

little short of hard currency. He hopes, however, to persuade them to contribute rugs.

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Did Heisenberg Misconceive A-Bomb?

I was disappointed to see that Samuel Goudsmit's defenders (May 1991, page 13) have yielded the central point to the campaign being conducted by Mark Walker against Goudsmit's scientific and personal intelligence.

Your correspondents seem to have accepted it as a fact that Werner Heisenberg did understand that any atomic bomb would depend on the scientific principle of a fast-neutron reaction. There is a great deal of direct evidence to the contrary, starting with Heisenberg's original paper of December 1939 that mapped out the strategy of the German uranium project. This paper (now available in *Heisenberg: Gesammelte Werke*, series A, part 2 [Springer-Verlag, 1989]) suggests that Heisenberg's concept of a bomb at this stage was a reactor fueled by pure U-235 that would use an immense mass of the isotope to ensure that there would be enough time (given the length of time that slow-neutron diffusion would require) for a useful enough amount of the U-235 to be turned into energy. It was the vast amount of U-235—tons—that was needed for this reactor-bomb that in fact forestalled the German atomic project. (For a reference to this absurd conception of a critical mass of tons, see R. V. Jones's introduction to the American Institute of Physics reissue of Goudsmit's *Alsos* [Tomash, 1988]: Jones and his colleague Charles Frank actually heard the tapes of Heisenberg's Farm Hall internment conversations in 1945 and affirm that he made out the critical mass to be 4 or 5 tons.)

As to the still classified transcripts of the Farm Hall tape recordings of the German scientists' reactions to the news of Hiroshima in August 1945, all those who have had access to them—including Goudsmit himself, Jones, Frank, Leslie Groves, Paul Rosbaud and Margaret Gowing (the author of the official history *Britain and Atomic Energy 1939-1945* [Macmillan, London, 1964])—are agreed that they bear out the truth of Goudsmit's charge that Heisenberg never did understand during the war the scientific principle of the atomic bomb. Is Walker going to argue that

all these people are wrong or blinded by personal losses during the war? I do not believe that Walker can continue to assert blithely that Heisenberg knew what he was doing and that Goudsmit was all at sea. At the very least, the fact that Heisenberg claimed after the war never to have made a calculation of the critical mass of an atomic bomb should ring warning bells about the danger of relying on anything he or other German scientists had to say after Hiroshima about their wartime uranium project.

If it seems farfetched that a physicist of Heisenberg's caliber should have got wrong the essential principle of the bomb, one should recall that in February 1940 hopes for a uranium bomb had been written off in Britain and Otto Frisch—the true inventor of the bomb—had himself so far missed the fast-neutron principle. It was only a brain wave that inspired him in March 1940 to consider a fast-neutron bomb and, along with Rudolf Peierls, calculate that a comparatively small amount of U-235 was needed. In the US this idea was not appreciated until the summer of 1941, as is apparent from the memoirs of Arthur Compton and Mark Oliphant and from much other documentation. Even Niels Bohr himself believed that a fast-neutron bomb would entail a large mass of U-235—that is, until his arrival in London and briefing by the British on 8 October 1943.

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WALKER REPLIES: I deeply regret that Paul Lawrence Rose has chosen to follow Jonathan Logan's and Max Dresden's lead by misconstruing gravely my words and intent. Thus I feel compelled to reiterate: I have never written or said that Samuel Goudsmit's claims should be rejected *because* he had suffered at the hands of Germans and therefore was no longer objective. Goudsmit's claims are false because of *evidence* to the contrary of those claims.

The report Werner Heisenberg wrote in 1939 is a good source for his understanding of the problem at that time, but people can change their minds. Subsequent documents such as "Die theoretischen Grundlagen für die Energiegewinnung aus der Uranspaltung" (26 February 1942), which is also reprinted in Heisenberg's *Gesammelte Werke*, prove that Heisenberg knew that both uranium-235 and plutonium could be used as nuclear explosives and that these nuclear

explosives (and thereby nuclear weapons) used fast-neutron chain reactions. As far as the critical mass is concerned, page 13 of the comprehensive German Army Ordnance report of February 1942, "Energiegewinnung aus Uran" (from Erich Bagge's private papers, Kiel), written by Army physicists in consultation with Heisenberg and the other project scientists, proves that the German researchers were working with an estimate of 10-100 kilograms, comparable to the Allied estimates at this time. Heisenberg may have sounded confused at Farm Hall, but that proves little about what he knew or did during the war. Heisenberg and his colleagues knew how to build a bomb in principle by February 1942 at the latest, and it is unlikely that they would have forgotten so soon.

I respectfully suggest that Rose consult my book, especially since I believe he is writing his own book on this subject. If he remains unconvinced I am willing to send him copies of the relevant documents.

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Legislating Science Funding Levels

It is sad but increasingly apparent: A scientist has to be politically savvy to be scientifically successful. Leon Lederman's Reference Frame column "The Privilege—and Obligation—of Being a Physicist" (April 1991, page 9) will have received thousands of sympathetic ears, I am sure, but haven't we heard this kind of plea more than once before? I am quite suspicious of the notion that a cohesive political strategy representing the interests of all subfields of physics, to say nothing of the interests of individual institutions, groups and investigators, can be formulated and executed effectively.

I hereby propose a *legal* alternative to Lederman's admirable *political* course. We must keep our message and tactics simple. Start with legislation to mandate that funds are committed to basic science and technology research at a *per capita* rate comparable to that of our major economic competitors (notably Japan). Such a legal course has several advantages. First, it's simple and forceful. Many a politician who might sniff privately at the idea of giving more funds to science may find it politically unwise to object publicly. Second, it is a uniting path of action, around which all disciplines of