## Fundamental Constants in Semantic Physics

This section introduces hypothesized constants that govern the dynamics and structure of semantic systems. Just as physical theories are shaped by constants such as the speed of light $c$ and Planck's constant $\hbar$, semantic theory may be bounded by limits that constrain propagation, granularity, and transformation of knowledge in cognitive and computational systems.

### 1. $c_{\mathbf{sem}}$: Semantic Propagation Speed

We define $c_{\text{sem}}$ as the maximum speed at which valid semantic content (truth-preserving knowledge transformations) can propagate through a semantic graph or manifold.

$$c_{\text{sem}} = \max\left(\frac{d_{\text{sem}}(v_i, v_j)}{\Delta t}\right)$$

where $d_{\text{sem}}$ is the semantic distance between knowledge nodes $v_i$ and $v_j$, and $\Delta t$ is the minimal inference or communication interval.

This is a structural bound, not a computational one. It reflects the fact that semantic resolution and transformation require time and energy, even in idealized systems.

### 2. $c_{\mathbf{obs}}$: Observation Realization Bound

Observation is not instantaneous. $c_{\text{obs}}$ is defined as the fastest rate at which observation can instantiate information into a resolved, discrete knowledge state.

$$c_{\text{obs}} \leq c_{\text{sem}} \leq c$$

Here $c$ is the physical speed of light, which caps classical signaling. Observation may be bottlenecked by sensory, cognitive, or formal resolution constraints.

### 3. $\hbar_{\mathbf{lang}}$: Minimum Symbolic Action

Language does not transmit arbitrary meaning in zero-cost units. We hypothesize the existence of a symbolic quantum, $\hbar_{\text{lang}}$, representing the minimal semantic action needed to produce a distinguishable, transmissible symbolic change.

$$\delta S \geq \hbar_{\text{lang}} \quad \text{(Minimum action to shift meaning state)}$$

This places a lower bound on granularity in symbol systems and supports the idea of a minimal "bit" or "token" in semantic systems analogous to Planck length.

### 4. $G_{\mathbf{sem}}$: Semantic Gravitation Constant

This constant governs how semantic weight (information density) distorts the local geometry of a belief or knowledge graph.

It is analogous to Newton's $G$:

$$F = G_{\text{sem}} \frac{w_i w_j}{d^2}$$

Here $w_i$ and $w_j$ are the information weights at nodes $i$ and $j$, and $d$ is the graph distance. The force $F$ reflects how much two ideas influence one another based on their semantic mass.

## 5. Future Formalization

Each of these constants serves as a hypothesis. They invite:

- Experimental estimation (e.g., in LLM drift analysis or belief network dynamics)
- Analogy with epistemic phase transitions and state collapse
- Formal inclusion in semantic field equations