Feynman's Dining Hall Dynamics

Benjamin Fong Chao

Citation: Physics Today **42**, 2, 15 (1989); doi: 10.1063/1.2810900
View online: http://dx.doi.org/10.1063/1.2810900
View Table of Contents: http://physicstoday.scitation.org/toc/pto/42/2
Published by the American Institute of Physics

memorials. Beyond a doubt some of these will be the sorts of things that Feynman himself would have found inappropriate. We would like to make a suggestion for a form of memorial project that an organization such as APS could easily undertake and that would have a lasting impact.

We suggest that all the extant videotapes of Feynman lecturing be gathered together, transcribed to a modern format and distributed. Surely many physicists and teachers would, like us, be delighted to have "The Character of Physical Law" and other classics available for our classes and for our own use. What better way to honor one of the greatest teachers of our time?

PHILIP NELSON
Boston University
Boston, Massachusetts
SIDNEY COLEMAN
Harvard University
Cambridge, Massachusetts
6/88

Feynman's Dining Hall Dynamics

Richard Feynman's adventurous autobiography *"Surely You're Joking, Mr. Feynman!"* (Norton, New York, 1985) is one of the books I enjoyed most in recent years. In it is this story: "I was in the [Cornell] cafeteria and some guy, fooling around, throws a plate in the air. As the plate went up in the air I saw it wobble, and I noticed the red medallion of Cornell on the plate going around. It was pretty obvious to me that the medallion went around faster than the wobbling.... I started to figure out the motion of the rotating plate. I discovered that when the angle is very slight, the medallion rotates twice as fast as the wobble rate—two to one. It came out of a complicated equation!" He then tried to look at this in a more fundamental way. "I don't remember how I did it, but I ultimately worked out what the motion of the mass particles is, and how all the accelerations balance to make it come out two to one." He showed this to Hans Bethe, who remained unimpressed. But this eventually rekindled his love for "playing" with physics, and "the diagrams and the whole business that I got the Nobel Prize for came from that piddling around with the wobbling plate."

Great story, except for one little twist: A torque-free plate *wobbles* twice as fast as it *spins* when the wobble angle is slight. The ratio of spin to wobble rates is 1:2, not 2:1!

Being less adventurous, I can only present the reasoning in a conventional manner—through the principle of angular momentum conservation. There are a number of ways to do this.[1] The simplest is perhaps to solve Euler's equation for an axial-symmetric rigid body (a "top") in the body reference frame. Let the top's three principal moments of inertia be A, A and C, where $C \neq A$ so that rotation about the figure axis is stable and a wobble is possible. For small wobble angles, the solution to Euler's equation gives the wobble rate $\omega = f\Omega$, where $f \equiv (C - A)/A$ and Ω is the spin rate. The value of f is always between -1 and 1, approaching -1 for a slender cylinder (a "rod," for which $C = 0$) and 1 for a thin circular disk (a "plate," for which $C = 2A$). For a slightly oblate spheroid (such as the Earth or a neutron star), f is slightly larger than 0 and the wobble is very slow compared with the spin. In any case, we have $-\Omega \leq \omega \leq \Omega$.

But this is as seen from the body frame, which is rotating. In the inertial frame (where Feynman looks on as the Cornell plate goes up in the air) the wobble rate is $\omega_0 = \omega + \Omega$, so that $0 \leq \omega_0 \leq 2\Omega$. For a rod, $\omega_0 = 0$ (it does not wobble); for the Earth, ω_0 is slightly faster than one cycle every 24 hours. And for our plate, $\omega_0 = 2\Omega$: The spin-to-wobble ratio is 1:2.

"Surely You're Joking, Mr. Feynman!" has little to do with physics *per se*, and the above story is one of the few mentions in the book about specific physics. Whether the error is a mere slip in memory, or, in keeping with the spirit of the author and the book, another practical joke meant for those who do physics without experimenting, we do not know and perhaps never will. One thing is certain, though: This story appears on page 157 of the book and the text is 314 pages long; and we all know that the ratio of 157 to 314 is 1:2!

Reference

1. L. D. Landau, E. M. Lifshitz, *Mechanics*, 3rd ed., Pergamon, Oxford (1976).

BENJAMIN FONG CHAO
NASA Goddard Space Flight Center
Greenbelt, Maryland
3/88

Inflation Reputation Reparation

In the first editions of my book *A Brief History of Time* (Bantam Books, New York, 1988 [reviewed in PHYSICS TODAY, November, page 115]) I stated that I had mentioned Andrei Linde's idea of a slow rolldown in the infla-

continued on page 123