M9 – Radiative Exchange Dynamics on Scalar–Conformal NUVO Space

Preprint, Version 1.0[*]

Rickey W. Austin
St Claire Scientific Research, Development, and Publishing

Notation and Conventions

- $\mathcal{M}$ denotes the spacetime manifold.
- η denotes the reference Lorentzian metric (typically Minkowski in a global chart).
- g denotes the physical metric.
- The scalar field $\Lambda : \mathcal{M} \to \mathbb{R}_{>0}$ is the NUVO modulation field.
- The physical metric is scalar–conformal:

$$g_{\mu\nu} = \Lambda^2 \, \eta_{\mu\nu}.$$

- $\Lambda_0 > 0$ denotes the baseline scalar availability level supported by the intrinsic delivery structure of the underlying field. In the absence of localized structural occupation the scalar field satisfies $\Lambda(x) = \Lambda_0$.
- The dimensionless scalar diagnostic is

$$\mathcal{A}(x) := \frac{\Lambda(x)}{\Lambda_0}.$$

- The scalar field represents the *locally available structural capacity* of the underlying delivery field. Localized structures may reduce this availability through occupation or transport, but the intrinsic delivery baseline Λ_0 remains fixed.
- Greek indices $\mu, \nu, \ldots$ range over spacetime coordinates $0, 1, 2, 3$.
- We use the Einstein summation convention unless explicitly stated otherwise.

[*]Bibliography is provisional. Cross-references to companion NUVO-series papers (M-, SR-, Q-, QB-, QM-series) will be updated with Zenodo DOIs in subsequent versions.

Notation convention. We reserve distinct symbols for fundamental fields and derived quantities. The scalar field Λ represents structural availability, while $\mathcal{A}$ denotes a derived normalized response field. These should not be conflated.

Remark 0.1. *Unless otherwise stated, the background signature is* $(-,+,+,+)$.

Abstract

We develop the radiative dynamics of the exchange sector on scalar–conformal NUVO space. Building on the weak-limit exchange field structure established previously, we examine the behavior of accelerating bundled structures in the exchange-sector continuum description and the resulting transport of energy and momentum through the exchange field.

We show that time-dependent exchange currents generate propagating exchange waves carrying stress–energy across the scalar–conformal manifold. The associated energy flux yields the familiar radiation power scaling for localized sources. Incorporating finite-core structure for bundled sources provides a natural regularization of self-interaction effects and leads to a weak-limit radiation-reaction description consistent with the Landau–Lifshitz equation.

Throughout, the exchange sector remains kinematically coupled to the scalar–conformal background but does not source the scalar diagnostic field. These results complete the classical radiative weak-limit dynamics of the exchange sector within the M-series framework.

1 Introduction

The preceding paper in the M-series [1] established the weak-limit field structure associated with open-loop exchange transport on scalar–conformal NUVO space. Beginning from the exchange current introduced earlier in the series, it was shown that the operational structure of exchange observables leads naturally to a gauge description in terms of a potential field. The resulting antisymmetric field-strength tensor provides the minimal continuum representation of oriented exchange flux through spacetime surfaces. Imposing locality, Lorentz covariance, gauge invariance, and minimal derivative order yields the Maxwell system as the weak-limit field equations governing exchange transport.

The present paper develops the dynamical consequences of that exchange field structure when exchange sources undergo acceleration. While the previous analysis focused primarily on static and slowly varying configurations, accelerating exchange currents produce propagating disturbances in the exchange field that transport energy and momentum through spacetime. These disturbances constitute the radiative regime of exchange transport.

Radiative exchange fields arise naturally from the hyperbolic structure of the field equations derived in the weak limit. Disturbances of the exchange field propagate along null characteristics of the scalar–conformal geometry, carrying stress–energy away from the accelerating source. The resulting far-field configuration exhibits the familiar inverse-distance scaling associated with radiation fields, distinct from the inverse-square scaling of static exchange sources.

The transport of energy and momentum by the exchange field is described through the associated stress–energy tensor. Conservation of this tensor leads to a flux law governing the transfer of energy from accelerated sources to the radiative field. For localized bundled structures this energy transport produces the characteristic radiation power scaling familiar from classical electrodynamics.

The emission of radiation also implies a back-reaction on the emitting structure. A consistent description of this reaction requires careful treatment of the near-field structure surrounding the source. Within the present framework bundled structures are not treated as strictly point-like objects but instead possess finite structural extent. This finite-core structure regularizes the near-field behavior of the exchange field and provides a natural basis for deriving an effective radiation-reaction force acting on the emitting bundle.

The resulting effective dynamics coincide, in the weak-field limit, with the Landau–Lifshitz form of the radiation-reaction equation. Thus the familiar radiative corrections to classical motion emerge naturally from the structural description of accelerating exchange sources within the M-series framework.

Taken together, the results of the present paper complete the classical radiative dynamics of the exchange sector on scalar–conformal NUVO space. Static interaction fields, wave propagation, energy transport, and radiation reaction are all obtained within a unified framework derived from the structural principles established in the earlier papers of the M-series.

Definition of proper acceleration in NUVO. In the present work we employ the standard kinematic notion of proper acceleration a^μ for localized bundled structures in the weak-limit exchange-sector description. Within the full NUVO framework this quantity is not taken as primitive. As established in M6.5, M7, and M7.5 [2–4], the support-sector state of a persistent bundled structure is determined by its boundary flux distribution, inertial persistence corresponds to a stationary boundary state, and proper acceleration arises when this boundary configuration evolves in time.

Support–exchange hierarchy. Within the NUVO framework, it is essential to distinguish the origin of acceleration from its exchange-sector manifestation. As established in M6.5, M7, and M7.5 [2–4], the fundamental support-sector dynamical variable of a persistent bundled structure is its boundary flux distribution. Proper acceleration does not arise as a primitive kinematic quantity, but as the macroscopic descriptor of the evolution of this boundary state.

Accordingly, the quantity a^μ employed in the present exchange-sector analysis is an effective descriptor of underlying support-sector dynamics. The causal chain is therefore

$$\text{boundary flux evolution} \;\longrightarrow\; \text{effective acceleration } a^\mu \;\longrightarrow\; \text{exchange-current variation.}$$

Radiative exchange fields arise only at the final stage of this hierarchy, as a consequence of time-dependent exchange currents induced by support-sector evolution. No independent notion of exchange-sector acceleration is introduced.

The exchange-sector analysis developed here operates in a weak-limit continuum description in which a^μ is treated as the effective macroscopic descriptor of this underlying support-sector evolution. Accordingly, accelerating bundled structures in the present paper are to be understood as bundles whose support-sector boundary state is time-dependent, with a^μ providing the corresponding effective kinematic description.

2 Radiative Exchange Fields

Origin of radiative sources. Radiative exchange fields are generated by time-dependent exchange currents associated with bundled structures. Within the NUVO framework, such time dependence is not fundamental at the exchange level. Rather, it reflects the evolution of the support-sector boundary state of the underlying bundled structure.

In particular, an "accelerating" exchange current corresponds to a bundled structure whose boundary flux distribution is evolving in proper time. The resulting variation in the effective exchange current provides the source term responsible for the generation of propagating exchange disturbances. Thus radiation is not taken as a primitive phenomenon, but as the exchange-sector response to support-sector boundary evolution.

The weak-limit exchange field derived in the preceding paper [1] satisfies the Maxwell system on the scalar–conformal background,

$$\nabla_\mu F^{\mu\nu} = J^\nu_{\rm ex}, \tag{1}$$

$$\nabla_{[\alpha} F_{\beta\gamma]} = 0. \tag{2}$$

In regions sufficiently far from localized exchange sources the current vanishes,

$$J^\nu_{\rm ex} = 0,$$

and the exchange field therefore satisfies the vacuum Maxwell system

$$\nabla_\mu F^{\mu\nu} = 0, \tag{3}$$

$$\nabla_{[\alpha} F_{\beta\gamma]} = 0. \tag{4}$$

Introducing a potential representation

$$F_{\mu\nu} = \nabla_\mu A_\nu - \nabla_\nu A_\mu,$$

the homogeneous identity (4) is automatically satisfied. Gauge freedom allows the Lorenz condition

$$\nabla_\mu A^\mu = 0$$

to be imposed without loss of generality.

Under this condition the inhomogeneous Maxwell equation reduces to the covariant wave equation

$$\Box A^\nu = 0, \tag{5}$$

where

$$\Box = \nabla_\mu \nabla^\mu$$

is the d'Alembert operator associated with the scalar–conformal metric

$$g_{\mu\nu} = \Lambda^2 \eta_{\mu\nu}.$$

Equation (5) shows that disturbances of the exchange potential propagate as waves on the scalar–conformal geometry. The characteristic surfaces of the wave equation are determined by the null structure of the metric $g_{\mu\nu}$, and therefore satisfy

$$g_{\mu\nu} k^\mu k^\nu = 0,$$

where k^μ is the wavevector.

Because the scalar–conformal metric differs from the background metric only by an overall conformal factor, the null structure of spacetime is preserved. Exchange disturbances therefore propagate along null curves with invariant speed c.

These propagating disturbances constitute the radiative regime of the exchange field. In contrast to the near-field configuration of static exchange sources, which exhibits inverse-square scaling, the far-field radiative solution displays inverse-distance scaling characteristic of energy-carrying waves.

The presence of such radiative solutions is a direct consequence of the hyperbolic structure of the exchange field equations and does not require additional dynamical assumptions. Accelerating exchange currents therefore produce propagating exchange waves that transport energy and momentum through the scalar–conformal manifold.
The normalized scalar response

$$\mathcal{A}(x) = \frac{\Lambda(x)}{\Lambda_0}$$

provides a dimensionless diagnostic of the conformal geometry but does not independently determine the metric structure.

3 Energy Transport in the Exchange Field

The radiative exchange field transports energy and momentum through the scalar–conformal manifold. The local transport of these quantities is described by the stress–energy tensor associated with the exchange field.

For the antisymmetric field-strength tensor $F_{\mu\nu}$ derived in the preceding paper, the stress–energy tensor takes the form

$$T^{\mu\nu}_{\text{ex}} = F^{\mu\alpha} F^{\nu}{}_{\alpha} - \frac{1}{4} g^{\mu\nu} F_{\alpha\beta} F^{\alpha\beta}. \tag{6}$$

This tensor is symmetric and gauge invariant, and it represents the local density and flux of energy and momentum carried by the exchange field.

Interpretation of radiated energy. The stress–energy tensor $T^{\mu\nu}_{\text{ex}}$ describes the weak-limit bookkeeping of energy and momentum transport within the exchange sector. Within the NUVO framework, this is not to be interpreted as an independent support-delivery substance, but as the continuum encoding of exchange-sector radiative transport associated with bundled exchange interfaces.

In particular, the emission of radiative energy corresponds to a redistribution of exchange-sector interaction compatible with the underlying support-sector boundary state of the bundle. The invariant total intake

$$\dot{C}_S = mc^2$$

remains fixed, and no modification of support-sector consumption is required. Radiation therefore represents a reconfiguration of exchange-sector transport compatible with the boundary conditions imposed by the support sector.

Taking the covariant divergence of (6) and using the Maxwell equations yields

$$\nabla_\mu T^{\mu\nu}_{\text{ex}} = -F^{\nu\lambda} J^{\text{ex}}_{\lambda}. \tag{7}$$

Equation (7) expresses the local exchange of energy–momentum between the exchange field and the exchange current. In regions free of exchange sources the right-hand side vanishes, and the stress–energy tensor is conserved:

$$\nabla_\mu T^{\mu\nu}_{\text{ex}} = 0.$$

Thus radiative exchange waves transport energy and momentum through spacetime without local sources or sinks.

In a local inertial frame the temporal component of the stress–energy tensor represents the energy density of the exchange field, while the mixed components represent the energy flux. Introducing the electric and magnetic components of the exchange field in the usual manner [5], the energy density takes the form

$$u_{\rm ex} = \frac{1}{2}\left(E^2 + B^2\right), \tag{8}$$

and the energy flux vector is given by the Poynting expression

$$\mathbf{S} = \mathbf{E} \times \mathbf{B}. \tag{9}$$

The vector $\mathbf{S}$ represents the rate at which energy is carried by the exchange field through a unit area. In the radiative regime the electric and magnetic components of the field are mutually orthogonal and transverse to the direction of propagation, and the magnitude of the Poynting vector determines the outward flow of energy transported by exchange waves.

For localized accelerating exchange sources the outward flux of the Poynting vector through large spheres surrounding the source measures the total radiative power emitted by the system. Determining this radiation power is the subject of the next section.

4 Radiation from Accelerated Bundled Sources

We now consider the radiative field produced by an accelerating bundled source acting as a localized carrier of exchange current. Let the source worldline be denoted by $\gamma(\tau)$ with four-velocity u^μ and four-acceleration a^μ.

Here a^μ denotes the proper acceleration as defined in the Introduction. It is not taken as generated by the exchange field; rather, it represents the effective macroscopic description of underlying support-sector boundary evolution as formulated in M7.5.

For localized sources the exchange current is concentrated in a small spatial region surrounding the bundle core. Far from this region the field is well described by the vacuum Maxwell equations

$$\nabla_\mu F^{\mu\nu} = 0,$$

with the radiative solution determined by the retarded field generated by the source trajectory.

In the radiation zone, where the observation distance r from the source greatly exceeds the characteristic scale of the source region, the exchange field separates into two components:

1. a near-field component scaling as $1/r^2$, associated with the static interaction field, and
2. a radiative component scaling as $1/r$, associated with the accelerated motion of the source.

The radiative component dominates the far-field region. In this regime the electric and magnetic exchange fields are transverse to the direction of propagation and satisfy

$$|\mathbf{E}| = |\mathbf{B}|,$$

with both fields proportional to the transverse acceleration of the source.

More precisely, the magnitude of the radiative field at distance r scales as [5]

$$E_{\rm rad} \sim \frac{q\, a_\perp}{c^2 r}, \tag{10}$$

where q represents the effective exchange coupling strength of the bundled structure and $a_\perp$ is the component of the acceleration perpendicular to the line of sight.

The energy flux carried by the radiation field is determined by the Poynting vector

$$\mathbf{S} = \mathbf{E} \times \mathbf{B}.$$

Substituting the far-field radiation scaling into the Poynting flux and integrating over a large sphere surrounding the source yields the total radiative power emitted by the accelerating bundle.

The resulting power takes the familiar Larmor form [5, 6]

$$P = \frac{2}{3}\frac{q^2 a^2}{c^3}, \tag{11}$$

where a denotes the magnitude of the source acceleration.

Equation (11) shows that bundled structures undergoing support-sector-driven acceleration emit radiative exchange waves at a rate proportional to the square of the acceleration. Within the M-series framework this result arises directly from the radiative solutions of the exchange field equations and the associated energy transport described by the stress–energy tensor.

Radiation reaction as induced response. The radiation-reaction term obtained in the weak-limit description should not be interpreted as a fundamental force acting on the bundled structure. Within the NUVO framework, it represents the effective macroscopic description of how exchange-field transport responds to the underlying evolution of the support-sector boundary state.

Specifically, as the boundary flux distribution evolves, the induced exchange current generates radiative fields whose stress–energy transport feeds back on the effective motion of the bundle. The resulting correction to the trajectory is therefore an emergent exchange-sector response, consistent with the deeper support-sector description in which acceleration is identified with boundary flux evolution.

Thus bundled structures undergoing acceleration necessarily emit radiative exchange waves that carry energy away from the source. This emission plays an important role in the dynamical behavior of accelerating systems, as the loss of energy from the source must be accompanied by a corresponding effective radiation-reaction contribution to the exchange-sector momentum balance. The resulting radiation reaction is examined in the following sections.

5 Finite-Core Structure of Exchange Sources

The derivations of the preceding sections treat exchange sources as localized currents whose spatial extent is small compared with the scales relevant to the radiative field. This approximation is sufficient for determining the far-field radiation produced by accelerating sources. However, a complete dynamical description requires attention to the near-field region surrounding the source.

In classical field theory a strictly point-like source produces divergent field strengths at the source location. These divergences complicate the analysis of self-interaction and radiation reaction. Within the M-series framework this difficulty does not arise in the same form because bundled structures are not point objects. As shown in the bundled-loop construction of persistent matter, each bundled structure possesses a finite structural extent determined by its persistent bundled architecture.

Let the bundled source occupy a compact spatial region $\mathcal{S}$ with characteristic radius r_c. The exchange current associated with the bundle is then distributed throughout this finite region rather than concentrated at a single point. The exchange current density therefore satisfies

$$J^{\mu}_{\text{ex}}(x) = 0 \qquad \text{for} \qquad x \notin \mathcal{S}.$$

Within the bundle core the current distribution remains bounded, and the resulting exchange field remains finite everywhere. The near-field behavior of the solution is therefore regularized by the finite structure of the source.

At distances large compared with the core radius,

$$r \gg r_c,$$

the detailed structure of the current distribution becomes irrelevant and the field reduces to the standard multipole expansion determined by the total exchange charge and current moments of the bundle. In this regime the familiar Coulomb and radiation fields derived in the preceding sections are recovered.

The presence of a finite structural core therefore provides a natural regularization of the exchange field near the source while preserving the standard far-field behavior required for agreement with classical interaction phenomena.

This finite-core structure also provides the correct setting for analyzing the reaction force produced by radiation emission. Because the exchange field remains finite within the bundle region, the self-field acting on the bundle can be treated consistently within an effective dynamical description. The resulting effective radiation-reaction term is derived in the following section.

6 Radiation Reaction and Effective Dynamics

The emission of radiative exchange waves implies that an accelerating bundled structure loses energy and momentum to the surrounding field. Conservation of the combined stress–energy of the bundled source and the exchange field therefore requires that the emitting structure experience an effective reaction term in the exchange-sector momentum balance associated with the radiative flux.

The origin of this force can be understood by examining the exchange field in the near region surrounding the source. The total field in this region may be decomposed schematically into two parts:

$$F_{\mu\nu} = F_{\mu\nu}^{\text{self}} + F_{\mu\nu}^{\text{ext}},$$

where $F_{\mu\nu}^{\text{self}}$ represents the field generated by the bundle itself and $F_{\mu\nu}^{\text{ext}}$ represents the field due to external sources.

Because bundled structures possess a finite structural core, the self-field remains finite throughout the source region. This allows the force acting on the bundle to be defined by averaging the Lorentz force density over the bundle volume. The resulting effective force may be written schematically as

$$f_{\text{eff}}^{\mu} = qF_{\text{ext}}^{\mu\nu}u_{\nu} + f_{\text{rad}}^{\mu},$$

where the first term represents the usual Lorentz force due to the external field and f_{rad}^{μ} represents the radiation reaction produced by the bundle's own emission.

The reaction force must account for the rate at which energy and momentum are carried away by radiative exchange waves. Using the stress–energy conservation law derived earlier,

$$\nabla_{\mu} T_{\text{ex}}^{\mu\nu} = -F^{\nu\lambda} J_{\lambda}^{\text{ex}},$$

the flux of field momentum through a large sphere surrounding the source determines the rate of momentum loss from the bundle.

Evaluating this momentum balance in the weak-field limit yields an effective reaction force proportional to the derivative of the acceleration. In covariant form the leading contribution takes the structure

$$f^{\mu}_{\mathrm{rad}} = \frac{2}{3}\frac{q^2}{c^3}\left(\dot{a}^{\mu} + a^2 u^{\mu}\right), \tag{12}$$

where a^{μ} is the four-acceleration and $\dot{a}^{\mu}$ denotes the proper-time derivative of the acceleration.

Direct use of this expression leads to the well-known difficulties of the Abraham–Lorentz equation [5], including runaway solutions. Within the present framework these pathologies are avoided by treating the reaction force as a perturbative correction to the external dynamics. Substituting the leading-order acceleration obtained from the external Lorentz force into (12) yields the reduced equation of motion

$$ma^{\mu} = qF^{\mu\nu}_{\mathrm{ext}} u_{\nu} + \frac{2}{3}\frac{q^2}{c^3}\left(\frac{\mathrm{d}}{\mathrm{d}\tau}\left(qF^{\mu\nu}_{\mathrm{ext}} u_{\nu}\right) - a^2 u^{\mu}\right). \tag{13}$$

Equation (13) coincides with the Landau–Lifshitz form of the radiation-reaction equation [6]. In this form the weak-limit exchange-sector momentum balance of the bundled source is described by the external exchange field together with a small correction accounting for the energy and momentum lost through radiative emission.

Thus the classical radiation-reaction dynamics emerge naturally from the exchange field structure developed in the preceding papers, provided the finite-core structure of bundled sources is taken into account. The resulting effective weak-limit equation describes the combined influence of external exchange fields and radiative loss on the bundled source in the continuum description, while the underlying origin of the motion remains governed by support-sector boundary evolution as formulated in M7.5.

7 Consistency with Scalar Geometry

The radiative exchange dynamics developed in the present paper occur within the scalar–conformal geometry established in the earlier papers of the M-series. It is therefore important to clarify the relationship between the exchange sector and the scalar capacity sector that determines the background metric.

The scalar field $\Lambda(x)$ is determined by the support sector through the local structure of capacity delivery and consumption by persistent bundled configurations. Within the post-M6.5 framework, capacity is treated as a locally presented delivery process rather than a transported conserved substance, and anchors act as localized consumers that determine the scalar availability structure.

Weak-limit sector separation. The exchange field developed in the present paper carries energy and momentum through its stress–energy tensor $T^{\mu\nu}_{\mathrm{ex}}$. It is therefore natural to ask whether this exchange stress–energy should itself contribute to the support sector and hence modify the field Λ.

Within the weak-limit M-series framework adopted here, the answer is no. The scalar diagnostic field is determined by the support-sector intake structure of persistent bundled configurations. The exchange field describes directional interaction transport occurring on the scalar–conformal background, but its stress–energy does not enter the scalar sourcing relation at the level of the present theory.

Accordingly, the transport of energy and momentum by radiative exchange waves is treated as an internal exchange-sector bookkeeping structure governing Lorentz-force transfer, radiative flux, and radiation reaction, while the scalar geometry remains determined solely by the support sector. Any explicit coupling of exchange stress–energy back into the scalar-capacity structure would represent a higher-order extension of the framework and is not included in the weak-limit theory developed here.

This approximation is consistent with the structural hierarchy of the M-series: scalar geometry sets the background on which exchange processes propagate, and exchange dynamics feed back on bundled structures through weak-limit momentum transfer and radiation reaction without acting as an independent source for Λ.

Exchange transport, by contrast, is governed by the exchange current J^{μ}_{ex} and the associated field-strength tensor $F_{\mu\nu}$. The exchange field equations

$$\nabla_{\mu} F^{\mu\nu} = J^{\nu}_{\mathrm{ex}}$$

describe directional interaction transport but do not contribute to the sourcing of the scalar field.

As a consequence, the radiative exchange waves derived in the present paper propagate on the scalar–conformal background but do not modify the scalar field itself. Energy and momentum carried by the exchange field are exchanged with bundled structures through the Lorentz force and radiation-reaction terms, while the scalar geometry remains determined solely by the capacity sector. This statement is to be understood as a weak-limit closure assumption of the present M-series development rather than as a claim that no higher-order exchange-to-scalar coupling can ever arise in future extensions.

This separation preserves the structural hierarchy developed throughout the M-series: scalar geometry arises from the support sector, while exchange fields describe directional interaction processes occurring within that geometry.

8 Conclusion

We have developed the radiative dynamics of the exchange sector on scalar–conformal NUVO space. Building on the weak-limit exchange field structure derived previously, we examined the behavior of accelerating exchange sources and the resulting transport of energy and momentum through the exchange field.

Accelerated exchange currents were shown to generate propagating disturbances of the exchange field that travel along null characteristics of the scalar–conformal geometry. These disturbances constitute radiative exchange waves carrying stress–energy through spacetime. The associated energy flux is described by the stress–energy tensor of the exchange field and the corresponding Poynting vector.

For localized bundled structures the far-field radiation produced by accelerated motion yields the familiar Larmor power scaling, showing that the radiative emission rate is proportional to the square of the source acceleration. The loss of energy and momentum through radiation implies an effective radiation-reaction contribution acting on the emitting bundled source. Taking into account the finite-core structure of bundled sources provides a natural regularization of the near-field behavior of the exchange field and leads to an effective radiation-reaction equation that reduces to the Landau–Lifshitz form in the weak-field limit.

The results obtained here complete the classical radiative dynamics of the exchange sector within the M-series framework. Static interaction fields, propagating exchange waves, energy transport, and radiation reaction all emerge from the structural principles governing open-loop exchange transport.

Together with the preceding papers of the M-series, the present work establishes a coherent description of scalar geometry, structural mechanics of bundled structures, and the classical interaction and radiative behavior associated with exchange transport on scalar–conformal NUVO space.

We emphasize that, within the M-series framework, acceleration of bundled structures is not generated fundamentally by exchange fields. Rather, exchange-sector radiation and reaction describe the weak-limit redistribution of energy and momentum associated with support-sector-driven motion.

A Kinematic Interpretation and Sectoral Causality in NUVO

A.1 Purpose and Scope

The present appendix records the interpretive relationship between the kinematic quantities used in the weak-limit exchange sector and the underlying support-sector dynamics established in M6.5, M7, and M7.5. Its purpose is to ensure consistent reading of terms such as acceleration, force, and energy across the M-series framework.

This appendix does not introduce new dynamical assumptions. It clarifies how standard continuum quantities appearing in the exchange sector relate to the structural ontology of bundled structures and capacity delivery.

A.2 Acceleration as an Effective Descriptor

In the M-series framework, the physical state of a bundled structure is determined by the boundary flux distribution presented to it by the support sector. Persistent inertial motion corresponds to a stationary boundary configuration, while non-inertial motion arises when this boundary configuration evolves in time.

Accordingly, the four-acceleration a^μ of a bundled structure is not taken as a primitive dynamical quantity. Instead, it is an effective kinematic descriptor of time-dependent evolution in the support-sector boundary flux.

In the weak-limit continuum description adopted in the exchange sector, a^μ is used in the standard relativistic sense to parameterize the motion of localized sources. This usage is purely kinematic and does not imply that acceleration is generated by exchange-sector fields.

A.3 Separation of Causality Between Sectors

A central structural feature of the M-series framework is the separation between:

- the **support sector**, which governs capacity delivery, anchor sustenance, and the scalar field, and
- the **exchange sector**, which governs directional interaction transport through open-loop coupling.

Within this structure:

- Acceleration of a persistent bundled structure is determined by support-sector boundary flux evolution, as established in M7.5.

- Exchange fields do not generate acceleration. They provide a weak-limit continuum description of interaction transport associated with that motion.

Thus the causal structure differs from that of classical field theories in which forces are taken as primary drivers of motion. In the present framework, motion originates in the support sector, while the exchange sector encodes the interaction consequences of that motion.

A.4 Interpretation of Force Laws

The Lorentz-force-type expression derived in M8,

$$f^{\mu} = F^{\mu\nu} J^{\text{ex}}_{\nu},$$

is to be interpreted as a statement of momentum exchange between the exchange field and the bundled structure through its open-loop interfaces.

It does not represent a fundamental cause of acceleration. Rather, it provides a weak-limit bookkeeping relation describing how exchange-mediated momentum transfer is distributed in the continuum description.

The underlying dynamical response of the bundle remains governed by support-sector boundary evolution.

A.5 Radiation and Reaction

In the radiative regime developed in the present paper, accelerating bundled structures emit exchange waves that carry energy and momentum through the manifold.

This radiation is a consequence of the kinematic state of the bundle as described by its effective acceleration. The associated radiation-reaction terms describe the redistribution of energy and momentum between the bundle and the exchange field.

These reaction terms should not be interpreted as generating the motion of the bundle. Instead, they represent the exchange-sector contribution to the overall momentum balance associated with support-sector-driven dynamics.

A.6 Summary

The interpretation adopted throughout the M-series may be summarized as follows:

- The support sector determines motion through boundary flux evolution.
- Acceleration is an effective kinematic descriptor of this evolution.
- The exchange sector provides a continuum description of interaction transport associated with that motion.
- Force and radiation-reaction expressions represent momentum exchange and energy transport, not primary dynamical causes.

This separation preserves the structural hierarchy of the M-series and ensures consistency between the scalar-capacity framework and its weak-limit exchange-sector realization.

References

[1] Rickey W. Austin. M8: Weak-limit exchange structure on scalar–conformal nuvo space. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[2] Rickey W. Austin. M6.5: Anchors, capacity delivery, and flux imbalance in scalar–conformal nuvo space. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[3] Rickey W. Austin. M7: Bundle transitions and reconfiguration on scalar–conformal nuvo space. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[4] Rickey W. Austin. M7.5: Boundary flux evolution law on scalar–conformal nuvo space. NUVO M-series. St Claire Scientific Research, Development, and Publishing. Zenodo DOI to be assigned., 2025.

[5] John David Jackson. *Classical Electrodynamics*. Wiley, New York, 3rd edition, 1999.

[6] L. D. Landau and E. M. Lifshitz. *The Classical Theory of Fields*, volume 2 of *Course of Theoretical Physics*. Pergamon Press, Oxford, 4th edition, 1975.