

Research Flow Notebook

Topic: demo-topic Lane: formal_theory

AITP v2 Protocol

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Abstract

This flow notebook archives the complete research trajectory for topic `demo-topic`, from question framing through derivation to validated claim. It serves as the mandatory pre-paper artifact required before L5 writing.

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1 Research Question

Bounded Question: What quantity is bounded here?

Scope: One model, one regime.

Target Quantities: Gap and symmetry sector.

1.1 Non-Success Conditions

- No convergence in the numerical solution after 10^4 iterations.
- Dimensional analysis yields inconsistent units.

1.2 Uncertainty Markers

- Sign convention ambiguity in the Green's function.
- Unknown validity of perturbative expansion beyond second order.

2 Conventions And Regime

2.1 Notation Choices

Symbol	Meaning	Source
$G(\mathbf{r}, \mathbf{r}')$	Green's function	source-a
Σ	Self-energy	source-a
E_{gap}	Band gap	convention

Units: Natural units ($\hbar = 1$).

Sign Convention: $(-, +, +, +)$ metric signature.

3 Derivation Route

3.1 Ideation

The core idea is to verify whether the AITP v2 protocol produces correct provenance chains from framing through validation.

Motivation: Without a complete provenance chain, claims cannot be audited or reproduced.

3.2 Planning

1. Frame the research question with explicit scope boundaries.
2. Walk through all five L3 subplanes in sequence.
3. Validate the distilled claim against physics checks.
4. Render the flow notebook as the archive checkpoint.

Derivation Route: Step-by-step verification of each protocol stage gate.

3.3 Analysis

Applied unit tests and manual inspection to verify:

- Each L3 subplane artifact has required frontmatter fields.
- Each subplane artifact contains required headings.
- Transitions follow the allowed directed graph.

Key equation from analysis:

$$\Sigma(\mathbf{r}, \mathbf{r}'; \omega) = i \int \frac{d\omega'}{2\pi} G(\mathbf{r}, \mathbf{r}'; \omega + \omega') W(\mathbf{r}, \mathbf{r}'; \omega') \quad (1)$$

3.4 Result Integration

All stages connected properly. The provenance chain from L1 framing through L3 derivation to L4 validation is complete and consistent.

Findings:

- All 74 unit tests pass across 6 waves.
- Flow notebook TeX renders correctly with all required sections.
- Promotion to global L2 succeeds with correct trust classification.

3.5 Distillation

Distilled Claim: The AITP v2 protocol produces correct provenance chains from question framing through validated claim promotion.

Evidence Summary: Tests pass, flow TeX renders correctly, trust classification is basis = validated, scope = bounded_reusable.

4 Validation And Checks

4.1 Validation Contract

Field	Value
Candidate ID	cand-1
Mandatory checks	dimensional_consistency, limiting_case_check

4.2 Review: cand-1

Field	Value
Outcome	pass
Notes	All physics checks passed.
Dimensional consistency	✓
Limiting case check	✓

5 Current Claim Boundary

Claim: The AITP v2 protocol produces correct provenance chains from question framing through validated claim promotion.

	Dimension	Value
Trust Classification:	Trust basis	validated
	Trust scope	bounded_reusable
	Version	1

Assumptions:

1. The topic follows the `formal_theory` lane.
2. All L1 artifacts are filled before advancing to L3.
3. At least one candidate passes L4 review before promotion.

6 Failures And Open Problems

6.1 Known Limitations

- The flow notebook currently embeds raw Markdown in TeX; a proper renderer should convert headings to \LaTeX sections.
- The `contradiction_register` requires manual population; it does not auto-detect contradictions from source analysis.

6.2 Open Problems

- Extending the protocol to support multi-model comparison topics.
- Integration with Lean 4 for formal verification of mathematical claims.
- Automatic detection of scope creep during L3 derivation.

6.3 Negative Results

- Attempting to skip subplanes (e.g., jumping from ideation to distillation) is correctly blocked by the protocol gates.