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LETTERS SCIENCE & SOCIETY POLICY FORUM BOOKS *ET AL.* PERSPECTIVES REVIEWS

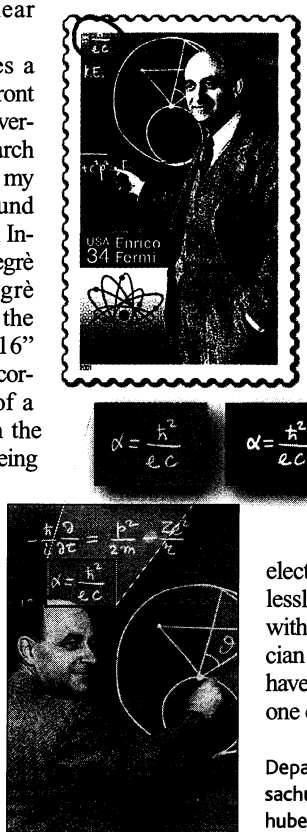
Postage Stamp Poses a Fermi Problem

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 α, 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 α 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 α. 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 α male? The α 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).

GREG HUBER
Department of Physics, University of Massachusetts, Boston, MA 02125, USA. E-mail: huber@umb.edu

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 α, 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 α; 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-

Letters to the Editor

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fer of acquired traits to the genome. When and if such an event affects germ cells, evolution might be advantaged and propelled by information gained not only by the life or death of individuals, but by the experience of those individuals.

MARK J. ADLER
Director of Experimental Oncology, San Diego Cancer Research Institute, Vista, CA 92083, USA. E-mail: mja@sdcri.org

NIH Budget Grows, but not R01 Success Rates

THE PRINCIPAL SOURCE OF U.S. FUNDING FOR biomedical research has been the National Institutes of Health (NIH) and its main mechanism, the investigator-initiated, competitive, peer-reviewed R01 project grant. Data for funding such grants in fiscal year 2000 (*1*), just prepared by NIH for the National Caucus of Basic Biomedical Science Chairs (NCBBSC), are especially pertinent because during the past 2 years the NIH budget has increased by about 30%. Table 1 reveals, however, little change in success rates of unamended new or renewal R01 applications (unamended refers to the first submission, in contrast to results after all revisions).

In FY 2000, the total number of unamended R01 applications submitted to NIH grew only minimally (3.4% more new applications submitted, 2.7% more funded; 10.6% and

SUCCESS RATES FOR UNAMENDED NIH GRANT APPLICATIONS

	New R01s			New PAs		New RFAs		Renewal R01s		
NIH Institute*	Sub.	Fund.	SR (%)	Fund.	SR (%)	Fund.	SR (%)	Sub.	Fund.	SR (%)
AA	105	18	17.1	16	34.0	8	53.3	34	10	29.4
AG	373	64	17.2	18	15.5	28	31.8	84	29	34.5
AI	818	154	18.8	36	20.2	20	45.5	240	115	47.9
AR	242	36	14.9	23	22.1	**	31.6	77	39	50.6
AT	69	21	30.4	**	16.7	8	80.0	0	0	0
CA	1512	259	17.1	64	20.8	**	60.0	73	193	51.7
DA	213	51	23.9	18	22.0	36	37.5	84	42	50.0
DC	129	35	27.1	**	43.8	**	66.7	80	39	48.8
DE	136	25	18.4	**	14.7	18	27.3	44	12	27.3
DK	690	107	15.5	14	18.2	61	20.5	276	127	46.0
ES	172	27	15.7	9	28.1	22	32.4	50	22	44.0
EY	234	63	26.9	**	20.7	**	100	167	100	59.9
GM	996	235	23.6	29	29.9	10	13.9	612	345	56.4
HD	479	78	16.3	15	21.1	38	26.8	127	60	47.2
HG	**	**	29.6	**	42.9	**	40.0	13	10	76.9
HL	1097	245	22.3	24	19.5	96	39.3	359	207	57.7
MH	550	112	20.4	19	13.7	34	19.8	139	57	41.0
NR	73	20	27.4	**	9.1	8	57.1	**	**	23.1
NS	670	168	25.1	31	26.1	34	77.3	282	132	46.8
RR	**	**	11.4	**	7.7	0	0	**	**	28.6
Total FY 2000	8620	1730	20.1	348	21.0	444	29.9	3068	1546	50.4
FY 1998†	8337	1684	20.2	232	20.4	324	24.9	2774	1354	48.8
% increase over 2 years	3.4	2.7	0	50.0	2.9	37.0	20.0	10.6	14.2	3.3

* AA, National Institute on Alcohol Abuse and Alcoholism; AG, National Institute on Aging; AI, National Institute of Allergy and Infectious Diseases; AR, National Institute of Arthritis and Musculoskeletal and Skin Diseases; AT, National Center for Complementary and Alternative Medicine; CA, National Cancer Institute; DA, National Institute on Drug Abuse; DC, National Institute on Deafness and Other Communication Disorders; DE, National Institute of Dental and Craniofacial Research; DK, National Institute of Diabetes and Digestive and Kidney Diseases; ES, National Institute of Environmental Health Sciences; EY, National Eye Institute; GM, National Institute of General Medical Sciences; HD, National Institute of Child Health and Human Development; HG, National Human Genome Research Institute; HL, National Heart, Lung and Blood Institute; MH, National Institute of Mental Health; NR, National Institute of Nursing Research; NS, National Institute of Neurological Disorders and Stroke; and RR, National Center for Research Resources. **Denotes a small number. NIH has requested deletion because of privacy concerns. † Data for FY 1998 includes R01 and R29 applications.

Table 1. Data on initially submitted (i.e., unamended), unsolicited, competing NIH grant applications: new R01, new Program Announcement (PA) and Request for Application (RFA), and renewal R01 applications, and their funding success for FY 2000, by component NIH institutes. Data for FY 1998 are shown for comparison. If an amended R01 application is reviewed by NIH within the same fiscal year as the original, as happens in some 6% of cases, the fate of only the revised version is reported, thereby raising the apparent success rate for the initial application. Sub., submitted; Fund., funded; SR, success rate.