

Extending the MDMA Framework

# Physics of Decisions

## Relativistic and Observational Effects on Decision-Making Ability

Based on the core MDMA preprint: <https://doi.org/10.5281/zenodo.16265521>

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### Abstract

This preprint extends the Machine Decision-Making Ability (MDMA) framework into a physical setting, asking how motion, gravity, and measurement shape the *rates at which decisions are observed*. We introduce two complementary extensions: (1) **Einstein-MDMA Relativity**, which relates observed decision rates to relativistic (kinematic) and gravitational time dilation; and (2) **Observable-DMA Collapse**, which treats observation as an information-resolving decision event, measured in bits per unit time. The goal is not to claim new physics, but to provide operational, physically grounded lenses that connect decision-making capacity to reference frames and measurement. These extensions help separate a system's local (proper-time) capability from its frame-dependent appearance, and formalize the informational yield of observation as a decision process.

## 1 Introduction

**Machine Decision-Making Ability (MDMA)** quantifies a system's autonomous capacity to change internal state. Prior work grounded MDMA in concrete substrates (mechanical, electronic, quantum) and emphasized a universal, physically countable unit of autonomy. Here we ask: how do *relativity* and *observation* affect the *apparent* pace and yield of decision-making?

We present two operational treatments. First, we show that the *observed* decision rate scales with relativistic time dilation, while the system's *local* (proper-time) capability remains unchanged. Second, we model observation as an act that resolves uncertainty, yielding a *decision rate of observation* in bits per unit time. Together, these perspectives integrate MDMA with basic features of modern physics without over-interpreting their scope.

### Notation and Assumptions

- $MDMA_0$ : local decision rate measured in the system's *proper time*.
- "Observed MDMA": decision rate as inferred by a remote observer in a different frame.

- Relativistic formulas are used *operationally*: they map counting over proper time to counting over the observer's time coordinate.
- No claim is made that time dilation *creates* additional computation; it rescales how rates are *perceived and compared* across frames.

## 2 Einstein–MDMA Relativity

### Relativity and Time Dilation

Let a system perform  $\text{MDMA}_0$  autonomous state transitions per unit of its *proper time*. For an inertial observer seeing the system move at speed  $v$ , the special-relativistic time dilation factor is

$$\gamma(v) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}},$$

so the *observed* decision rate is

$$\text{MDMA}_{\text{rel}} = \gamma(v) \text{MDMA}_0 = \frac{\text{MDMA}_0}{\sqrt{1 - \frac{v^2}{c^2}}},$$

where  $c$  is the speed of light.

In a static gravitational field (Schwarzschild), the gravitational redshift factor at radius  $r$  from mass  $M$  is

$$\Gamma(r) = \frac{1}{\sqrt{1 - \frac{2GM}{rc^2}}},$$

so a distant observer infers

$$\text{MDMA}_{\text{grav}} = \Gamma(r) \text{MDMA}_0 = \frac{\text{MDMA}_0}{\sqrt{1 - \frac{2GM}{rc^2}}},$$

with  $G$  the gravitational constant.

**Physical Consistency.** These relations *do not* assert that the machine exceeds physical computation limits in its local frame; they state that when one converts counts-per-proper-time to counts-per-observer-time, rates scale by the appropriate dilation factor.

### Implications

An AI near a compact object or moving relativistically can *appear* faster (higher decisions per second) to a remote observer, purely due to time dilation. Conversely, the same system looks slower to a co-moving observer that sees the remote evaluator's clock dilated.

### Applications.

- Deep-space or high-orbit systems that require long deliberation could be *scheduled* with frame effects in mind (mission planning, timestamping, synchronization).
- Comparative benchmarking across frames (e.g., LEO vs. ground) can be normalized by  $\gamma$  or  $\Gamma$  to recover  $\text{MDMA}_0$ .

## 3 Observable–DMA Collapse

### Observation as a Decision Event

We treat observation as a resolution of uncertainty: the observer obtains  $\Delta I_{\text{resolved}}$  bits of information in a resolution interval  $\Delta t_{\text{collapse}}$ . Define the *observational decision rate*

$$\text{DMA}_{\text{obs}} = \frac{\Delta I_{\text{resolved}}}{\Delta t_{\text{collapse}}},$$

interpretable as bits per second harvested by measurement.<sup>1</sup>

### Interpretation

- A which-path detector in a double-slit setup produces discrete observational decisions by resolving among alternatives.
- Different observers (e.g., moving vs. stationary) can *disagree* on the rate at which the same stream of events is produced, due to time dilation, while agreeing on the *count* collected in a given proper interval.
- For engineered systems (sensors, classifiers),  $\text{DMA}_{\text{obs}}$  connects measurement bandwidth and noise to the rate of *useful* decisions extracted from data.

## 4 Discussion and Future Work

### Key Insights.

- Relativity separates *local capability* from *frame-dependent appearance*:  $\text{MDMA}_0$  vs. observed  $\text{MDMA}$ .
- Observation can be cast as a decision process with an explicit information yield per unit time,  $\text{DMA}_{\text{obs}}$ .

### Future Work.

- Integrate physical computation limits (e.g., Landauer, Margolus–Levitin) explicitly with  $\text{MDMA}_0$  to bound local decision rates.
- Couple  $\text{DMA}_{\text{obs}}$  to channel capacity and detector physics (SNR, bandwidth) for end-to-end *decision-throughput* design.

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<sup>1</sup>This is an operational definition; it does *not* commit to a particular interpretation of quantum measurement.

- Explore protocol-level synchronization for fair benchmarking across frames (normalizing to proper time).

## References

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