

# Attosecond Prediction of Quantum Entanglement Formation as Supporting Evidence for the $T_0$ -Time-Mass-Duality Theory

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## Abstract

This document summarizes the theoretical prediction of the time-resolved formation of quantum entanglement (Jiang et al., 2024) and presents it as supporting evidence for the fundamental time dynamics postulated in the  $T_0$ -Time-Mass-Duality Theory. All theoretical interpretations are drawn exclusively from the content of the Master Narrative (FFGFT\_Narrative\_Master\_En.pdf) and related documents in the repository: <https://github.com/jpascher/T0-Time-Mass-Duality/tree/main/2/>.

## 1 The Theoretical Work

The study by Jiang et al. (2024) demonstrates theoretically that quantum entanglement does **not** form instantaneously, but emerges over a measurable local time window.

### 1.1 Key Details from the Simulation

- **System:** Helium atom driven by an intense high-frequency EUV laser pulse (photoionization).
- **Process:** One electron absorbs energy and escapes (ionizes), while the second electron is excited to a higher energy state.
- **Superposition:** The escaping electron is in a superposition of different departure times (no single sharp instant).
- **Correlation:** The final energy of the bound electron is directly correlated with the departure time of the escaping electron:
  - Higher energy in the bound electron  $\rightarrow$  escaping electron departed earlier
  - Lower energy  $\rightarrow$  escaping electron departed later

- **Predicted Time Window:** Full time-dependent Schrödinger equation simulations yield an entanglement formation window of  **$\sim 232$  attoseconds** ( $\approx 2.32 \times 10^{-16}$  s).
- **Proposed Experimental Verification:** A double-pulse scheme (generation pulse + probe pulse) combined with coincidence detection of both electrons to reconstruct the shared quantum history and time the formation process.

**Important note:** This is a theoretical/numerical prediction. No laboratory measurement has been performed yet. The authors propose a feasible future experiment using current attosecond laser technology.

## 1.2 Popular-Science Video

Video summary of the work: <https://www.youtube.com/watch?v=t3wjY95zvNM> („Scientists Measure Quantum Entanglement Speed — And It Breaks Physics“, Channel: NASA Space News, Uploaded: January 14, 2026)

## 2 Connection to the $T_0$ -Time-Mass-Duality Theory

This theoretical result provides strong conceptual support for the core postulate of the theory:

„In the  $T_0$ -Time-Mass-Duality Theory, time is ontologically equivalent to mass and therefore not merely a coordinate, but an active physical quantity with real dynamics on all scales. Quantum correlations (entanglement) therefore do not arise instantaneously, but develop as a temporal, emergent process within a local interaction window. The predicted attosecond formation time of  $\sim 232$  as confirms exactly this finite, dynamical build-up without non-local ‘spooky action at a distance’ and without violating causality.“

This highlights that all quantum phenomena carry intrinsic time dynamics — a direct consequence of the fundamental duality between time and mass.

## 3 References

1. Jiang, W.-C., Zhong, M.-C., Fang, Y.-K., Donsa, S., Březinová, I., Peng, L.-Y., Burgdörfer, J. (2024).  
*Time Delays as Attosecond Probe of Interelectronic Coherence and Entanglement.*  
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DOI: [10.1103/PhysRevLett.133.163201](https://doi.org/10.1103/PhysRevLett.133.163201)
2. Video: „Scientists Measure Quantum Entanglement Speed — And It Breaks Physics“. YouTube, Channel: NASA Space News.  
<https://www.youtube.com/watch?v=t3wjY95zvNM> (accessed January 15, 2026)