fixed negative spectral parameter, the exterior resolvent witness has the explicit formula and a profile-uniform $O(\varepsilon^{2\nu})$ error from its nonzero Friedrichs value.

Corollary (The alternative for any declared one-channel class). *Let $\mathscr{C} \subset \mathfrak{L}_{\mathrm{loc}}$ be any specified class whose selected channel limits are nonnegative self-adjoint extensions of this same ℓ_ν, with no coupling to other deficient channels. Let $\mathcal{S}_{\mathscr{C}}$ be its set of selected channel limits. Then*

$$\{h \in \mathcal{S}_{\mathscr{C}} : h \text{satisfiesW}\} \quad \text{is either} \quad \varnothing \quad \text{or} \quad \{h_{\nu, \mathrm{E}_0}\}.$$

For the positive class of Definition , it is empty.

Proof. The first assertion is Theorem (i); the second is part (ii).

Remark (The repaired scope). The assertion that *every* local smooth scalar core fails the demand is not proved. Definition alone does not exclude attractive resonant interactions. Nor does one exceptional scalar identity select every unrelated channel of a larger operator. If a whole-operator uniqueness statement is desired, all spectator channels must be fixed in the chart, or tested by additional identities. The theorem states the completed obstruction in its declared positive local class and leaves broader existence questions open.

Proof of the gate

Endpoint traces and the two resolvents

For $\rho \geq 0$, let $h_{\rho, \mathrm{F}}$ be the operator associated with the closure of

$$\mathfrak{q}_{\rho, \mathrm{F}}[u] = \int_0^\infty \left(|u'|^2 + \frac{\rho^2}{r^2}|u|^2 \right) r \, \mathrm{d}r, \qquad u \in C_c^\infty(0, \infty).$$

Lemma (Endpoint facts and normalized kernels). *Let $0 < \nu < 1$. The maximal domain of ℓ_ν has the traces , with*

$$f'(r) = \nu A(f) r^{\nu - 1} - \nu B(f) r^{-\nu - 1} + o(1).$$

The relations $B = 0$ and $A = 0$ define self-adjoint realizations. The first is Friedrichs, and both are nonnegative.

Put

$$c_{\nu} = \frac{2\sin(\pi\nu)}{\pi} > 0, \qquad K_{\rho}^{\kappa}(r) = K_{\rho}(\kappa r).$$

With kernels taken relative to $r' \, \mathrm{d}r'$,

$$R_{\nu,\mathrm{F}}^{\kappa}(r,r') := (h_{\nu,\mathrm{F}} + \kappa^2)^{-1}(r,r') = I_{\nu}(\kappa r_{<})K_{\nu}(\kappa r_{>}),$$

$$R_{\nu,\mathrm{E}_0}^{\kappa}(r,r') := (h_{\nu,\mathrm{E}_0} + \kappa^2)^{-1}(r,r') = I_{-\nu}(\kappa r_{<})K_{\nu}(\kappa r_{>}),$$

$$R_{\nu,\mathrm{E}_0}^{\kappa} - R_{\nu,\mathrm{F}}^{\kappa} = c_{\nu}|K_{\nu}^{\kappa}\rangle\langle K_{\nu}^{\kappa}|.$$

Here $r_{<} = \min(r,r')$ *and* $r_{>} = \max(r,r')$.

Proof. If $g = \ell_{\nu} f \in \mathscr{H}_{r}$, variation of parameters near zero expresses the remainder after the two homogeneous powers using

$$r^{-\nu}\int_0^r s^{1+\nu} g(s)\,\mathrm{d}s, \qquad r^{\nu}\int_0^r s^{1-\nu} g(s)\,\mathrm{d}s.$$

Cauchy–Schwarz in $L^2(s\,\mathrm{d}s)$ makes both terms $o(r)$; differentiating their combination gives an $o(1)$ derivative remainder. The endpoint boundary pairing is

$$\lim_{r\,\mathrm{downarrow}\,0} r(\overline{f}\,g' - \overline{f}'\,g) = 2\nu(\overline{B(f)}A(g) - \overline{A(f)}B(g)).$$

Both powers are square-integrable at zero. At infinity, the negative-energy equation has exactly one square-integrable solution, $K_{\nu}(\kappa r)$. Thus no boundary condition is available there. The pairing , and the surjectivity of the two traces obtained by cutting off the two powers, show that $A = 0$ and $B = 0$ are self-adjoint conditions. The form excludes the singular power, so its operator has $B = 0$.

The modified Bessel Wronskian is

$$W_r(I_{\nu}(\kappa r), K_{\nu}(\kappa r)) = -r^{-1}.$$

The resulting derivative jump gives . The connection formula

$$I_{-\nu}(x) = I_{\nu}(x) + c_{\nu} K_{\nu}(x)$$

gives and ; these are the standard Bessel identities recorded in [16]. The leading series of $I_{-\nu}$ is $r^{-\nu}$ followed by powers $r^{2j-\nu}$, so its regular trace A is zero.

For completeness, is a bounded operator: is a nonnegative-operator resolvent and $K_{\nu}^{\kappa} \in \mathscr{H}_{r}$, so is a bounded rank-one correction. It solves the inverse equation and the condition $A = 0$. The decaying homogeneous solution $K_{\nu}(\kappa r)$ has nonzero regular coefficient $2^{-\nu-1}\Gamma(-\nu)\kappa^{\nu}$, and therefore is not in that endpoint domain. Hence the inverse is unique. This works for every $\kappa > 0$; the self-adjoint realization has no negative spectrum.

These calculations are also the radial-measure version of the inverse-square realizations studied in [14]: the unitary map to Lebesgue measure is $f \mapsto r^{1/2} f$. No theorem from a Cheung manuscript is needed here.

The exact Ward identity and its unique solution

Lemma (Spectral and resolvent formulations). *For any nonnegative self-adjoint extension h of ℓ_{ν}, demand* W *is equivalent to*

$$\mathfrak{W}_{\kappa}^{\mathrm{res}}(h; f, g) = 0$$

for every $\kappa > 0$ and every compact regular source and test.

Proof. No such extension has a zero eigenvector. Indeed a zero-energy solution is a linear combination of r^{ν} and $r^{-\nu}$, and no nonzero such combination belongs to $L^{2}(r\,\mathrm{d}r)$ at infinity when $0 < \nu < 1$. The same statement applies to $h_{\mu,\mathrm{F}}$.

Choose $0 \le \eta \le 1$, smooth on $[0, \infty)$, equal to one on $[0, 1]$ and zero on $[2, \infty)$. For $m \ge 1$, set

$$\chi_{m}(\lambda) = \frac{\eta(\lambda/m)\eta(1/(m\lambda))}{\lambda + \kappa^{2}}, \qquad \lambda > 0,$$

and extend by zero at $\lambda = 0$. Then $\chi_{m} \in C_{c}^{\infty}((0, \infty))$, and the spectral theorem gives

$$\chi_{m}(h) \to (h + \kappa^{2})^{-1} \quad \text{strongly.}$$

The absence of a zero atom justifies the cutoff near zero. The same holds for the target. Thus the spectral demand implies the resolvent demand.

Conversely, for fixed f, g, the two terms define finite complex spectral measures. If their integrals against $(\lambda + s)^{-1}$, $s > 0$, agree, they agree against every function in $C_0([0,\infty))$. One elementary justification is that the uniform closure of the linear span of these resolvent functions is an algebra: products with distinct poles reduce by partial fractions and repeated poles are uniform limits of difference quotients. This algebra separates points and vanishes nowhere. The C_0 Stone–Weierstrass theorem gives density. In particular the integrals agree for every allowed χ.

Lemma (Unique Ward branch and explicit Friedrichs defect). *For* $0 < \nu < 1$, $\mu = 1 - \nu$, *and every* $f \in C_c^\infty(0,\infty)$,

$$D_\nu R^\kappa_{\nu,\mathrm{E}_0} f = R^\kappa_{\mu,\mathrm{F}} D_\nu f.$$

The Friedrichs defect is

$$(D_\nu R^\kappa_{\nu,\mathrm{F}} - R^\kappa_{\mu,\mathrm{F}} D_\nu) f = c_\nu \kappa K^\kappa_\mu \langle K^\kappa_\nu, f \rangle.$$

Among all nonnegative self-adjoint extensions of ℓ_ν, *uniquely determines* h_{ν,E_0}.

Proof. The recurrences used here are

$$D_\nu I_{-\nu}(\kappa r) = \kappa I_\mu(\kappa r), \qquad D_\nu K_\nu(\kappa r) = -\kappa K_\mu(\kappa r).$$

They follow directly from the modified Bessel derivative identities [16].

Let $u = R^\kappa_{\nu,\mathrm{E}_0} f$. Below the support of f, it is a multiple of $I_{-\nu}(\kappa r)$. Consequently $D_\nu u$ is a multiple of $I_\mu(\kappa r)$ there and satisfies the Friedrichs target condition. Above the support it decays. The formal intertwining gives

$$(\ell_\mu + \kappa^2) D_\nu u = D_\nu f.$$

Uniqueness of the target inverse proves . Subtracting D_ν applied to gives , including its sign and normalization.

Now let another nonnegative self-adjoint extension h satisfy the same resolvent Ward identity. For a compact

regular f,

$$v = ((h + \kappa^2)^{-1} - R^{\kappa}_{v,\mathrm{E}_0})f$$

is a square-integrable homogeneous solution on $(0, \infty)$. Hence $v = c_f K^{\kappa}_{v}$. The two Ward identities imply $D_v v = 0$ against every compact regular test. But

$$D_v v = -\kappa c_f K^{\kappa}_{\mu},$$

so $c_f = 0$. Equality on a dense set gives equality of the bounded resolvents, and one resolvent determines its self-adjoint operator. Lemma completes the spectral statement.

Notice that the Ward demand tests a complete family of source–target pairings, not a curvature trace, a stress trace, or a single scalar number.

Why the positive local forms select Friedrichs

The limiting full spatial form is the Friedrichs closure of

$$q_{\mathrm{F},\beta}[v] = \int \left(|\partial_r v|^2 + \frac{|(\partial_\varphi + \mathrm{i}\beta)v|^2}{\alpha^2 r^2} + |\partial_z v|^2 \right) \mathrm{d}V_0$$

initially on smooth compactly supported functions avoiding the axis.

Lemma (The maximal finite-energy domain is the closure). *The functions in $\mathscr{H}_0$ with weak derivatives on the regular region and finite energy form exactly its Friedrichs form domain. Smooth compact functions avoiding the axis are form dense. The corresponding assertion holds for , including $\rho = 0$.*

Proof. Angular Fourier truncation reduces to finitely many channels. These truncations converge in both norm and energy because the form is a nonnegative orthogonal sum. Ordinary cutoffs first localize the longitudinal coordinate and large radii.

In a channel of positive order ρ, take a cutoff ζ_δ equal to zero for $r \le \delta$, one for $r \ge 2\delta$, and satisfying $|\zeta_\delta'| \le C/r$. The extra radial energy is bounded by

$$C \int_{r<2\delta} |v|^2 r^{-2} r \, \mathrm{d}r \, \mathrm{d}z,$$

which tends to zero because $\rho > 0$ controls this integral.

For a zero-order channel, truncate the amplitude first and localize in z. It suffices to treat bounded functions with compact longitudinal support. Use a logarithmic cutoff which is zero below δ^2, one above δ, and satisfies

$$\int_{\delta^2}^{\delta} r|\zeta_\delta'(r)|^2 \, \mathrm{d}r \le \frac{C}{\log(1/\delta)}.$$

The bounded amplitude makes the extra derivative energy tend to zero. All omitted original energy tends to zero by absolute continuity of the integrals. Subsequent smoothing on regular annuli is standard, since all coefficients there are smooth and uniformly elliptic on compact sets. The same proof without z gives the transverse statement.

Lemma (Local positive-core convergence). *For every family in Definition ,*

$$Q_\varepsilon \mathrm{xrightarrow\,Mosco} q_{\mathrm{F},\beta}.$$

If $B_{\mathrm{F},\beta}$ is the associated limiting operator, then for $s > 0$ and $f \in \mathscr{H}_0$,

$$(U_\varepsilon B_\varepsilon U_\varepsilon^{-1} + s)^{-1} f \to (B_{\mathrm{F},\beta} + s)^{-1} f \quad \text{strongly.}$$

The corresponding transverse radial forms and operators converge in every fixed angular channel.

Proof. We give the two form conditions and their resolvent consequence explicitly; the name Mosco refers to these conditions [15].

Weak lower bound. Suppose $v_\varepsilon \mathrm{rightharpoonup}\, v$ in $\mathscr{H}_0$ and the transported energies are bounded along a subsequence realizing their lower limit. Set $u_\varepsilon = P_\varepsilon^{-1/2} v_\varepsilon$. The multipliers $P_\varepsilon^{\pm 1/2}$ are uniformly bounded and converge strongly to one, because they differ from one only on $r < \varepsilon$. Hence $u_\varepsilon \mathrm{rightharpoonup}\, v$.

On any fixed compact regular annular cylinder, the coefficients are exactly the exterior coefficients once ε is small enough. The energy bound controls the weak derivatives there; the angular covariant derivative also controls the ordinary angular derivative on that annulus. Integration against compact regular tests identifies the weak derivative

limits with those of v. Every discarded core term is nonnegative. Therefore weak lower semicontinuity and exhaustion of the regular region give

$$\liminf_{\varepsilon \text{downarrow } 0} Q_{\varepsilon}[v_{\varepsilon}] \geq q_{\mathrm{F},\beta}[v].$$

Lemma identifies the finite-energy domain.

Strong recovery. Let $v \in \operatorname{Dom} q_{\mathrm{F},\beta}$. Choose $\varphi_j \in C_c^{\infty}(N)$, with N the spatial regular region, converging to v in form norm. For fixed j, every sufficiently small core misses $\operatorname{supp} \varphi_j$, and

$$U_{\varepsilon}\varphi_j = \varphi_j, \qquad Q_{\varepsilon}[\varphi_j] = q_{\mathrm{F},\beta}[\varphi_j].$$

A diagonal choice gives a strong recovery sequence. For v outside the form domain, the recovery upper bound with value $+\infty$ imposes no restriction.

Resolvents. Let v_{ε} minimize

$$J_{\varepsilon}[w] = Q_{\varepsilon}[w] + s\|w\|^2 - 2\mathrm{Re}\,\langle f, w\rangle.$$

Its minimizer is the transported resolvent applied to f. Coercivity gives bounded minimizers. The lower bound and a recovery sequence show that every weak cluster point is the unique minimizer v of the limiting functional and that the minimum values converge.

If w_{ε} is a recovery sequence for v, the minimizing equation gives

$$J_{\varepsilon}[w_{\varepsilon}] - J_{\varepsilon}[v_{\varepsilon}] = Q_{\varepsilon}[w_{\varepsilon} - v_{\varepsilon}] + s\|w_{\varepsilon} - v_{\varepsilon}\|^2.$$

The left side tends to zero. Thus $v_{\varepsilon} \to v$ strongly, proving .

The radial proof is identical, with the longitudinal variable omitted and fixed angular number inserted. Conversely, the product resolvents can also be obtained by longitudinal Fourier transformation and dominated convergence, using the bound $(s + k^2)^{-1} \leq s^{-1}$.

Remark (Attribution and topology). The preceding proof independently reproduces the relevant scalar

mechanism documented in I-B-VP-5 and I-B-VP-5-Ex2 [4, 5]; Friedrichs convergence is not claimed as new. The proof uses exact exterior recovery and nonnegativity of discarded terms. It does not assert disappearance of the energy inside the shrinking core for every bounded-energy sequence.

Strong-resolvent convergence is not norm-resolvent convergence, covariance convergence for an unbounded function at zero, or convergence of renormalized one-point observables.

Lemma (Spectral convergence for fixed vectors, uniformly over profiles). *For a fixed angular channel, fixed* $f \in \mathscr{H}_r$, *and* $\psi \in C_0([0,\infty))$,

$$\psi(\widehat{h}_\varepsilon)f \to \psi(h_{v_n,\mathrm{F}})f.$$

For fixed f, ψ, *this convergence is uniform over all admissible choices of the profiles at radius* ε. *This is not an operator-norm assertion.*

Proof. Strong convergence of one positive resolvent gives convergence of its polynomials on each fixed vector, since the resolvents are uniformly bounded. Polynomials with zero constant term in $(1+\lambda)^{-1}$ are uniformly dense in $C_0([0,\infty))$; the spectral theorem then proves the first statement.

For the second, a failure of uniformity would supply a sequence $\varepsilon_j \operatorname{downarrow} 0$ and an admissible profile at each ε_j violating convergence by a fixed amount. The proof of Lemma applies to precisely that sequence, with no uniform derivative hypothesis. The first statement gives a contradiction.

Positive impedance and an exterior quantitative witness

In the distinguished channel, the transverse core expression is

$$h_\varepsilon = -\frac{1}{P_\varepsilon r}\partial_r\left(\frac{r}{P_\varepsilon}\partial_r\right) + \frac{a_\varepsilon^2}{\alpha^2 r^2} + \xi R_\varepsilon.$$

Lemma (Uniform exterior coefficient). *Let* $\kappa > 0$, *and normalize the regular solution of* $(h_\varepsilon + \kappa^2)v = 0$ *by* $v(\varepsilon) = 1$. *Then*

$$v > 0, \qquad v' \geq 0, \qquad \Lambda_\varepsilon(\kappa) := \varepsilon v'(\varepsilon) \geq 0.$$

For exterior arguments, the transported resolvent satisfies

$$\widehat{R}^{\kappa}_{\varepsilon}(r, r') = R^{\kappa}_{\nu,\mathrm{F}}(r, r') + c_\varepsilon(\kappa) K^{\kappa}_{\nu}(r) K^{\kappa}_{\nu}(r'), \qquad r, r' > \varepsilon,$$

where, with $t = \kappa\varepsilon$,

$$c_\varepsilon(\kappa) = \frac{t I'_\nu(t) - \Lambda_\varepsilon(\kappa) I_\nu(t)}{\Lambda_\varepsilon(\kappa) K_\nu(t) - t K'_\nu(t)}.$$

For κ *in any fixed compact subset of* $(0, \infty)$,

$$|c_\varepsilon(\kappa)| \leq \max\left\{ \frac{I_\nu(t)}{K_\nu(t)}, \frac{I'_\nu(t)}{-K'_\nu(t)} \right\} \leq C\varepsilon^{2\nu},$$

with a constant independent of the profiles.

Proof. The regular central solution has a positive constant leading term. Its equation is

$$\left(\frac{r}{P_\varepsilon} v' \right)' = \left(\frac{P_\varepsilon a_\varepsilon^2}{\alpha^2 r} + \xi P_\varepsilon r R_\varepsilon + \kappa^2 P_\varepsilon r \right) v.$$

While $v > 0$, the right side is nonnegative, and the regular initial behavior gives $rv'/P_\varepsilon \geq 0$. A first zero is impossible. Normalization therefore gives all the stated sign properties.

The exterior regular solution is proportional to $I_\nu(\kappa r) + c_\varepsilon K_\nu(\kappa r)$. Matching its logarithmic derivative at $r = \varepsilon$, where $P_\varepsilon = 1$, yields . The Wronskian with the decaying exterior solution is unchanged by adding a multiple of K_ν, which proves .

For $t > 0$, $I_\nu, I'_\nu, K_\nu, -K'_\nu$ are positive. The denominator in is positive. The quotient is a convex combination of

$$\frac{I'_\nu(t)}{-K'_\nu(t)} \quad \text{and} \quad -\frac{I_\nu(t)}{K_\nu(t)}.$$

This gives the first inequality in . The small-argument expansions of I_ν and K_ν give the second [16]. No bound on Λ_ε from above is needed.

Choose nonzero real nonnegative $f, g \in C_c^\infty((a,b))$, where $0 < a < b < \infty$. For $\varepsilon < a$, integration by parts against the exterior test and give

$$\text{boxed}\, \mathfrak{W}_\kappa^{\mathrm{res}}(\widetilde{h}_\varepsilon; f, g) = \kappa(c_\nu - c_\varepsilon(\kappa))\langle g, K_\mu^\kappa\rangle\langle K_\nu^\kappa, f\rangle.$$

Both pairings are strictly positive. For fixed $\kappa > 0$,

$$\mathfrak{W}_\kappa^{\mathrm{res}}(\widetilde{h}_\varepsilon; f, g) \geq \frac{\kappa c_\nu}{2}\langle g, K_\mu^\kappa\rangle\langle K_\nu^\kappa, f\rangle > 0$$

for every sufficiently small core, uniformly over profiles. This proves the quantitative resolvent assertion.

A fixed genuine spectral packet and completion of the proof

Fix the preceding f, g, κ. By ,

$$L := \mathfrak{W}_\kappa^{\mathrm{res}}(h_{\nu,\mathrm{F}}; f, g) > 0.$$

Use the nonnegative cutoffs χ_m in . The proof of Lemma gives

$$\mathfrak{W}_{\chi_m}(h_{\nu,\mathrm{F}}; f, g) \to L.$$

Choose one finite m for which this value exceeds $L/2$, and fix $\chi = \chi_m$. Lemma , applied to the first term in , gives

$$\mathfrak{W}_\chi(\widetilde{h}_\varepsilon; f, g) \to \mathfrak{W}_\chi(h_{\nu,\mathrm{F}}; f, g)$$

uniformly over profiles. The second term has no ε-dependence. Hence, for every sufficiently small admissible core,

$$\mathfrak{W}_\chi(\widetilde{h}_\varepsilon; f, g) \geq L/4.$$

This proves Theorem (iii).

Part (i) is Lemmas and . Part (ii) is Lemma , together with the distinct endpoint relations in . The proof of Theorem is complete.

The same witness can be multiplied by a smooth longitudinal spectral envelope. For a full product resolvent the

radial parameter is $\kappa = (s + k^2)^{1/2}$; a compact longitudinal frequency window keeps it in a compact positive interval. Thus the channel calculation is compatible with smooth product packets. No global spacetime Green theorem is used.

What would have to change, and what does not select

A necessary negative-impedance tuning

The obstruction has an explicit escape condition, but that condition is not an existence theorem.

Proposition (Necessary resonance for a broader local model). *Consider a rotational local scalar model with the same exterior expression, but allow a signed local core interaction. Suppose its nonnegative transported channel operators converge strongly in resolvent sense to* h_{ν, E_0}. *Where the regular core solution at energy* $-\kappa^2$ *is normalized at the matching radius, its impedance must satisfy, for each fixed* $\kappa > 0$,

$$\Lambda_\varepsilon(\kappa) = -\nu + o(\varepsilon^{2\nu}).$$

In particular it is negative for all sufficiently small ε.

Proof. The exterior Green kernel still has the form , without the sign conclusion of Lemma . A nonzero exterior matrix element, compared with , shows that strong-resolvent convergence to h_{ν, E_0} forces $c_\varepsilon(\kappa) \to c_\nu$.

For small ε, this coefficient is nonzero and

$$\Lambda_\varepsilon = \frac{tI_\nu'(t) + c_\varepsilon tK_\nu'(t)}{I_\nu(t) + c_\varepsilon K_\nu(t)}, \qquad t = \kappa\varepsilon.$$

The denominator is nonzero for sufficiently small t, so the normalization is then available. Write

$$\begin{aligned} I_\nu(t) &= i_\nu t^\nu + O(t^{\nu+2}), & i_\nu &= \frac{2^{-\nu}}{\Gamma(1+\nu)}, \\ K_\nu(t) &= k_- t^{-\nu} + k_+ t^\nu + O(t^{2-\nu}), & k_- &= 2^{\nu-1}\Gamma(\nu), \\ & & k_+ &= 2^{-\nu-1}\Gamma(-\nu). \end{aligned}$$

The identity $I_{-\nu} = I_\nu + c_\nu K_\nu$ implies $i_\nu + c_\nu k_+ = 0$. Consequently

$$\Lambda_\varepsilon + v = \frac{2v(i_v + c_\varepsilon k_+)t^v + O(t^{2-v})}{c_\varepsilon k_- t^{-v}(1 + o(1))} = o(t^{2v}) + O(t^2).$$

Since $0 < v < 1$, $t^2 = o(t^{2v})$. This proves .

This proposition identifies a condition that the positive class cannot meet. It does not prove that a signed local core attaining it exists, that one zero-energy matching condition suffices for operator convergence, or that such a model supplies a physical source.

The curvature measure is not the missing coupling

Proposition (The same concentrated curvature is compatible with Friedrichs). *For the metrics in Definition ,*

$$R_\varepsilon \, \mathrm{d}V_{g_\varepsilon} \rightharpoonup 4\pi(1-\alpha)\delta_{\mathscr{W}},$$

where

$$\langle \delta_{\mathscr{W}}, F \rangle = \int_{\mathbb{R}^2} F(t, o, z)\, \mathrm{d}t\, \mathrm{d}z.$$

This nonzero measure does not force a non-Friedrichs operator limit.

Proof. The transverse curvature density is

$$R_\varepsilon P_\varepsilon \alpha r \, \mathrm{d}r \, \mathrm{d}\varphi = \frac{2\alpha P_\varepsilon'}{P_\varepsilon^2} \mathrm{d}r \, \mathrm{d}\varphi.$$

It is nonnegative, supported in $r \le \varepsilon$, and has mass

$$4\pi\alpha \int_0^\infty \frac{P_\varepsilon'}{P_\varepsilon^2} \mathrm{d}r = 4\pi\alpha(\alpha^{-1} - 1) = 4\pi(1-\alpha).$$

Uniform continuity of a compact smooth test at the axis proves , including the product variables.

The operator limit is nonetheless exactly the Friedrichs form of Lemma . Its recovery sequences avoid the core. In the neutral zero-order channel this avoidance has vanishing logarithmic cutoff cost, as shown in Lemma . Weak convergence of curvature measures does not permit multiplication by arbitrary varying form-domain sequences and passage to the limit.

Thus curvature concentration is not an operator-limit rule. This reproduces, rather than withdraws, the separation documented in I-B-VP-5 [4]. The measure in is also not the packet curvature regularity criterion of I-B-G-S.

Dilation, profile regularity, and threshold boundaries

The selected ideal endpoint $A = 0$ is a coordinate singular branch and is dilation invariant. It does not require a continuous projective family of unequal-order boundary relations.

To make the distinction explicit, in a two-channel chart write x for singular traces and y for order-weighted regular traces. At orders $u \neq v$, radial dilation has four distinct weights

$$-u, \quad -v, \quad u, \quad v$$

after removal of the common scalar factor. An invariant subspace is a sum of these weight spaces. A self-adjoint two-dimensional boundary subspace must choose exactly one element from each symplectically paired singular/regular coordinate pair. Hence there are four coordinate choices. The equal-order degeneracy, which permits projectors and a rank-one $\mathbb{CP}^1$ parametrization, is absent. This is consistent with the documentary exceptional list of I-B-VP-9-Ex1 [8]; that list is not needed in the proof of the scalar gate.

Our profile-uniform estimates concern selected operators and fixed exterior Ward tests. They do not make finite stress moments or renormalized interior constants profile independent. One may restrict to a declared uniformly regular unit-core class, for example by imposing fixed C^k bounds and a common central interval before scaling. Such a restriction preserves the present theorem but does not supply equal-minimal-radius universality. The distinct finite-part obstruction documented in I-B-VP-5-Ex1 and Ex1-B remains a separate question [9, 10].

The strict range $1/2 < \alpha < 1$ is essential for the nontrivial endpoint distinction used here. At $\alpha = 1/2$, the exceptional order is zero and the quoted curvature-regular prescription is no logarithm. We do not substitute a singular positive-order formula at that threshold. No new obstruction at $\alpha \leq 1/2$ is asserted.

Enter, the prescribed spacetime, and the shredder philosophy

Cheung's introductory philosophy separates destructive readout, quantum recovery, physical implementation, and geometric identification [1]. At the declared Enter interface, a measured quantum name is consumed and a classical record is returned. This is not a statement that all implementing degrees of freedom are physically annihilated. A channel identity alone is not a heat or work ledger, and a useful analogy is not a gravitational identification. These distinctions explain why a reported boundary-condition label is not a continuum selection theorem.

The spacetime interface of I-B installs finite names, locations, accessible algebras, calibrated clocks, and controls on a geometry that is already supplied [2]. For an orthonormal clock basis $\{|\tau_j\rangle\}$, the destructive instrument has the explicit form

$$\mathcal{M}(Z) = \sum_j |j\rangle\langle j|_R \otimes (\langle\tau_j| \otimes I) Z (|\tau_j\rangle \otimes I).$$

Its Kraus completeness relation is

$$\sum_j (|\tau_j\rangle\langle\tau_j| \otimes I) = I.$$

Thus it is completely positive and trace preserving, including after tensoring with an untouched reference. It consumes the clock factor, not the geometric time coordinate. Nothing in chooses P_ε, a_ε, or an apex domain.

The shredder interface in I-C distinguishes a complete classical-only accessible output from coherent quantum return [3]. The meaning of its $1/d$ bound must be specified: it concerns reference-preserving entanglement fidelity, not success in printing a supplied classical branch label.

Indeed, if a d-dimensional unknown code has only a complete classical output, every decoder produces a measure-and-prepare channel

$$\mathcal{N}(\rho) = \sum_j \mathrm{Tr}\,(M_j \rho)\sigma_j.$$

Its normalized Choi state is separable [17]. For the maximally entangled vector $|\Phi_d\rangle = d^{-1/2}\sum_{\ell=1}^{d} |\ell,\ell\rangle$, every

normalized product vector satisfies

$$|\langle \Phi_d, a \otimes b \rangle|^2 \le \frac{1}{d}$$

by Cauchy–Schwarz. Convexity therefore gives

$$F_e(\mathcal{N}) = \langle \Phi_d | (\mathrm{id} \otimes \mathcal{N})(|\Phi_d\rangle\langle\Phi_d|) | \Phi_d \rangle \le \frac{1}{d}.$$

A supplied orthogonal classical identifier can nevertheless be reported perfectly. Neither fact acquires an unknown continuum operator. The conclusion also presupposes that no message-bearing quantum memory, bath, or entangled resource has been omitted from the declared accessible output.

This philosophical background supplies no premise for the analytic gate. It prevents an analytic boundary condition, a finite certificate, and an implemented physical source from being identified without the required maps.

Documentary comparisons, contribution, and exact release

What is and is not new

The local Friedrichs convergence mechanism is already documented in the supplied scalar core sheets. The exceptional Ward defect and the idealized branch are already documented in I-B-G-S. Positive tensor-core exclusion is already documented in I-B-G-S-B [7]. This paper makes no priority claim for those results.

Its focused contribution is the independently proved scalar compatibility gate:

1. uniqueness from the complete exceptional source-test Ward demand, without assuming dilation invariance;

2. a profile-uniform, explicitly normalized exterior resolvent witness and a fixed genuine spectral-packet witness;

3. a necessary negative-impedance tuning for a broader local model that could evade the positive-core obstruction.

These statements explain exactly why neither a bare curvature measure nor an engineered nonlocal cap can supply the proposed physical choice.

Non-transfer ledger

All Cheung manuscript comparisons below are documentary. No predecessor theorem is an undeclared premise of Theorem .

toprule Documentary record Use and non-transfer boundary

midrule endfirsthead toprule Documentary record Use and non-transfer boundary

midrule endhead

I-B-VP-9-Ex1 [8] The finite-mode cap is excluded by locality. Its apex-arrival and supported-transfer comparisons are not core selection or state identification. Its contact ledger is not imported as a source.

I-B-VP-5 and Ex2 [4, 5] Their declared scalar positive-core Friedrichs conclusions are not withdrawn. The present flux example remains inside that positive mechanism; it does not claim to escape it. Dirac signs and threshold-square conventions are not used.

I-B-G-S [6] The existing curvature-regular name and exceptional radial identity are retained. Their scalar restriction is proved here directly. The complete spin-1/spin-2 uniqueness statement, ghost tower, and curvature regularity theorem are not imported.

I-B-G-S-B [7] Positive tensor-core selection is a separate result. No tensor or spin-2 core theorem is inferred from the scalar flux model of this paper.

I-B-VP-9 [11] Boundary selection is not finite Bernoulli stress closure. No rational dependence of stress on a selected matrix is asserted.

I-B-G [12] No globally hyperbolic Green theorem is transferred. The proof uses spatial self-adjoint resolvents and their declared domains, not a slab Green matrix.

I-B-VP-8 and its extension [13] Temperature and the Friedrichs thermal prescription remain inputs to those state constructions. No apex state or curvature-regular state is selected here.

I-B and I-C [2, 3] The host is prescribed. Finite readout reports supplied data. Append-only classical records, quantum return, thermodynamic implementation, and continuum acquisition remain distinct.

bottomrule

The regular host in is not globally hyperbolic: for a fixed angular and longitudinal coordinate, take endpoints $(t, r) = (-a, a)$ and (a, a). Their causal diamond contains $(0, r_j)$ with $r_j \text{downarrow } 0$, which has no convergent subsequence in the regular host. This elementary observation is enough to block an unqualified import of a globally hyperbolic slab theorem.

No pure-trace or Ward-trace evaluation is promoted to recovery of an unrestricted kernel. No heat kernel is interpreted as reservoir heat, and no KMS condition is interpreted as the zeroth law. The OpenAI catalogue, including the documentary family comparisons mentioned in the development plan, is not a premise and is not verified here.

Exact release

Inside the declared positive local metric–curvature–flux class, and under the named exceptional source-test Ward demand, no selected local core limit meets the demand. More generally, within the declared one-channel chart, a demanded selected limit can only be the existing curvature-regular exceptional endpoint E_0, or no such limit exists. The angularly nonlocal cap of I-B-VP-9-Ex1 is excluded and is not a premise. Friedrichs selection on the VP-5 and Ex2 classes is not withdrawn. I-B-G-S is documentary and is not a theorem premise. No Einstein source law, tensor-core selection, physical evaporation model, or spacetime emergence is derived. O.1 stays NOT_CLOSED.

The unrestricted local class with signed resonant interactions remains outside the proved obstruction. XVI-N is not discharged; XV-B's downstream admission exit is not opened; H2, I3, and J2 are not closed by this sheet.

Provenance and execution statement

The mathematical hypotheses used in the proof are printed locally. The Cheung references distinguish directly

consulted documentary pages from version-qualified excerpts supplied with the development material. An excerpt or a searchable companion is not an independent audit of an entire manuscript. No unpublished date, publication status, or theorem beyond the identified record is inferred.

This is a single-file pdfLaTeX source with an internal bibliography. No successful compilation, numerical execution, proof-assistant verification, laboratory implementation, or independent referee approval is asserted.

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