

as a free invention of the human mind, since it broadens our horizons and allow us to go beyond the shackles of point particles and local quantum field theories based on them.

Finally, a note of caution. Since the path is so long, ranging from 100 to 10^{19} GeV, many new and unexpected things may happen on the way. Even fundamental changes in our ideas comparable to the quantum revolution and the relativity revolution might occur. In this respect, superstrings turn out to be conservative: In superstring theory, nothing really so new and revolutionary seems to be happening and yet the theory is claimed to be valid even at Planck energies. In some sense, this is the most disappointing aspect of superstring theories. Real physics may turn out to be even stranger!

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India: Another 'pioneer'

The article "Pioneer scientists in pre-independence India," by William A. Blanpied (May, page 36), revived a flood of memories of my own association with one such "tribal leader." I am referring to Vikram A. Sarabhai (1919-71), who was a scion of a famous Gujarati industrial family. The Sarabhais of Ahmedabad, in Gujarat State, had strong links to the Indian independence movement and its important leaders like Mahatma Gandhi, Jawaharlal Nehru and Sardar Patel. The Sarabhais were leaders in the textile industry.

Sarabhai studied with Chandrasekhara V. Raman and Homi J. Bhabha of the Indian Institute of Science at Bangalore and developed a lifelong interest in the study of the time variation of cosmic rays. In 1941 he reported on the muon intensity measurements that he made near the geomagnetic equator at Bangalore and in 1943 he led an expedition to Kashmir that measured muon intensity at altitudes up to 13 900 feet. After the end of World War II he went to England to study with Patrick M. S. Blackett. His association with Blackett appears to have gotten him excited about the idea of setting up continuous-monitoring instruments for measuring vertical muon intensity at several sites in India. Upon his return, he obtained support from his family trust fund to put his ideas to work. He set up continuous-

monitoring Geiger-Müller counter telescopes at a site on Mount Kodikanal in South India and another one in his hometown of Ahmedabad. The results on daily variation of muon intensity encouraged him to set up a research group to understand the nature of this phenomenon. This led to the establishment of the Physical Research Laboratory in 1952. It was to be the first of many premier institutions that Sarabhai set up during his life. I joined him there as a graduate student in August 1954. He persuaded me to set up and supervise a continuous-monitoring muon telescope at a Himalayan mountain site at Gulmarg (8900 ft.) in Kashmir. I had to design and build my own equipment, which we transported to Gulmarg in May 1955. This is how my own involvement with the study of the time variation of cosmic-ray intensity began. I spent the next three years, almost continuously, collecting data on time variation of muon intensity at Gulmarg. The herculean effort paid off when we were able to establish the extraterrestrial nature of most of the observed variations after correcting the data for meteorological and environmental effects. One of the early excitements came about when we discovered a spectacular enhancement in muon intensity on 23 February 1956, immediately after the occurrence of a giant solar flare, at all four observing sites in India. This led us to conclude that the Sun must have produced cosmic rays with energies as large as 67.5 GeV! Several large solar flares and associated ground level enhancements have been observed in the intervening 30 years, but none have produced solar cosmic rays of such high energy. So the event is unique.

Sarabhai was a great believer in the future of science enterprise in India. He believed that "the development of a nation is intimately linked with the understanding and application of science and technology by its people." He used to talk enthusiastically about projects such as large nuclear power stations serving giant agro-industrial complexes and synchronous satellites for direct broadcast television for use in educating the masses of India in remote villages. Fortunately for him he was able to lay a foundation for his dream during his short life span of 52 years. When Bhabha was killed in a plane crash in 1966, Sarabhai was chosen to succeed him. What a worthy successor he turned out to be! He set up an Electronic Commission to encourage the development of high-technology electronic industry in India, and founded the Indian Space Research Organization to launch India into the space

age, among other achievements. He was a believer in international collaborations. He himself served on several important international organizations. He invited well-known scientists from other lands to visit India and teach graduate students for varying periods of time. Henry V. Neher, George Clark, Philip Morrison, Herbert S. Bridge, Alexander J. Dessler, Eugene N. Parker, Donald A. Glaser, Hugh Carmichael, Linus Pauling, Maurice M. Shapiro, Y. Sekido, Blackett, Paul A. M. Dirac, Pierre V. Auger, A. Ehmer, Hannes Alfvén and a host of others visited the Physical Research Laboratory while I was still a graduate student there. Such visits turned out to be very inspiring for the students and resulted in collaborations and lifelong friendships. For example, in 1961 Dessler and I collaborated on a model that related the diurnal anisotropy of cosmic rays to the dynamics of the solar wind and the interplanetary magnetic field, which later led to the development of an extremely successful diffusion-convection model for understanding a variety of modulation effects observed in cosmic rays. So I agree completely with one of Blanpied's conclusions: "Basic research conducted in less developed countries, under far from optimal conditions, can contribute significantly to international scientific progress."

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Refuseniks' thanks

For the past 14½ years, we have been refusenik physicists in the USSR. Now we are very pleased to announce that we are finally out and living in freedom in Israel.

We believe that the long-term support from hundreds of physicists is what kept our cases alive. Senator Edward Kennedy played a role in our release, for which we are most thankful. The moral support from our fellow scientists kept our spirits up. Our memberships in The American Physical Society and in the New York Academy of Sciences helped us also. The scientific journals we received enabled us to keep up with important scientific developments in the West. Unfortunately, the KGB often confiscated these journals during raids on our apartment. We would like especially to thank Joel Leibowitz and Paul Plotz for their efforts on our behalf. We apologize that we cannot thank every individual who helped us but we would like to say thank you to all members of The American Physical Society.