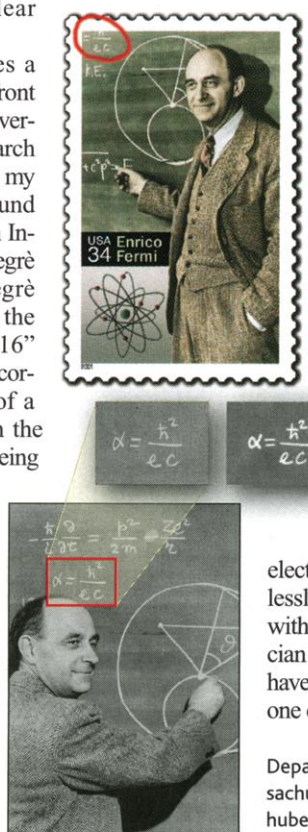
## Postage Stamp Poses a Fermi Problem

**ENRICO FERMI WAS WELL-KNOWN FOR** giving his students outrageous problems that could be tackled with insightful back-of-the-envelope estimates, but it seems that the stamp just issued by the U.S. Postal Service on 29 September (*1*) presents it own problem. The problem has to do with what Fermi wrote on the board, and you don't have to be a nuclear physicist to figure it out.

The stamp reproduces a photo of Fermi taken in front of a chalkboard at the University of Chicago on 26 March 1948. In an online search, my friend Chris Bergevin found the picture at the American Institute of Physics Emilio Segrè Visual Archives. The Segrè Archives has designated the original photo "Fermi A16" (*2*). In the upper left-hand corner of the stamp is part of a formula neatly written on the board, the full expression being out of the frame (indicated in the figure by a red circle on the stamp). A little digging with the marvelous staff at the Segrè Archives turned up another photograph, "Fermi A15" (bottom photo), taken on the same day, at the same photo shoot, probably within a minute or two of Fermi A16 (the postage-stamp photo). And, there it is—Fermi has written the definition of $\alpha$, the fine-structure constant (*3*). Well...sort of. Fermi has completely screwed it up, by interchanging the role of $\hbar$ and $e$: The expression should have read $\alpha = e^2/\hbar c$.

At first, I was reluctant to believe that Fermi, author of the 4-vertex model, maestro of the neutron, the atomic pile, and other great ideas, could have committed a blunder of this magnitude. I considered other explanations: (i) Fermi didn't write the equations on the board. Nope, it's his handwriting. I compared it with characters from his handwritten notes (*4*) (see the right-hand inset in the figure; black and white are reversed to make the comparison). (ii) His $\alpha$ is another quantity. Highly unlikely. If you work out the units—(mass × length)$^{3/2}$—they make no sense (*5*). Or (iii) Fermi was a prankster. Perhaps, but what is the joke, and is it funny?

While pondering this last alternative, I ran into a friend, a distinguished professor at the University of Chicago, and he pointed out the obvious: "Fermi was just having a bad day. Trotted out in front of the camera, his memory playing tricks on him, he simply mis-regurgitated $\alpha$. End of story. It could happen to anyone." I think my friend is right, but one doubt still nags at me: How could Fermi have remembered the correct sign on all the terms of the Schrödinger equation, but have forgotten that the fine-structure constant is basically the electromagnetic coupling? Did he seamlessly merge the fine-structure constant with $\hbar^2/2m$, the coefficient of the Laplacian in the Schrödinger equation? You'd have to be a neuroscientist to figure that one out.




**Fermi—an $\alpha$ male?** The $\alpha$ in question appears in the upper left corner of the new postage stamp (top). That Fermi wrote the expression on the blackboard seems evident from a comparison with an example from his own notebooks (middle right), shown beside the expanded view from photo Fermi A15 (bottom).

CREDIT: (TOP) U.S. POSTAL SERVICE; (BOTTOM) UNIVERSITY OF CHICAGO, COURTESY AIP EMILIO SEGRÈ VISUAL ARCHIVES

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References and Notes

1. Enrico Fermi was born on 29 September 1901.
2. http://webster.aip.org/history/esva/html/fermi_a16.html
3. Max Planck and Albert Einstein first noted that Planck's constant $h$ had the same dimensions as $e^2/c$ and roughly the same order of magnitude. The constant $\alpha$, later named and used concretely by Arnold Sommerfeld in atomic theory, is the dimensionless quantity that links the discreteness of electric charge ($e$), quantum theory ($h$), and relativity ($c$).
4. E. Fermi, *Notes on Quantum Mechanics* (Univ. of Chicago Press, Chicago, IL, 1995).
5. Multiply Fermi's expression with the square root of the true $\alpha$; the dimensions do not change, but one gets $(\hbar/c)^{3/2}$.

## A Novel Mechanism for Evolution?

**FINDINGS FROM A REPORT IN *SCIENCE* OPEN** the possibility that any genetic change that occurs in any cell at any time in the life of an organism may be inherited. In their report "Developmental changes due to long-distance movement of a homeobox fusion transcript in tomato" (13 Jul., p. 287), Minsung Kim and colleagues demonstrate that endogenous messenger RNA (mRNA) molecules not only travel between plant cells, but also execute their developmental functions within cells far removed from the original cells within which the RNAs were initially transcribed. To have found that transported RNA effects distinct phenotypic consequences—in this case, the induction of a graft-derived leaf morphology at a distant site in a host plant—the authors may indeed be justified in claiming "a new paradigm for gene expression patterns."

The promotion of mRNA from the role of an intracellular to an intercellular information conduit results in less apparent, but potentially more profound, implications for the realm of evolutionary biology. Since the 19th-century dominance of Darwinian over Lamarckian models, and their reduction in the 20th century to the concept that selection operates on mutations within the unidirectional central dogma of information transfer (DNA→RNA→protein), the influence of the potential of acquired characteristics has been minor. With the establishment that novel mRNA species can act at a distance, and the ability of viruses to reverse transcribe mRNA into DNA, mechanisms exist for the trans-

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