

charge quantization is built into it and is as intrinsic to it as the existence of the neutral currents.<sup>1,2</sup> The proof is consistent and complete.

The SM is not without mystery. For instance, why are there three generations of quarks and leptons, and why do anomalies cancel generation by generation? Charge quantization, though, is now one of its certainties. In fact, the color dependence of the electric charge, as arising in the SM, has become a powerful tool to put constraints on the extensions beyond the SM. Also, a careful study of the same charge quantization shows that when the electroweak symmetry was restored in the early universe, there was no electric charge present.<sup>3</sup> So, in the absence of such a charge, who needs GUTs?

Furthermore, it is erroneous to think that the SM permits millicharged particles. It has been demonstrated that the same method that proves charge quantization in the SM also forbids the existence of millicharged particles.<sup>2</sup>

## References

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2. A. Abbas, *J Phys G* 16, L163 (1990).
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**AFSAR ABBAS**

(a/sar@iopb.res.in)

*Institute of Physics*

*Bhubaneswar, India*

## Physics Students in 1950 Got PhDs Fast, Rarely Worked as TAs

As a graduate student who received his PhD in physics at Yale University in 1950 only three years after his BS, I'm reminded by your story on teaching assistants' union activities (May, page 57) about how well off I was then, and how poorly off grad students are today.

There were very few TAs in my time, and physics professors taught 9 to 12 hours per week. The GI Bill of Rights, preinflation, supplied my basic expenses for the first two years, although I did grade exam papers to supplement my income. Being a Navy contract assistant the third year just about covered my expenses, and my only duty was to do research for my dissertation.

It is now practically against the law to get a PhD in three years. I hear that four is possible, and five or more is the norm. The reason is that grad students are there to support government contracts or grants, and the university requires most faculty members to get outside support. In

fact, they are paid in part or in full by this support. Profs don't teach now, at least not very much, and their job is often done by TAs.

Add to that the increase in the retirement age, and we have a very difficult situation for the grad student trying to get out and join a faculty. I was very fortunate, and present-day students are in deep yogurt.

Please spare me the comment that research is so much better today. It's just more expensive.

**DANIEL BINDER**

(danbinder@blomand.net)

*Monteagle, Tennessee*

## In the 1950s, Some Physicists Suffered Inferred-Red Effects

While we are celebrating the centennial of the American Physical Society, we should not forget the less pleasant happenings of the century, especially those of the McCarthy era.

Unless one lived through the first half of the 1950s, it may be hard to understand its impact, which included the rise of a creeping sense of personal fear, even in an academic environment. One minor but telling effect that I experienced in New York City, where I was a Columbia University graduate student in physics, was that we students became wary of signing any petition. During the warmer months in those days, there was usually a group of tables and chairs set up near the corner of Broadway and 116th Street, with people trying to get signatures on petitions. Normally, we would have signed anything that sounded reasonable. But that changed when we began to realize that anything we signed might be used against us.

Even today, I recall three specific experiences that really jolted me. The first involved an individual, whom I'll call Dr. Bern, who was hired temporarily to help the students in the Columbia physics department. We found him to be very bright, patient, understanding, and helpful. So it was a shock to see a newspaper headline revealing that he had been indicted for perjury on the grounds that he had lied to one of the McCarthy committees about not knowing a person under investigation as a Communist spy. We were very upset, and some of us went to Bern's lawyer to volunteer to appear as character witnesses and to ask if a petition would help. The lawyer informed us that, out of fear, Bern had lied under oath about something that was easily

disproved, so there was nothing we could do. I never did learn what then happened, but I do know that we were quite shaken up about having McCarthyism strike so close to home.

My second experience involved a very bright and creative physicist I'll call Dr. Robart. He had been fired from his job at a government laboratory because of suspicions that he was a Communist. He was given lab space at Columbia, and worked with me since he was interested in my thesis work. Of course, I spoke to him at great length about his difficulties. He never could understand why he had been fired; the best he could figure was that he had been punished for having received requests from Soviet scientists for reprints of his papers, even though he had never even sent the reprints out. I was alarmed. If that could happen to him, why not to me? I met Robart a few years later and learned that he had successfully sued the government and been awarded back pay. I said that it sounded like an excellent outcome, but he said sadly that he had never really recovered from the incident. Despite the favorable judgment, he had spent tens of thousands of dollars in legal fees, lost a few years of his life, and suffered unimaginable personal anguish.

My third experience pertained to J. Robert Oppenheimer. On Friday afternoons, the Columbia physics department held a seminar, for which outside speakers were invited at times. Typically, the audience would consist of perhaps 50 people from the department. At the height of the Atomic Energy Commission's actions against Oppenheimer, he was invited to give one of the seminars. The word rapidly spread throughout Columbia, and because of the large interest shown, his talk was moved from the usual lecture room to McMillan Hall, which could probably hold over 500 people. The hall was packed with people hoping that he would comment about his situation. As I recall, he started with the words, "Problems in this century have tumbled down like apples from a tree," and then he went to the blackboard, wrote an equation, and proceeded to deliver a highly technical talk. At the end, looking around the audience, I realized with grim amusement that most of the people there had not understand a word he had said, except for the opening sentence. When I chatted with some of them later, they agreed, but said that they had attended chiefly to show their support for a great man.

**LEONARD R. WEISBERG**

(lenw5678@aol.com)

*Alexandria, Virginia* ■