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We have investigated the 3 d orbital excitations in CaCuO<sub>2</sub> (CCO), Nd<sub>2</sub>CuO<sub>4</sub> (NCO), and La<sub>2</sub>CuO<sub>4</sub> (LCO) using high-resolution resonant inelastic x-ray scattering. In LCO they ...

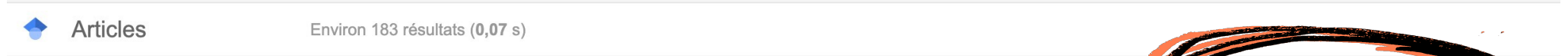
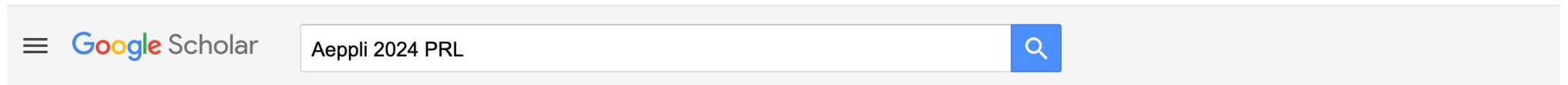
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### Clock with $8 \times 10^{-19}$ Systematic Uncertainty

[A Aeppli](#), [K Kim](#), [W Warfield](#), [MS Safronova](#), [J Ye](#) - **Physical Review Letters**, 2024 - APS

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### A clock with $8 \times 10^{-19}$ systematic uncertainty

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### Collective nature of orbital excitations in layered cuprates in the absence of apical oxygens

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## Clock with $8 \times 10^{-19}$ Systematic Uncertainty

Alexander Aeppli, Kyungtae Kim, William Warfield, Marianna S. Safronova, and Jun Ye  
Phys. Rev. Lett. 133, 023401 – Published 10 July 2024

**Physics** See Viewpoint: Reducing Uncertainty in an Optical Lattice Clock

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### ABSTRACT

We report an optical lattice clock with a total systematic uncertainty of  $8.1 \times 10^{-19}$  in fractional frequency units, representing the lowest uncertainty of any clock to date. The clock relies on interrogating the ultranarrow  $^1S_0 \rightarrow ^3P_0$  transition in a dilute ensemble of fermionic strontium atoms trapped in a vertically-oriented, shallow, one-dimensional optical lattice. Using imaging spectroscopy, we previously demonstrated record high atomic coherence time and measurement precision enabled by precise control of collisional shifts and the lattice light shift. In this work, we revise the black body radiation shift correction by evaluating the  $5s4d\ ^3D_1$  lifetime, necessitating precise characterization and

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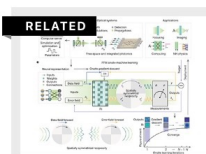
## Physics solves a training problem for artificial neural networks

Systems that emulate biological neural networks offer an efficient way of running AI algorithms, but they can't be trained using the conventional approach. The symmetry of these 'physical' networks provides a neat solution.

By [Damien Querlioz](#) 



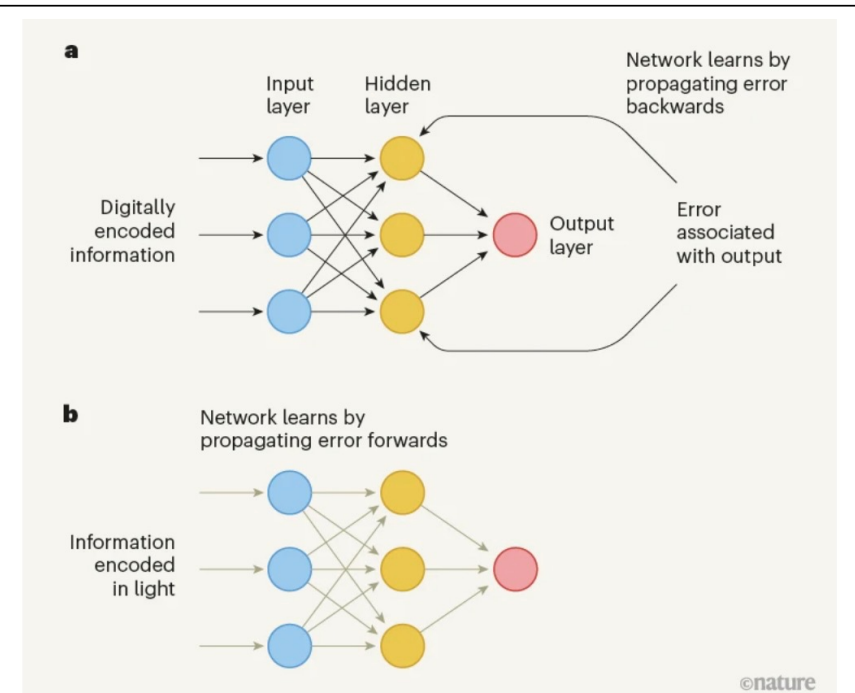
Huge changes are already under way in health care, industry and education as a result of advances in artificial intelligence (AI), but the costs could outweigh the benefits if AI's enormous energy consumption is not reined in. The problem is that AI relies heavily on deep neural networks, which are layered algorithms that involve millions or even billions of computations, requiring massive, energy-hungry access to the memories in conventional computers. One possible solution is to replace the computers with systems that more closely reflect the physical structure of biological neural networks, but such systems are typically incapable of performing one of the main steps in training the network. In [a paper in Nature](#), Xue *et al.*<sup>1</sup> report an ingenious workaround that uses physics to overcome the problem.



**Read the paper: Fully forward mode training for optical neural networks**

'Physical' neural networks can be designed using several platforms involving, for example, optics<sup>2</sup>, nanoelectronics<sup>3,4</sup> or mechanics<sup>5</sup>. These systems naturally implement the unidirectional data flow of neural networks, and their physical parameters (which could be, for example, the refractive index of an optical filter, the electrical resistance of a component, or the stiffness of a spring) represent the parameters that encode the nodes and connections of the neural network<sup>6</sup>. However, training these networks efficiently remains a major hurdle.

The backbone of most software for training neural networks is a method called gradient descent, which involves calculating the error associated with a neural network's output, and



**Figure 1 | Training a neural network.** **a**, Most protocols for training artificial neural networks involve calculating the error associated with the network's output, and then minimizing error by updating its 'hidden' layers through a process called backpropagation. **b**, Optical networks (for example, those using laser light moving through optical fibre) could implement machine-learning algorithms more efficiently than can conventional computers, but they have clear inputs and outputs, so backpropagation is not possible. Xue *et al.*<sup>1</sup> developed an alternative approach called fully forward-mode learning, based on the physical principle that light can travel in one direction through an optical system just as easily as it can in the opposite direction. This means that backpropagation can be simulated without information needing to be propagated backwards.

A leading solution to this challenge involves using a mathematical model, and not the physical system itself, to perform the calculation<sup>7</sup>. Others rely on emerging learning schemes that avoid backpropagation altogether<sup>8</sup>. However, none of these solutions can match the accuracy of neural networks implemented in conventional computers when applied to complex tasks.

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Alexander Aeppli, Kyungtae Kim, William Warfield, Marianna S. Safronova, and Jun Ye  
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Via Altmetrics :

The screenshot shows the Altmetric website interface for the article "Clock with  $8 \times 10^{-19}$  Systematic Uncertainty". The attention score is 260, which is in the top 5% of all research outputs. The article is published in Physical Review Letters, July 2024. The authors are Alexander Aeppli, Kyungtae Kim, William Warfield, Marianna S. Safronova, and Jun Ye. The article is mentioned by 28 X users. The interface includes a navigation bar with "What is this page?", "Embed badge", and "Share" buttons. A "SUMMARY" section is visible with tabs for "News", "Blogs", "X", "Reddit", and "Dimensions citations". The "News" tab is circled in red. A "Mentioned by" section is partially visible at the bottom, showing a map of the world.

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## Clock with $8 \times 10^{-19}$ Systematic Uncertainty

Overview of attention for article published in Physical Review Letters, July 2024

260

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**Title** Clock with  $8 \times 10^{-19}$  Systematic Uncertainty

**Published in** Physical Review Letters, July 2024

**DOI** 10.1103/physrevlett.133.023401

**Pubmed ID** 39073965

**Authors** Alexander Aeppli, Kyungtae Kim, William Warfield, Marianna S. Safronova, Jun Ye

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- Reducing Uncertainty in an Optical Lattice Clock** (Physics) - American Physical Society - Physics, 29 Jul 2024. Authors: Han-Ning Dai and Yu-Ao Chen. University of Science and Technology of China, Hefei, China.
- An optical lattice clock based on strontium atoms achieves unprecedented accuracy** (msn) - MSN, 24 Jul 2024. Researchers at the Ye Lab at JILA (the National Institute of Standards and Technology) and the University of Colorado Boulder.
- An optical lattice clock based on strontium atoms achieves unprecedented accuracy - SwiftTelecast** (SWIFTTELECAST) - Swift Telecast, 24 Jul 2024. Researchers at the Ye Lab at JILA (the National Institute of Standards and Technology) and the University of Colorado Boulder.

A fourth news story from Phys.org is partially visible at the bottom right, with the same title as the msn story.



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Via Wikipedia (US et FR) :

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## Atomic clock

66 languages

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*For a clock updated by radio signals, see [Radio clock](#). For the clock as a measure for risk of catastrophic destruction, see [Doomsday Clock](#). For other topics, see [Atomic Clock \(disambiguation\)](#).*

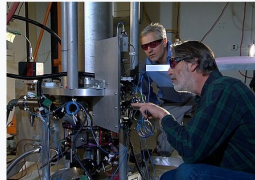
An **atomic clock** is a [clock](#) that measures time by monitoring the resonant frequency of atoms. It is based on atoms having different [energy levels](#). Electron states in an atom are associated with different energy levels, and in transitions between such states they interact with a very specific [frequency](#) of [electromagnetic radiation](#). This phenomenon serves as the basis for the [International System of Units'](#) (SI) definition of a [second](#):

The second, symbol s, is the SI unit of time. It is defined by taking the fixed numerical value of the caesium frequency,  $\Delta\nu_{\text{Cs}}$ , the unperturbed ground-state hyperfine transition frequency of the caesium-133 atom, to be 9 192 631 770 when expressed in the unit Hz, which is equal to s<sup>-1</sup>.

This definition is the basis for the system of [International Atomic Time](#) (TAI), which is maintained by an ensemble of atomic clocks around the world. The system of [Coordinated Universal Time](#) (UTC) that is the basis of civil time implements [leap seconds](#) to allow clock time to track changes in [Earth's rotation](#) to within one second while being based on clocks that are based on the definition of the second, though leap seconds will be phased out in 2035.<sup>[2]</sup>


The accurate timekeeping capabilities of atomic clocks are also used for navigation by [satellite networks](#) such as the [European Union's Galileo Programme](#) and the United States' [GPS](#).

### Atomic clock



NIST physicists Steve Jefferts (foreground) and Tom Heavner with the NIST-F2 caesium fountain atomic clock, a civilian time standard for the United States

<b>Classification</b>	<a href="#">Clock</a>
<b>Industry</b>	<a href="#">Telecommunications</a> , <a href="#">science</a>
<b>Application</b>	<a href="#">TAI</a> , <a href="#">satellite navigation</a>
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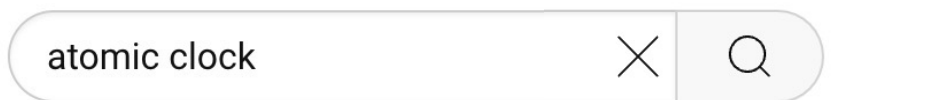
- [Schrödinger, Erwin](#) (August 1952). "Are there quantum jumps? Part I"  (PDF). *The British Journal for the Philosophy of Science*. **3** (10): 109–123. doi:10.1093/bjps/iii.10.109  . [Part 2](#) 
- "There are no quantum jumps, nor are there particles!"  by H. D. Zeh, *Physics Letters* **A172**, 189 (1993).
- Ball, Philip (June 5, 2019). "[Quantum Leaps, Long Assumed to Be Instantaneous, Take Time](#)" . *Quanta Magazine*. Retrieved June 6, 2019.
- "Surface plasmon at a metal-dielectric interface with an epsilon-near-zero transition layer"   by Kevin Roccapiore et al., *Physical Review B* **103**, L161404 (2021).

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Categories: [Atomic physics](#) | [Electron states](#)

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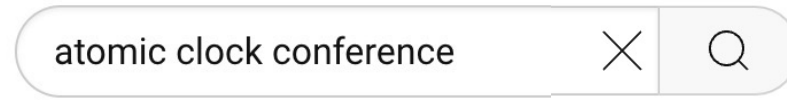
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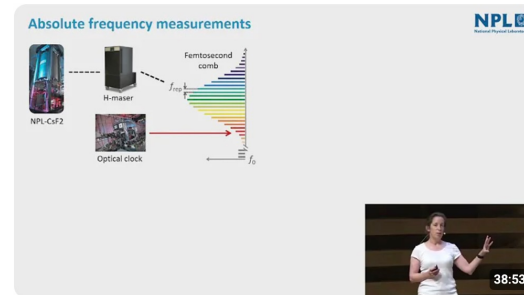
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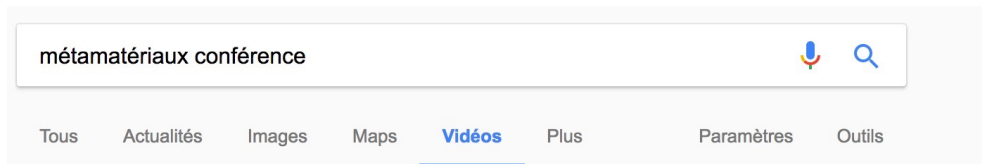


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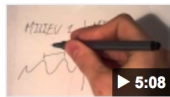
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### LEVER DE VOILE SUR L'INVISIBILITÉ

Les Conférences de l'Université de Toulon :

Animée par Monsieur Frédéric ZOLLA, Institut FRESNEL, Aix-Marseille Université.

Date de n  
Durée du  
Classific

**Frédéric Zolla**, né le 20 avril 1963 à Paris, est un professeur des universités exerçant son enseignement à l'université d'Aix-Marseille et son activité de recherche à l'Institut Fresnel<sup>1</sup>. Ses recherches dans les domaines de l'électromagnétisme et de l'optique l'ont amené à travailler sur la réalisation d'une cape d'invisibilité<sup>2,3,4,5</sup>. Il a également écrit "Foundations of Photonic Crystal Fibres" en 2005<sup>6</sup> puis une seconde édition en août 2012<sup>7</sup>. Il travaille actuellement au sein de l'équipe "ATHENA" à l'Institut Fresnel dont la thématique centrale est l'étude des problèmes électromagnétiques « structurellement complexes » par des méthodes théoriques et numériques de type générique<sup>8</sup>.

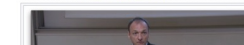
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1 Biographie  
1.1 Jeunesse  
1.2 Carrière  
2 Notes et références

Biographie [modifier | modifier le code]

Jeunesse [modifier | modifier le code]

**Frédéric Daniel Zolla** est né le 20 avril 1963 à Paris<sup>9</sup> dans l'Île-de-France.

Carrière [modifier | modifier le code]



Frédéric Zolla est un professeur des universités et également chercheur exerçant son activité de recherche à l'Institut Fresnel à

### Frédéric Zolla



Frédéric Zolla en 2007

**Nom de naissance** Frédéric Daniel Zolla

**Naissance** 20 avril 1963 (54 ans)  
Paris (France)

**Domicile** Marseille (France)

**Nationalité** Française (France)

**Domaines** Physique, Physique quantique

**Renommé pour** Cape d'invisibilité, métamatériaux<sup>1</sup>

Foundations of Photonic Crystal Fibres

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The image shows a Google Scholar search for 'Aeppli 2024 PRL'. The main search results page shows approximately 183 results. The first result is 'Clock with  $8 \times 10^{-19}$  Systematic Uncertainty' by A. Aeppli, K. Kim, W. Warfield, M.S. Safronova, and J. Ye, published in Physical Review Letters in 2024. The 'Citer' button for this article is circled in red. An arrow points from this button to a zoomed-in view of the article's citation information.

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