Research Meta-Spec v1.0

A Formal Protocol for Autonomous, Auditable Conjecture Research

0. Purpose and Scope

This document defines a domain-agnostic protocol for autonomous, falsifiable, reproducible AI-assisted research.

It formalizes a research state machine that enforces determinism, traceability, and epistemic discipline.

1. Core Epistemic Invariants

- P1 — Falsifiability: Every claim must define explicit failure conditions.
- P2 — Evidence/Inference Separation: Finite survival is not proof.
- P3 — Deterministic Reproducibility: Identical inputs produce identical outputs.
- P4 — Traceability: Every claim must reference specification and manifest hashes.
- P5 — Protocol Precommitment: Search space defined before execution.

2. Architecture Layers

Cognitive Layer (4 Phases): Formalization → Protocol Freeze → Deterministic Execution → Meta-Audit.

Execution Layer: Specification, Execution, Hypothesis Mining, Falsification, Structural Analysis, Ranking, Reporting.

3. Formal Phases

- Phase 1 — Formalization: Define research question, null hypotheses, measurable variables, stop criteria.
- Phase 2 — Protocol Freeze: Define domain grid, ranking version, density thresholds. No tuning allowed after freeze.
- Phase 3 — Deterministic Exploration: Execute, generate conjectures, record falsifications, compute density and structure.

- Phase 4 — Meta-Analysis & Audit: Evaluate bias, structural fragility, search bias, statistical overconfidence.

4. Formal Claim Structure

Each claim must minimally include:

- Statement
- Pipeline hash
- Tested domains
- Density estimate
- Structural skeleton
- Ranking breakdown
- Classification level (E0–E4)

5. Reproducibility Requirements

- Canonical manifest.json
- Environment freeze metadata
- Dependency lockfile
- Determinism rerun test
- Reproducibility bundle (.zip)
- Integrity audit report

6. Failure Conditions

- Non-stable hashes across reruns
- Protocol drift after execution
- Missing falsification logs
- Hidden negative results
- Opaque ranking model

7. Abstract Operator Form

Research v1.0 = A ■ ρ ■ Σ ■ F ■ Ψ ■ E ■ Π ■ Φ

Where Φ=Formalization, Π=Protocol Freeze, E=Execution, Ψ=Hypothesis Extraction, F=Falsification, Σ=Structural Compression, ρ=Ranking, A=Audit.

8. Research State Machine

Intent → Formalization → Protocol Freeze → Execution → Conjectures → Falsification → Structure → Ranking → Audit → Reproducible Bundle

All transitions must satisfy Determinism, Traceability, Versioning, and Falsifiability constraints.