all non-accelerating (that is, inertial) frames.

▶ The vacuum speed of light, c, is the same for all inertial frames.

▶ The total energy E of a body of mass m and momentum p is given by $E = \sqrt{m^2c^4 + p^2c^2}$. In particular, the energy of a body measured in its own rest frame is given by $E = mc^2$, and the energy of a massless body is $E = pc$.

Collectively, these laws should, in my opinion, be called Einstein's laws of special relativity. Others may prefer slightly different wording, or more lawyerly definitions; with that I have no quibble. Time dilation, length contraction, and the relativity of simultaneity could be considered corollaries of these laws.

Some may ask what is the consequence of renaming a "theory" to a "law"; obviously Nature does not care. To my way of thinking a theory is speculation based on incomplete knowledge, and a law is valid in all cases where the appropriate circumstances apply. I believe that the special theory of relativity falls into the latter category equally with Newton's laws, Coulomb's law, or Faraday's law. If nothing else, this change would help us impress upon students and nonscientists (a) the importance of special relativity to our understanding of nature and (b) the multitude of advances in science made possible as a consequence of its formulation.

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Nuclear power's costs and perils

In "Stronger Future for Nuclear Power" (PHYSICS TODAY, February 2006, page 19), Paul Guinnessy surveys plans for refurbishing, expanding, and building new civilian nuclear power reactor facilities in numerous countries. In the US, passage of the 2005 energy bill marks the federal government's readiness to put the national credit card behind the nuclear industry. Tax credits worth \$3.1 billion and the renewal of legislation mandating that the US taxpayer assume all corporate nuclear liability in excess of about \$9.3 billion[1] represent a nice vote of confidence.

Some observers attribute these ambitious plans, after 25 years of drought in investment in nuclear power, to a gradual dissipation of the fear that followed the 1979 Three Mile Island accident. Arguably the more important factor in the drought was that when all costs are accounted, nuclear energy is not cost-competitive with fossil energy.

The reason that well-informed and intelligent people are still talking about Three Mile Island emerges clearly from two major new scholarly works published in 2004. The first, by J. Samuel Walker,[2] was sponsored by the US Nuclear Regulatory Commission. The authors of the second book, Bonnie A. Osif, Anthony J. Baratta, and Thomas W. Conkling,[3] chose the 25th anniversary of the accident as an occasion to evaluate its impact.

Both books describe the TMI accident as a watershed event. The story of how that accident happened—how it could possibly have happened—emerges not so much as a technological who-done-it as a loss of the public's confidence in the people who own, operate, regulate, and oversee the nuclear power enterprise.

Woven throughout the technical details is the unmistakable thread of facts manipulated and people misinformed. The 1979 *Report of the President's Commission on the Accident at Three Mile Island* documents that what the technical people knew minute by minute had been concealed from the media and public officials. Repeated assurances of "no danger," continued even after TMI station manager Gary Miller had declared a "general emergency," which includes in its official definition "the potential for serious radiological consequences to the health and safety of the general public."

Osif and coauthors remind us that before the accident, the nuclear industry believed it had designed "accident-proof plants . . . thanks to the many safety features engineered into each reactor" (page 32). Now, 25 years later, as those same assurances are being repeated, perhaps they are losing credibility.

What went wrong at TMI was not primarily a technology fiasco but a character flaw in management and regulation. Lessons learned from the technical failings may well have led to some technical improvements. However, one could easily suspect that the character flaw is intrinsic to the political–industrial complex; consider, for example, the sequence last year that started with the coal-mining industry's lobbying for and obtaining a lowering of national safety standards and ended with the needless deaths of 17 coal miners.

The TMI accident happened not because a pump failed, but because the management—staffing, training, maintenance, and a sense of public responsibility—failed. For more than two hours on 28 March 1979, reserve coolant injection that could have saved the plant from a major catastrophe was manually throttled because the problem was misdiagnosed. And two of the technical failures leading to the accident—the stuck pressure relief valve and the clogged polisher—had occurred before and had not been properly addressed. Even with the redesign of the failed gadgets, TMI remains an icon of a profit-driven industry cutting corners.

One would expect that the decision to give unparalleled government subsidy to the nuclear power industry would be made after public discussion and input from the best scientific and technical authorities in the country. Instead, decisions have been made in a political setting. Even the possible future directions for nuclear power generation were chosen in a casual and cavalier way. As far as anyone not on the inside knows, no one was invited to the Vice President's Energy Task Force in 2002 who might have supported funding for development of Carlo Rubbia's thorium reactor.[4]

Walker recognizes in his book that the Nuclear Regulatory Commission has tried hard to improve its regulatory function. (See a review of Walker's book in PHYSICS TODAY, February 2005, page 63.) However, TMI continues to be discussed because we have not yet come to terms with the fact that it was allowed to happen.

Rather than disparage those who raise concerns about nuclear safety, physics educators might try to present students with facts not colored by free teaching materials paid for by those with a financial interest in biasing materials used in schools.

The lay public is not as stupid as some experts would have us believe. For one thing, there are out there in America some 2500 young adults who have an appreciation for the complexities of nuclear power, which they gained in a physics unit at Huron High School in Ann Arbor, Michigan.[5] In that unit they learned to think for themselves, to shy away from a decision to be simplistically for or against nuclear energy, and to apply knowledge about how a reactor works, from control rods, primary coolant, and emergency core cooling system, to pressurization, relief valves, and loss-of-coolant conditions.

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5. See course materials in W. Scheider, *A Serious but Not Ponderous Book About Nuclear Energy,* Cavendish Press, Ann Arbor, MI (2001).

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In light of Edwin Karlow's letter supporting nuclear power (PHYSICS TODAY, February 2006, page 11) and the article "Stronger Future for Nuclear Power" in that same issue (page 19), I would like to remind readers of the many reasons why nuclear power is a bad idea.

Nuclear power is not economically viable. Karlow explains the subsidies that the nuclear power industry needed in the past and pleads for continued subsidies in the future. Contrary to the early promise that nuclear power would be so cheap we would not need electric meters, nuclear power is very expensive. The main reason is that it is so dangerous; expensive safeguards must be attempted.

The risk of a catastrophic accident persists. Nuclear power plants are built and run by humans, who make mistakes and who can be pressured into making decisions that put profit above safety. And the same government that took care of us after Hurricane Katrina will assume responsibility for us after a nuclear accident.

Nuclear power plants are possible terrorist targets. A dedicated attack against a nuclear plant could not be prevented, and the highly radioactive spent fuel is poorly contained in many plants and is particularly open to attack.

The waste disposal problem is not solvable in the near future. The politically chosen Yucca Mountain disposal site is nowhere near opening, precisely because of its geological problems, and because of local opposition. So spent fuel will continue to pile up around the country, producing increasingly dangerous sources of radioactive materials vulnerable to human error, accident, and attack.

Current nuclear plants are being operated unsafely. The Nuclear Regulatory Commission is lax in its supervision of those plants. The NRC does not have workable evacuation plans for many power plants, including the Indian Point plant just upwind of New York City and the oldest plant in the country, in Oyster Creek, New Jersey. Fire safety problems have not been addressed. Routine operation of nuclear plants results in planned and unplanned releases of radioactivity, and there is no safe level of radiation exposure. The procedures for extending the life of unsafe reactors do not allow meaningful public input.

The most important reason why nuclear power is a bad idea is that it results in nuclear weapons proliferation. A fuel-processing plant for a standard 1000-MW reactor could produce enough uranium for between 10 and 30 uranium weapons per year. Its waste reprocessing plant could produce enough plutonium for 30 plutonium weapons per year. It is no accident that Iran and Venezuela, nations awash in oil, are pursuing nuclear power. India and Pakistan received nuclear fuel and technical help from other countries to develop nuclear power, and took advantage of this opportunity to make nuclear weapons. And the material can find its way into the hands of terrorists. Even a small nuclear attack or a small war between newly nuclear states would be devastating to humanity. Having invented nuclear weapons, we physicists have a moral responsibility to do everything we can to lower the probability of their use.

I am a climatology professor doing research on global warming. In my opinion, we must reduce our greenhouse gas emissions to mitigate future negative consequences to the climate. But nuclear power is not the answer.

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Atoms and quarks, two 20th-century revolutions

One aspect of Albert Einstein's heritage seems to have been overlooked in the many centenary celebrations of his annus mirabilis. The 20th century began with the confirmation of the revolutionary finding that matter was not continuous but made of atoms and molecules. It ended with a second revolutionary finding that matter is made of even tinier objects called quarks. The similarity between the two revolutions has been missed. Einstein played a crucial role in the first. A number of physi-