continued from page 15

aggression and the enslavement of more states? If we weaken ourselves, will the Russians follow suit? Have they ever? What do the Russians themselves say about their purposes for arming? Is it just for defense of the homeland? For socialist imperialism? Does Russian Marxism–Leninism in fact hold that conflict, including war, with capitalistic countries is inevitable?

Delta-factor. With great erudition and arithmetic detail, authors have calculated what might happen in various military or confrontational scenarios. However, they all seem to omit an important factor, a factor so incredibly small and preposterous that it would deserve instant disbelief were it not so repeatedly found in military conflict. This factor is the probability, call it δ, that people or events in a war, a battle or even a skirmish will actually go as planned. Allowance for this factor is therefore of the utmost importance in deciding how much munitions or how many troops are enough. Extreme danger occurs when planners unconsciously assume the factor to be of the order of 1.

Examples, incredible examples, of small delta abound. We need only mention two. For those sentient in the 1940s, the Pearl Harbor debacle jumps to mind as a classic case with $\delta \ll 1$. In brief (and vastly oversimplified), Washington, having knowledge, did not clearly and effectively inform the Hawaii commanders that war was imminent. (In fact, an army message was sent by Western Union! It arrived a few hours after the attack was over.) The military was, in any case, not prepared. In fact, it was unbelievably, inconceivably unprepared and complacent. Finally, what local warning military leaders did have, to wit radar and sub contacts, were ignored.

More appropriate as an analogy (not an identity) to present missile reliability was the Navy experience with torpedoes in the Pacific in early World War II. In short, they didn't work. And submarine commanders who reported that fact or who altered the torpedoes so they would work were summarily relieved of command. Great loss of life in the submarines and in the torpedo bombers (and consequently to Americans generally) ensued. Again $\delta \ll 1$.

In ballistic missiles and multiply targeted re-entry vehicles together with their launching and control devices, we have an enormously more complicated munition, (I hope forever) untested in combat. This weapon system is properly under very tight control. But tight control also inevitably decreases δ. (There is an apocryphal story of an ammunition sergeant at Hickam Air Field in Hawaii, 7 December 1941, under actual Japanese air attack, who refused to release anti-aircraft ammunition without proper authorization.) The strategic nuclear stakes are the highest possible—civilization itself—again leading properly to caution, but also perhaps to indecision, consequently to a yet smaller δ. What then is δ for this entire weapon system? For example, if δ is even as large as 0.05 then a ten times "overkill" in vehicles calculated on target is not sufficient. Calculation-on-target is itself a smaller number than the vehicles available before conflict in the US, and a much smaller number after a first strike against us. What if $\delta < 0.01$? What if $\delta \ll 0.01$? Unfortunately the delta factor includes such imponderables as errors, stupidity, ignorance, unexpected contingencies, military rigidity, peacetime attitudes, battle confusion, inaction in novel stressful situations, and hesitancy, not to mention poor, ambiguous or absent communication.

So estimates of δ are both difficult and unreliable—extremely so. But for truly realistic planning for peace it appears essential, absolutely essential, to estimate and conservatively allow for δ.

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3/84

PT as recruiting device

I thought that some of your readers at academic institutions might be interested in a use we at George Mason University have found for old issues of PHYSICS TODAY. We have placed a large display poster, using PHYSICS TODAY covers to illustrate numerous reasons students might want to major in physics, in the front lobby of the physics building. Students can often be found reading the poster, which is probably an effective and inexpensive recruiting device.

ROBERT EHRLICH
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2/84

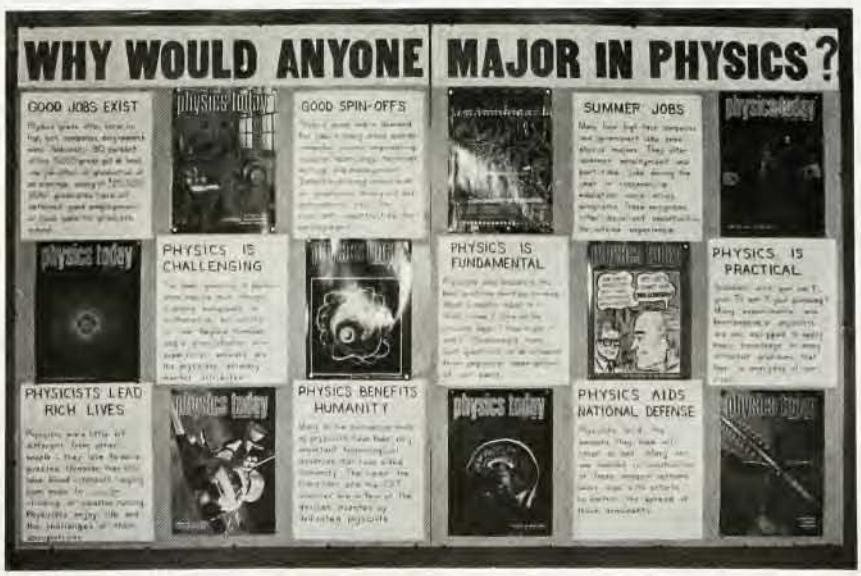
Early days in heavy elements

Commenting on C. P. Snow's *The Physicists*, Ruth Sime (December, page 84) remarks that nobody "saw through" (Snow's phrase) the problem of interpreting Fermi's experiments on uranium bombarded with neutrons. There is danger of forgetting that Ida Noddack did "see through" it, but was ignored.

Fermi[1] reported that the bombardment produced several β-active nuclear species, including one with a halflife of 13 minutes. Chemical procedures that resulted in precipitation of this species did not have a similar result when applied to known elements near the end of the periodic table. Fermi concluded that the investigation "suggests the possibility that the atomic number" of the 13-minute β-rayer "may be greater than 92." That interpretation was widely accepted.

Noddack,[2] however, having repeated Fermi's chemical manipulations and having found that many elements could by that process be carried down in the precipitate, asserted that Fermi's line of reasoning was not convincing. Instead (my translation),

> One can just as well suppose that, in these new kinds of nucleus-smashing by neutrons, "nuclear reactions" take place that are significantly different from those observed up to now in the action of



protons and alpha rays on atomic nuclei. In the last-named irradiations one finds only nuclear transformations involving release of electrons, protons and helium nuclei, whereby in the case of heavy elements the mass of the irradiated nucleus is changed only a little, so that near-neighboring elements come into being. It would be thinkable that in the case of bombardment of heavy nuclei with neutrons, these nuclei disintegrate in several rather *large* [Noddack's emphasis] fragments, which are no doubt isotopes of known elements, but are not neighbors of the irradiated elements.

She was not taken seriously,[3] and the identification of fission was postponed for five years.[4]

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1. E. Fermi, Nature **133**, 898 (1934).
2. I. Noddack, Angew. Chem. **47**, 653 (1934).
3. I. Noddack, Naturwissenschaften **27**, 212 (1939).
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JOHN MCCUE

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2/84

THE AUTHOR COMMENTS: It is true that Ida Noddack's idea of nuclear disintegration was ignored. But Noddack herself did not perform any further experiments to support her speculation, even though as co-discoverer of the element rhenium she was in a good position to investigate the chemistry of the supposed element 93, at the time presumed to be a higher homologue of Re. Possibly she was not taken seriously because in 1925 she and her husband claimed to have discovered element 43, but their findings could never be verified.[1] Noddack's suggestion thus remains a curiosity in the history of physics—more a premonition that came true than a scientific accomplishment. In his review article,[2] L. A Turner commented,

> If [Noddack's] early suggestion of what has turned out to be the correct explanation was anything more than speculation it is regrettable that the reasons for its being considered plausible were not more fully developed. It seems to have been offered more by way of pointing out a lack of rigor in the argument for the existence of element 93 than as a serious explanation of the observations. . . . It seems to have had no influence on the subsequent course of events.

References

1. Fritz Krafft, *Im Schatten der Sensation, Leben und Wirken von Fritz Strassmann*, Verlag Chemie, Weinheim (1981), page 316.
2. L. A. Turner, *Rev Mod Phys* **12**, 1-29 (1940).

RUTH L. SIME

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3/84

Rewards for students

Allen Rothwarf (March, page 142) identifies the crisis in education to be that we "expect children to do what no adult would do . . . work hard for no payment." I am sure he means *immediate payment in money*. Many adults do their hardest work in early years, learning, founding businesses, investing in themselves, toward the prospect of future rewards of only estimated probability. Rothwarf seems also to confuse rewards with money, which, while absolutely necessary at some level, is often not the major incentive compared to those of intellectual satisfaction, discovery and peer recognition. What led Rothwarf to Drexel rather than to General Motors?

I must suppose that there are children who will respond to "hard subjects" in response to the carrot of a bicycle or $50. For those who would, and otherwise would not, there's no place on my staff.

HENRY ERNST SOSTMAN

Yellow Springs Instrument Co., Inc.

Yellow Springs, Ohio

4/84

Mediterranean summer

Last summer, while sailing among the islands off the Mediterranean coast of France, my wife and I came across a sloop named *Phys Rev*. This seemed odd, so we went over and discovered that its owners are both physicists for whom the *Physical Review* has the status of an icon, hence a logical name for their boat. Since there are French boats with names like *Oesophage Boogie* and *Credit Agricole* around (not to mention American boats with names like *Katrinka Finklesplatt*), this seems an unusually reasonable choice these days.

ARTHUR BEISER

Le Brusc, France

Pledge against nuclear arms

It is heartening to see, in recent issues of PHYSICS TODAY and other publications, that more members of the scientific community are slowly opening their eyes to the ever-increasing threat from nuclear weaponry. It is high time that we of the scientific community come out of the thick shells of elitism with which we have long covered ourselves. In our view, most scientists in nonsocialist countries can today be broadly divided into two types: those who either lock themselves away in their labs or become grossly obsessed in their intellect as contained on a chalkboard, and those who are more than happy to indulge in "corporate prostitution" and sell themselves as a commodity without stopping for a moment to think about the socio-economic motives and influence of their employers. In both cases, we consciously or unconsciously push our social responsibilities under the rug. We are oblivious as to whether our work is irrelevent or even harmful to the masses. If we believe that our work is universal and are aware that the consequences of our work can lead toward destructive ends, then we must acknowledge our obligation to all people without regard to national or political boundaries.

We conclude that there is not a lot we can do, given the present socio-political morass in which we are embedded. Since this very situation ultimately directs scientific activities, however, we should take a clear and conspicuous stand on relevant issues and try to influence political decisions. This thesis can be easily applied to the case of nuclear arms, which most of us, we hope, consider an urgent and pressing issue. Though the governments of various countries are to blame for the monstrous nuclear calamity facing us today, we scientists are guilty of perpetuating the nuclear threat. After all, we are the ones who actually carry out the sinister projects for our governments. We, then, can do far more than sign petitions that do not seem to take us anywhere; an organized campaign by the scientific community as a whole would have more influence in removing the threat of nuclear war than any other group would have. The campaign can begin with each of us pledging that we will never involve ourselves in any way with the development or production of nuclear arms.

Of course, this campaign would result in a greater competition for fewer jobs. We may have to settle temporarily for less lucrative jobs. At least we won't be a part of the death racket any more. And once we have achieved our goals, the industries would have to invest in less harmful sectors to make profits (and reinforce our job market).