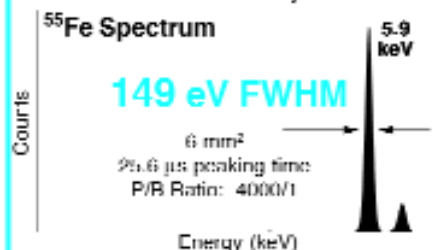


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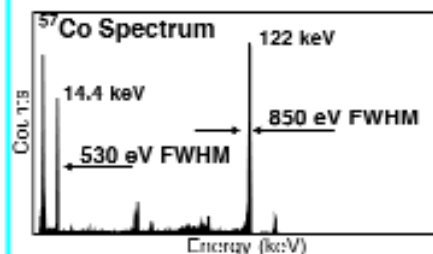
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pleased with the “derivations” we gave in our paper, derivations that used the crutches of Newtonian gravity and special relativity. In Einstein’s theory, the exact derivation using a stationary Killing vector is very simple but deemed to be beyond the comprehension of physics undergraduates. It is a scandal that, despite this year’s monumental Einstein lip service, his greatest achievement of 80 years ago, his theory of gravitation, has not become a regular part of the undergraduate physics curriculum.

David Taylor contends that clock rates do not increase with gravitational potential. We understand clock rates to be the number of ticks per second. An increased clock rate means a “blueshifted” clock. We also define the gravitational potential as increasing with distance from Earth. Thus, our clock rates increase with gravitational potential.

However, the gravitational potential introduced by Joseph Louis Lagrange was defined with the opposite sign, so that its gradient gave the acceleration. After the conservation of energy was discovered, physicists redefined the gravitational potential with the opposite sign while as-

tronomers and geophysicists often stayed with the old definition.

We are grateful to Jeremy Bernstein for pointing to the work of professor Carroll O. Alley. Unfortunately, we did not know that he had experimentally confirmed Einstein’s theory of gravitation by studying clock rates at different latitudes. In addition to the reference Bernstein quotes, a talk by Alley appears in the *Proceedings of the Thirteenth Annual Precise Time and Time Interval Application and Planning Meeting, 1982* (NASA Conference Publication 2220). Referring to that talk, Alley writes in a letter to Bernstein: “When I told the audience of physicists about the required understanding of relativistic time in the engineering of modern timekeeping systems, Eugene Wigner was so pleased that he interrupted my talk to beat his hands on the table in front of him in the European fashion!”

We do not agree with the views of Bill Shields on the history of science. Although they may be valid for a history of religion, science—unlike religion—can be tested against experiment and observation of nature. Mismatches between theory and observation are the germs for exciting new developments. To keep histori-

ans of science from discussing the truth seems absurd to us. If they discuss a flat-earth theory, are they not allowed to mention that the theory has a problem?

**Alex Harvey
Engelbert Schucking**
New York University
New York City

Pursuit Nontrivial

Thanks to Matt Landreman for his Opinion piece (PHYSICS TODAY, March 2005, page 52). I have shared his sentiments since I was a student. The one bit of condescending jargon I disliked most was, “It is obvious to the alert student that . . .” It was never obvious to this alert student. The longer I studied and read and taught, the more obvious it became that it was not obvious and usually involved many complicated steps.

Two things helped me deal with such presumptions. First, my father taught me that anything is easy when you know how, and I was determined to learn how. Second, many of my early students were mature US Army aviation warrant officers who would not let me get away with such statements. Their comment was, “I’ll

bet she can't fly a helicopter!"

May we all excise inconsiderate talk from our physics vocabulary.

Mary Ann Higgs Brown
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Troy University
Dothan, Alabama

Until I read Matt Landreman's Opinion piece, I thought the affliction he described was specific to computer scientists. When asked to explain any particular topic, a computer scientist invariably begins with "Basically, . . ." and then fills several chalkboards with detailed set-theory equations. It's good to know that physicists are also on the cutting edge when it comes to belittling the masses!

Al Friebe
(afriebe@compuserve.com)
Springfield, Virginia

Having taught physics at Swarthmore College from 1955 to 1958, I suspect I know something of Matt Landreman's experience there. I had some very good students, but unfortunately for them and me, I don't believe any of them made it to Oxford University on a Rhodes scholarship. To the litany of trivial stories I can add mine from when I took Philip Morse's Methods of Theoretical Physics course at MIT. When Morse explained how he got the answer to some problem, I complained, "That was a trick!" He replied, "A trick that works twice is a method."

Daniel Willard
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Bethesda, Maryland

I agree with the spirit of Matt Landreman's Opinion but not with all of its substance. Words such as "trivial" and "easy" are sometimes used in a patronizing manner, but I think they are more often intended in the spirit of a hint. If an author tells me that a derivation is "easy," I take it to mean that if I get bogged down in some messy equations I am probably doing it wrong and should back up and try again. That hint can save me from flailing away needlessly on the wrong path. I would urge that such adjectives be used with discretion and care rather than eliminated altogether.

Rio Beckwith
(rvbeckwith@compuserve.com)
El Segundo, California

Landreman replies: The use of "easy" and its synonyms described by Rio Beckwith is indeed a

Albert Einstein to George Ellery Hale¹

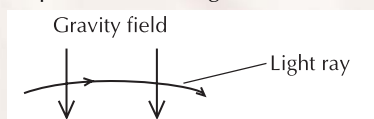


Translated and annotated by Bertram Schwarzschild
Einstein writes to Hale (1868–1938), director of the Mount Wilson Observatory near Los Angeles, seeking advice about the observability of the gravitational bending of light he had recently deduced from the equivalence principle.² Einstein's 1913 prediction is only half the deflection predicted by the full general theory of relativity, completed two years later.

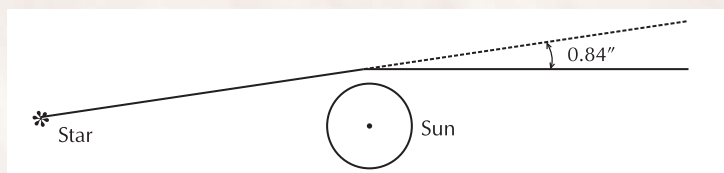
Zurich, 14 October 1913

Highly honored colleague,

A simple theoretical consideration makes it plausible to assume that light rays in a gravitational field experience bending.



At the edge of the Sun, the total deviation should be 0.84 arcseconds, and it should fall off like $1/R$ (R being the ray's [closest] distance from the Sun's center).



It would therefore be of the greatest interest to know how close to the Sun fixed stars could be seen *in daylight* with the strongest magnification.

On the advice of my colleague, Professor [Julius] Maurer, I therefore ask you to let me know what you—with your rich experience in these things—take to be achievable with the best modern instruments.

Yours very respectfully,

A. Einstein

Technische Hochschule Zürich

Hale responded that "there is no possibility of detecting the effect in full sunlight." But he did pronounce the alternative of exploiting a solar eclipse "very promising."³

The rest of the story has become Einstein lore: A German team set out to measure the effect in Russia during an upcoming 1914 eclipse. But the outbreak of war intervened. In a sense, that was fortunate, because the team would have been comparing the measurement with Einstein's first, incorrect prediction. By the time Arthur Eddington's eclipse expedition set out in 1919, the predicted effect had doubled and the war was over. Eddington's confirmation of the general-relativistic bending of light, albeit with a large observational uncertainty, made Einstein instantaneously famous.

References

1. *The Collected Papers of Albert Einstein*, vol. 5, M. J. Klein, A. J. Fox, R. Schulmann, eds., Princeton U. Press, Princeton, NJ (1993), p. 559.
2. A. Einstein, proceedings of *Schweizerische Naturforschende Gesellschaft* **96**, part 2, 137 (1913), in *The Collected Papers of Albert Einstein*, vol. 4, M. J. Klein, A. J. Fox, J. Renn, R. Schulmann, eds., Princeton U. Press, Princeton, NJ (1995), p. 475.
3. *The Collected Papers of Albert Einstein*, vol. 5, M. J. Klein, A. J. Fox, R. Schulmann, eds., Princeton U. Press, Princeton, NJ (1993), p. 566.

standard one. We utter these words to convey that a calculation is not analytically impossible, that it does not require the years of monastic toil required to prove the Last Theorem of Fermat, or that the solution is immediately comprehended by the speaker—who, unlike his audience, has regularly thought about the topic for the past 10 years. But the

English language provides other words that more aptly express what we mean: "possible," "feasible," "soluble," "practicable." There is nothing inherently wrong with an instructor's hinting that a student's derivation involving 17-term expressions and elliptic integrals is probably going awry. However, you can be a much more effective communicator