continued from page 15
sumes an average temperature and then shows the resulting volumetric change in the event of an increase of 1 °C to that average temperature. I chose the height of the shell, 300 miles, or 480 km, because that is typical for many satellites. I have *never* mentioned "satellite-based measurements." I have, however, looked at descriptions of the atmosphere issued by NASA ("US Standard Atmosphere Supplements," 1966 and 1977) and asked if present or future measurements, made under appropriate conditions, could be compared with them. I do hope that the accompanying letters are not implicitly suggesting that the NASA documents are valueless and such a comparison would be of no use. That would be asserting that a very large committee made a terrible mistake and compounded it 11 years later.

What these two letters say is that for a more nearly accurate calculation three shells with three mean temperatures should be considered. As these kind researchers are very familiar with the models they cite, it would be most considerate of them to make what they consider to be correct calculations. As they have more confidence in their models than in the one I created, they might view the task as a straightforward step. They could state the temperatures they assume in the respective zones and use either the ideal-gas law or "corrected" laws as they see appropriate to arrive at results that can be compared with the 1.488-km expansion that my first-approximation model predicts. Perhaps their intermediate-zone calculations would give useful predictions that could be compared with measured data. Thus they could make an immediate and positive contribution to our understanding of a serious problem that potentially threatens our coastal cities. I respectfully submit this as a serious request.

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Was Nazi Know-how Enough for an A-Bomb?

I found Irving Klotz's analysis (October 1993, page 11) of the state of knowledge of the German atomic energy project, as revealed by the Farm Hall documents, to be fascinating. Lothar Nordheim and I, in 1945, examined the German documents that had been captured by the Alsos mission. We concluded that the German understanding of chain reactions moderated by D_2O was equal to ours as far as the lattice spacing and critical size were concerned. However, we missed the fact that the Germans were unaware of the delayed neutrons, which of course determine the kinetics of a slightly supercritical reactor.

I was particularly interested in the Farm Hall discussion of a protactinium bomb, since, around 1943, I had discussed with Fermi the possibility of using protactinium in a bomb. Fermi regarded the idea as farfetched but did concede that if we were short of plutonium, a small amount of protactinium might be used to bring the total fissile mass up to what was needed for the first bomb.

Finally, some of what Klotz quotes appeared in General Leslie Groves's *Now It Can Be Told* (Harper, 1962; Da Capo paperback, 1983). Groves also includes the following excerpt from the Farm Hall discussions:

> *[Carl-Friedrich von] Weizsäcker*: We didn't do it . . . because all the physicists didn't want to do it on principle. If we had all wanted Germany to win the war we could have succeeded.
> *[Otto] Hahn*: I don't believe that, but I am thankful we didn't succeed.

Heisenberg's statement "Quite honestly I have never worked it out [the critical mass of a bomb]" proves that the German scientists did not take nuclear bombs seriously.

ALVIN M. WEINBERG
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Based on Irving Klotz's list of transcribed Farm Hall statements many readers might accept at face value his conclusion that the Germans knew little of the A-bomb. However, knowledge of certain technical details, at least with regard to the actinide element protactinium, which was mentioned in many of the technical statements, can lead to diametrically opposite conclusions.

Far from being indicative of the Germans' ignorance of A-bomb matters, their repeated references to protactinium in fact display a surprising degree of awareness of the practical aspects of procuring approximately correct quantities of the only naturally occurring element that has a fast fission cross section in the 1.5-barn range,[1] which is about the same as that of plutonium-239.

Protactinium's very low mineralogical abundance—about the same as radium's—is undoubtedly what made the Germans reluctant to believe American claims of an A-bomb. Their obvious ignorance of the nuclear properties of plutonium-239 and uranium-235, on the other hand, was probably due to the former's total absence from the mineral world and the latter's unavailability in an isotopically pure form (in constrast to protactinium, which is 100% isotope 231).

In those early days of the nuclear age protactinium represented a relatively low-tech, albeit long-shot, route to nuclear weapons materials acquisition. Today the vastly increased scale of the worldwide uranium mining industry makes milling plant tailings a practical source of protactinium—either for direct bomb use or as a starter for a fast breeder reactor for production of plutonium-239 or uranium-233. Someone like Saddam Hussein might discover one of these days that the protactinium route is the one that requires the least amount of restricted technology imports. If we misunderstand the meaning of the Farm Hall statements, we may yet pay a dear price for it.

Reference

1. D. I. Garber, R. R. Kinsey, *Neutron Cross Sections, Vol. II: Curves*, 3rd ed., BNL-325, Brookhaven Natl. Lab., Upton, N. Y. (1976). M. Srinivasan *et al.*, Nucl. Sci. Eng., July 1989, p. 295.

JAROSLAV FRANTA
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I would like to contribute to the discussion of the "secrets" of the atomic bomb.

In 1942 or '43, I was in Warsaw, Poland. I remember some of the physics lectures of Mieczyslaw Wolfke, a professor at the technical university I was attending. During one of them he explained the excess mass of low-atomic-number and high-atomic-number elements, and the minimum in between. He quickly mentioned that division of the high-atomic-number elements would result in conversion of mass to large amounts of energy and that studies of this effect were in progress before the war. He also said that if there had been more progress we would not have had the difficulties we were then experiencing (meaning that we would not have lost the September 1939 campaign and would not be occupied by Germany).

After the August 1944 insurrection in Warsaw, I ended up in a POW camp (Stalag 4B Muhlberg/Elbe) in Germany. Among the inmates in the barrack I was in were Leonard Sosnowski, who had been a professor at the University of Warsaw, and a couple of his clandestine students. For

those willing, he conducted a physics course. This was difficult—neither he nor we had books or paper. However, using his memory he did well.

In January 1945, using estimates of the neutron capture cross section of ^{235}U, he ended up estimating the size of a possible A-bomb to be between that of a soccer ball and a sphere 3 feet in diameter, depending on how pure the ^{235}U was. He also mentioned that obtaining pure ^{235}U would require a large amount of energy, and facilities that Germany was not capable of obtaining and only the US could procure.

In view of this, I cannot believe the German physics community was as ignorant as the published data seem to indicate.

BOGUSLAW FRACKIEWICZ
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A Literary Ancestor of Lorenz's Butterfly

On reading David Ruelle's article "Where Can One Hope to Profitably Apply the Ideas of Chaos?" (July, page 24) I was reminded of a short story, first published in 1911, by Arthur Schnitzler, the well-known Viennese author. In this story[1] a butterfly causes havoc and universal disaster, thus antedating the chaos-inducing butterfly of Edward Lorenz by nearly seven decades! The relevant part of the plot is roughly this:

A mountain spirit warns a hiker against crossing an alpine meadow, lest his home country encounter severe hardship. Disregarding the warning, the hiker proceeds and is reprimanded by the spirit: The hiker has disturbed a butterfly, which will fly agitatedly for many miles until it enters the royal park. From the eggs it will lay, a caterpillar will hatch that in turn will frighten the queen so much that she will give birth to a dead child. In the absence of an heir, the wicked brother of the king will ascend to the throne. The despotic new king will oppress his people and eventually will bring war and untold misery upon his country.

Reference

1. A. Schnitzler, "Die dreifache Warnung," in *Doktor Gräsler, Badearzt und andere Erzählungen*, Fischer Taschenbuch Verlag, Frankfurt am Main, Germany (1981).

PETER NAVÉ
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[*Editors' note:* Another example of a butterfly changing history occurs in the classic time-travel short story "A Sound of Thunder," by Ray Bradbury.]

Iran's Absentee Olympiad Awards

Barbara Goss Levi's article "The 1993 International Physics Olympiad" (September 1993, page 40) presented an interesting account of the origins and procedures of the event. But it was a bit of a surprise that the article contained no reference to Iran's absence from the gathering and the subsequent unofficial awarding of a gold and a bronze medal to members of the Iranian team.

The seven-member team, composed of top Iranian high school physics students, was kindly invited by the organizing committee to participate in the XXIV International Physics Olympiad. However, the embassy of the United States in Rome refused to grant the team visas, despite a formal request from the organizing committee.

The team thus was unable to participate in this international gathering, the purpose of which is to build friendships around a common interest in physics. The attempt to restrict the exchange of scientific knowledge between scientists of the world is as unprincipled as it is futile.

The action of the American authorities came as a shock to academic circles inside the country and abroad. Following an exchange of letters between officials of the Iranian team and the olympiad organizing committee on the circumstances that caused the team members' absence from the event, the organizing committee arranged for the theoretical part of the exam to be given in our country. Based on extrapolation of the theoretical exam performance to the total exam score and comparison with the official olympiad scores, the Iranian team unofficially won a gold and a bronze medal in this competition.

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The Hard Work of Seeking a Physics Job

On 10 June 1994, they called my name in front of 40 000 spectators and I was awarded my doctoral hood. I had achieved the highest of academic degrees. I was then, and remain, unemployed.

I got my degree from Ohio State University. My dissertation was a hybrid of magnetic materials, crystallography and organic chemistry. On my resumé I have a short list of the usual awards and scholarships and a patent. I did two stints of research at Du Pont—one summer at their experimental station and a two-year part-time project at a production facility. My grades were mediocre overall, but I guess the list of classes I subjected myself to is impressive. In summary, I am Joe Blow, PhD physicist, with little to separate me out of the pack. Hence my present situation.

For my job search I have moved in with relatives and am living a somewhat spartan lifestyle. In an average week I run 10–12 miles, lift a few weights and spend some time working on a '69 Chevy that needs it. I read a lot: novels that were too big to read in grad school (*Atlas Shrugged*, *Gone with the Wind*), professional self-help books (*A PhD Is Not Enough*, *Seven Habits of Highly Successful People*, *Sharkproof*) and lots and lots of trade journals. And I jump through the hoops of a job search.

What are those hoops? I average something over ten units a week, where a unit is one of three things: a letter to a personal contact who knows either me or the person who referred me well, two replies to advertisements for jobs that I am both qualified for and interested in, or ten unsolicited resumés to carefully selected individuals at appropriate companies. I spend most of my time researching individuals and companies and making phone calls. As of 14 September I've been doing this for ten weeks, and it has netted me 12 companies that, on some time scale, are interested in talking with me. I have a grocery sack full of rejections. My hit rate is about 1:10 for contacts, 1:20 for ads and 1:50 for the carefully selected individuals. The time for a hit to appear varies from a couple weeks to a couple months, which explains why the number of hits doesn't follow mathematically from the rates and the amount of time I have spent on my search.

These hits have resulted in three screening-type interviews and one full-day, this-is-it interview. Several of the other hits should develop into full-day interviews sometime in the future. I may receive a job offer (pleasepleaseplease) as a result of the one full-day interview so far. If I do, it will have a salary slightly less than the average reported by the university placement office and APS, but much more than I need. The job also has