Section 7. Charge–Spin Coupling (Magnetic Moment Emerges)

This section explains why a CUWF excitation that simultaneously carries (i) a phase-orientation charge structure, as developed in Sections 3–4, and (ii) a torsional spin topology, as developed in Section 6, must generically exhibit an effective magnetic dipole moment. The aim is not to replace QED, but to show that the familiar Pauli/QED structure appears as an effective projection of CUWF phase–torsion transport. The section therefore derives the form of the coupling while making explicit where precise numerical coefficients, including corrections such as $g-2$, must enter as higher-order channels rather than as unexplained primitives.

7.1 Why charged torsion implies a magnetic moment

7.1.1 CUWF structural ingredients

From the earlier sections, two transport structures are already in place. First, charge is carried by the phase sector, represented minimally by $\Psi(x) = A(x) \exp(i\theta(x))$, together with the local phase-connection A_μ introduced as the compatibility field required for local re-description of phase structure. Second, spin is carried by the torsion sector, represented by a torsion state ψ transported by an SU(2) torsion connection ω, including the central holonomy $-I$ around a torsional anchor in the spin-1/2 case.

An excitation that carries both structures is therefore not a particle endowed with two unrelated labels. It is a composite defect: simultaneously a phase defect, carrying winding and thus topological charge, and a torsional anchor, carrying spin topology. In CUWF language, charge and spin are co-located transport obstructions that must remain mutually compatible within the same entropic manifold.

7.1.2 Minimal reason a dipole must appear

A magnetic moment is the low-energy signature of a localized circulating structure: more precisely, of a localized source of antisymmetric field strength that behaves as a dipole in the far field. In the CUWF picture, a spin-carrying torsional anchor already defines an internal torsion-frame axis n(x), or equivalently a distinguished SU(2) generator direction. If that same localized region also carries a charge-related phase connection A_μ in the U(1) sector, entropic compatibility generically induces a cross-term: the U(1) connection acquires an effective circulation bias correlated with the torsion axis.

Operationally, the charged torsional anchor cannot be transported consistently without producing, in the effective U(1) sector, a localized solenoidal component of $\nabla \times A$ aligned with the torsion axis. This is precisely the far-field signature of a magnetic dipole. The magnetic moment is therefore not an extra attribute appended by hand. It is the effective large-scale imprint of the coexistence of a localized U(1) phase defect and a localized SU(2) torsional anchor.

7.1.3 A constructive effective coupling at lowest order

To make the argument explicit, one introduces the lowest-order entropic-effective interaction permitted by locality and by the coexistence of the U(1) and torsion sectors. Let $F_{\mu\nu}$ denote the U(1) curvature and let s^μ denote the spin pseudovector associated with the torsional class. Then the minimal Lorentz-covariant coupling takes the form

$$L_{int} = -\kappa\, s_\mu\, \tilde{F}^{\mu\nu}\, u_\nu,$$

where u^ν is the four-velocity of the localized excitation, $\tilde{F}^{\mu\nu}$ is the dual field strength, and κ is an effective coupling scale determined by CUWF microphysics. In the rest frame, where u = (1, 0, 0, 0), this reduces to the familiar dipole form

$$E_{int} = -\mu \cdot B,$$

with $\mu = \kappa$ s, up to unit conventions. Thus, once a localized spin pseudovector and a co-located charge sector are both present, a dipole moment aligned with the spin axis follows at lowest order as an effective necessity rather than as an additional assumption.

7.2 Projection to $\mu \propto g \cdot S$ (Pauli/QED mapping)

7.2.1 What must be reproduced

Standard quantum theory encodes the magnetic moment of a charged spin-1/2 particle through the Pauli term, which in the nonrelativistic limit of the Dirac theory is written as

$$H_{Pauli} = -(q/2m)\, g\, S \cdot B,$$

with $S = (\hbar/2)\sigma$ and $g \approx 2$ at the Dirac baseline, followed by small QED corrections. CUWF does not begin from this postulate. Instead, it must show that the Pauli form appears as the effective low-energy projection of phase–torsion compatibility.

7.2.2 CUWF-to-Pauli identification as effective projection

Section 6 established spin as a torsional topology class whose low-energy transport admits an SU(2) spinor representation as an effective description. Section 4 established electromagnetism as the curvature of the U(1) phase connection. When both structures are present in the same excitation, the effective single-excitation dynamics must include a mixed term linear in B and linear in the spin generator. One may therefore write the CUWF contribution in the low-energy Hamiltonian as

$$H_{CS} = -\mu_{eff}\, S \cdot B,$$

where μ_{eff} is not postulated at the fundamental level but arises after integrating out the internal CUWF degrees of freedom of the charged torsional anchor. Matching this to the Pauli form gives

$$\mu_{eff} = (q/2m)\, g_{eff},$$

and hence

$$\mu = g_{eff}\, (q/2m)\, S.$$

This is the intended sense of projection. The familiar proportionality between μ and S emerges in the standard effective basis, while the underlying ontology remains one of transport topology, compatibility, and defect structure rather than one of primitive spin and charge labels.

7.2.3 Why g ≈ 2 is natural in a torsion-lift picture

A key structural reason g tends toward 2 in spin-1/2 theories is that the SU(2) lift double-covers SO(3), yielding a factor-of-two relation between the generator of internal torsion transport and the generator of spatial rotation. In CUWF language, a full 2π spatial rotation corresponds to a nontrivial internal transport, namely the central element $-I$, so the internal response per unit spatial rotation is effectively doubled at the level of the projected coupling.

This makes g = 2 the natural baseline topology value for a minimally coupled spin-1/2 torsional anchor. Deviations from 2 are therefore not the primary mystery; they are correction channels around an already explained topological baseline. It is thus natural within the present construction to write

$g_{topology} = 2,$

with

$g_{eff} = g_{topology} + \delta g.$

7.3 Spin–orbit coupling as an entropic connection effect

7.3.1 Standard target form

In standard physics, spin–orbit coupling arises because the particle experiences an effective magnetic field in its rest frame while moving through an electric field, together with the familiar Thomas-precession correction. In the nonrelativistic limit, the coupling takes the form

$H_{SO} \propto (1/r)(dV/dr)\, L \cdot S,$

where V(r) is the electrostatic potential, L is orbital angular momentum, and S is spin. A satisfactory CUWF account must recover this operator structure, even if the ontological interpretation is different.

7.3.2 CUWF mechanism: torsion-axis transport in phase-gradient geometry

In CUWF, orbit is reinterpreted as the geometry of motion on the entropic manifold, whereas spin is the torsion-axis topology carried by the local anchor. The U(1) phase gradient $\nabla\theta$, or equivalently the phase connection A, defines a local transport geometry in which some directions are entropically cheaper and others more costly. A moving charged anchor therefore samples an anisotropic phase-transport environment.

The crucial CUWF statement is that spin–orbit coupling is the entropic response required to maintain compatibility between (i) transport of the torsion-frame axis and (ii) the phase-gradient geometry along a curved trajectory. At the effective level, this appears as a connection-induced precession of the spin axis. Writing Ω_{SO} for the resulting effective precession rate, the coupling takes the universal form

$$H_{SO} = -\Omega_{SO} \cdot S.$$

In the important case of a central potential, where $E = -\nabla V$, the phase geometry becomes axisymmetric about r-hat, and Ω_{SO} becomes proportional to L because orbital angular momentum encodes the curvature and orientation of the trajectory. The standard L·S structure is therefore recovered, but its origin is shifted from mechanical precession to transport compatibility on the entropic manifold.

7.3.3 Mapping note

CUWF does not deny the standard derivation. Rather, it reinterprets its meaning. The effective magnetic field in the particle's rest frame becomes the conventional projection of a deeper compatibility requirement between torsion transport and phase transport under motion. The operator form agrees with standard theory; the ontology does not.

7.4 g-factor: baseline topology value and correction channels

7.4.1 Decomposition

The natural decomposition in the present framework is

$$g_{eff} = 2 + \delta g,$$

where 2 is the baseline topology value for a minimal spin-1/2 torsional anchor and δg collects correction channels. CUWF therefore treats δg not as an inexplicable numerical accident but as a calculable functional of internal anchor structure and coupling to phase-connection dynamics.

7.4.2 Correction channel I: internal structure renormalization

If the charged torsional anchor is not perfectly point-like in the entropic manifold, but instead possesses a finite core, internal modes, or nontrivial sub-defects, then integrating out those internal degrees of freedom modifies the effective μ–S coupling. In effective-field language, this renormalizes the coefficient κ in the dipole term L_int = − κ s_μ F̃^{μν} u_ν, so that κ ⟶ κ + δκ and therefore δg ∝ δκ. In CUWF terms, internal deformation modes of the anchor alter the phase–torsion compatibility cost and thereby shift the projected magnetic response.

7.4.3 Correction channel II: phase-connection fluctuation dressing

Section 4 interpreted electromagnetic radiation as a propagating disturbance mode of the phase-connection sector. A charged torsional anchor interacting with these modes experiences self-interaction and backreaction. In conventional language this is a radiative correction; in CUWF language it is phase-connection fluctuation dressing of the torsional anchor. This dressing modifies the effective transport kernel that maps torsion state onto U(1) circulation bias and thereby generates a small δg.

7.4.4 Correction channel III: background and curvature effects

If the entropic manifold is not effectively flat, for example because of strong background gradients, nearby defects, or macroscale entropic curvature, then the torsion connection ω and the phase connection A cannot both be reduced to their minimal forms simultaneously. Cross-terms then arise that alter the effective μ–S projection. This yields context-dependent shifts conceptually analogous to bound-state g-factor modifications in atomic physics.

7.4.5 Scope statement

Section 7 claims only the following: first, that charged spin-carrying excitations generically possess an effective magnetic moment aligned with the spin axis; second, that the Pauli-form coupling arises as a low-energy projection of CUWF phase–torsion compatibility; third, that g = 2 is the natural baseline value for a minimal spin-1/2 torsional anchor; and fourth, that deviations from this baseline can be organized into a clear taxonomy of correction channels.

What Section 7 does not yet claim is equally important. It does not provide the explicit numerical computation of δg for particular particles such as the electron, nor does it yet derive κ directly from microscopic CUWF collapse-node dynamics. Those are downstream tasks once the present structural construction has been established.