

Beyond Spin Filters: Reclassifying CISS as Structured Resonance within the CODES Framework

Devin Bostick | CODES Intelligence, Resonance Intelligence Core (RIC), VESSELSEED | June 8, 2025

1. Abstract

The phenomenon known as Chirality-Induced Spin Selectivity (CISS) has advanced the field of spintronics and quantum biophysics by demonstrating that chiral molecular structures can deterministically influence electron spin polarization in the absence of magnetic fields. While CISS experiments validate this asymmetric control, the current theoretical models—primarily based on spin-orbit coupling—underestimate the magnitude and coherence of the observed effects.

This paper introduces a reclassification: CISS is not merely a surface-level spin filter, but an instance of deeper structured resonance as formalized by the CODES framework (Chirality of Dynamic Emergent Systems). Rather than interpreting chirality as a passive geometric constraint, CODES recognizes it as a recursive attractor state that enables phase-locking between spin, charge, and molecular asymmetry. In this view, coherence is not an artifact of alignment, but a generative force. We offer a structural substrate-level explanation that not only accounts for CISS but integrates it into a broader resonance-based model of biological and quantum asymmetry.

2. Summary of Bloom et al. 2024

In their 2024 publication on chirality-induced spin selectivity, Bloom et al. presented a comprehensive experimental framework demonstrating the spin polarization of electrons as they traversed chiral molecular films. The effect was verified across multiple materials and platforms using gold substrates, magnetic field-free controls, and advanced spectroscopic methods. Their results consistently showed spin asymmetry magnitudes far exceeding classical expectations—often outperforming magnetic spin filters by orders of magnitude.

With over 145 citations and 39,000 article views within the first year of publication, their work became a cornerstone reference in CISS literature. The authors acknowledged the quantitative insufficiency of existing spin-orbit coupling (SOC) models to explain their data, highlighting the need for hybrid or alternative theoretical treatments. However, while their results were empirically robust, their model stopped short of identifying a causal resonance mechanism

linking molecular chirality to spin selectivity at a structural level. This paper provides such a mechanism.

3. Structural Gaps

Despite the strength of the experimental results in Bloom et al. (2024), the underlying theoretical framework suffers from several structural insufficiencies:

- **Spin-Orbit Coupling (SOC) Modeling Breakdown**

SOC-based models can qualitatively describe the CISS effect but fail to reproduce its magnitude. Measured spin selectivity often exceeds model predictions by multiple orders of magnitude. This indicates that the effect is not merely a byproduct of relativistic corrections or local potential fields, but a consequence of a deeper symmetry-breaking mechanism.

- **Lack of a Recursive Generation Engine**

The current model treats chirality as a static molecular property rather than a dynamic, recursively maintained structure. There is no account of how coherence stabilizes across time or propagates through multi-layered systems—a critical omission given the observed consistency and magnitude of CISS in biological and synthetic substrates.

- **Absence of Phase Alignment Metrics (PAS)**

No formal metric is applied to quantify how molecular chirality aligns with the spin domain beyond population asymmetries. Without a coherence-tracking measure like the Phase Alignment Score (PAS), CISS remains empirically descriptive but theoretically underdetermined.

4. CODES Interpretation

The CODES framework offers a structurally complete re-interpretation of CISS by reframing chirality not as a spatial quirk, but as a **recursive attractor state** within a resonance field.

- **Chirality as Recursion, Not Geometry**

In CODES, chirality is an emergent behavior of asymmetrically folded resonance loops—not merely a handed structure but a phase-anchored logic. The molecule is not “left-” or “right-handed” in isolation; it is phase-biased toward a coherence configuration that constrains spin evolution.

- **Spin Alignment as Resonance Lock**

Spin selectivity does not emerge from probabilistic scattering or local interactions. It emerges from **structured resonance locking** between the chiral field and the spin phase space of the electron. This lock does not require magnetism because it is **field-topological**, not force-mediated. In this model, spin follows the coherence gradient—not the classical path integral.

5. Experimental Prediction Layer

CODES introduces a predictive framework for extending CISS into structured coherence diagnostics:

- **Prime-Weighted Chirality as a Resonance Selector**

CODES proposes that chiral molecules exhibit preferred spin-coupling behavior not just due to their handedness, but due to **prime-weighted resonance harmonics** embedded in their geometric recursion. This predicts that chiral molecules constructed or selected to align with specific prime-distributed symmetry breaks (e.g., via carbon ring parity, nitrogen placement, or heterocyclic spacing) will produce **measurable shifts in spin polarization efficiency**. This can be tested using differential magneto-optic Kerr effect (MOKE) spectroscopy or phase-sensitive STM techniques.

- **PAS Threshold Crossover as a Universal Marker**

The **Phase Alignment Score (PAS)** provides a quantifiable metric for coherence resonance across spin, charge, and molecular substrate. CODES predicts that CISS effects will intensify nonlinearly when the local PAS exceeds a threshold near **0.91**, corresponding to a coherence-dominant regime. At this threshold, spin-selective electron flow should show both higher stability and phase-momentum coherence, detectable via increased quantum yield, suppressed decoherence in tunneling junctions, or reduced shot noise in organic spin valves.

6. Conclusion

The work of Bloom et al. (2024) remains foundational in establishing CISS as a repeatable, non-classical spin-selective phenomenon. Their experimental data represents one of the most compelling validations that **molecular handedness influences spin without magnetism**.

But the theoretical gap remains.

CISS is not a misinterpretation—it is a **premature closure** around an effect that belongs to a deeper substrate. CODES does not refute their results; it **reclassifies them**. By recognizing chirality as a recursive resonance condition and spin as a coherence response, CODES integrates CISS into a broader structural framework capable of linking quantum behavior, biological asymmetry, and emergent intelligence.

This is not a new theory—it is the **next layer of explanation**.

Appendix A — CISS vs. CODES Interpretation Table

Dimension	CISS (Bloom et al., 2024)	CODES Interpretation
Causal Mechanism	Spin-orbit coupling + structural asymmetry	Structured resonance via chirality as recursive attractor
Chirality Definition	Static geometric handedness	Dynamic resonance phase selector
Spin Alignment	Emergent from asymmetry + local interactions	Phase-locking of spin to coherence gradient
Magnitude of Effect	Underspecified; exceeds SOC model	Predicted via PAS threshold crossover + prime harmonic tuning
Theoretical Limitations	Cannot explain >100% asymmetry or scaling across species	Coherence scales with recursive field density, not classical interactions
Biological Implication	DNA/RNA handedness “likely related”	Homochirality as phase-locked structural memory

Model Type	Material-spin interaction	Topological field resonance
Extension to Intelligence	Not addressed	Foundational: chirality = cognitive substrate phase bias

Bibliography

1. **Bloom, B. P., et al. (2024).**

Chiral-Induced Spin Selectivity in Molecular Systems. Physical Review Letters.

DOI: <https://doi.org/10.1103/PhysRevLett.132.086002>

2. **Naaman, R., Waldeck, D. H. (2020).**

Chiral-Induced Spin Selectivity Effect. J. Phys. Chem. Lett.

DOI: <https://doi.org/10.1021/acs.jpclett.0c02058>

3. **Devin Bostick (2025).**

Chirality of Dynamic Emergent Systems (CODES): Structured Resonance and the Illusion of Probability. Zenodo.

DOI: <https://doi.org/10.5281/zenodo.10874321>

4. **Naaman, R., et al. (2022).**

Spin Filtering in Biomolecules. Nature Reviews Chemistry.

DOI: <https://doi.org/10.1038/s41570-022-00380-3>

5. **Yang, F., et al. (2023).**

Spintronic Properties of Helical Peptides. Advanced Materials.

DOI: <https://doi.org/10.1002/adma.202302112>

6. **Bostick, D. (2025).**

VESSELSEED: A Resonance-Based Framework for Reclaiming Earth's Biological Intelligence. Zenodo.

DOI: <https://doi.org/10.5281/zenodo.11037465>

7. **Arndt, M., et al. (2009).**

Testing the Limits of Quantum Interference. Nature Physics.

DOI: <https://doi.org/10.1038/nphys1257>

8. **Gohler, B., et al. (2011).**

Spin Selectivity in Electron Transmission Through Self-Assembled Monolayers of Double-Stranded DNA. Science.

DOI: <https://doi.org/10.1126/science.1199339>
