contributions reach this stage. Anandan studies the effects that interacting gravitational and electromagnetic fields treated classically exert on quantum mechanical particle probes. Smolin discusses stochastic quantization on a curved background. On a more fundamental level, Károlyházy *et al.* and Penrose seek to explain the reduction of the wave packet as a gravitational effect, and Page reviews the Hartle-Hawking boundary conditions for the "wave function of the universe." Here we finally encounter some fascinating conjectures about how general relativity and quantum theory may meet in an unexpected manner. These papers bear the seal of relativity as a field. Károlyházy *et al.* and Penrose, however, never quite work their speculations into a coherent theory, and Page, like the sources he reviews, does not come to grips with the subtle problems of the probabilistic interpretation of the "state function of the Universe." One is left with an uncomfortable feeling that the founding fathers of quantum mechanics, by following its unpleasant consequences *bis zum bitteren Ende*, left us, as well as the subject, at an impasse. To get beyond the present stage, one cannot accept any reasoning that is less painstaking, less orderly, and less profound than theirs. Misunderstood and mistrusted, distorted and dismissed, and very probably provisional, the traditional interpretations of quantum mechanics, those of the Copenhagen school and of von Neumann, still stand (unfortunately, I feel) unsurpassed.

KAREL KUCHAŘ
Department of Physics, University of Utah, Salt Lake City, UT 84112

Imaginative Biochemistry

Free Radical. Albert Szent-Gyorgyi and the Battle over Vitamin C. RALPH W. MOSS. Paragon House, New York, 1987. xx, 316 pp. + plates. $22.95

This book is much more than the story of Albert Szent-Györgyi's battle over the discovery and function of vitamin C. It is a biography that covers his personal life, his entire scientific career, and his political beliefs and activities, particularly in Hungary and the United States. Szent-Györgyi was always in search of peace. As Studs Terkel says in his foreword, "Albert Szent-Gyorgyi saw the world, he saw hope. . . . As scientist, poet, and maverick, he always defied the 'institutional truths'." He didn't like to catch small fish, so when he went fishing he used the largest hook he could find. And, as he said, if you want to build a house you have to dig a foundation. He dug deep in science because he wanted to build the skyscraper of modern medicine.

The story of the discovery of vitamin C (formerly ignose, godnose, and hexuronic acid) is covered in detail. The story had its tragic moments, involving a battle of two scientists over priority of discovery. In 1937 Szent-Györgyi received the Nobel Prize for studies on cellular respiration and the isolation of vitamin C. His studies on respiration demonstrate the imagination of this great scientist. He stepped into a bitter argument between two giants of biochemistry, Otto Warburg and Heinrich Wieland. Warburg argued that oxidation was due to the activation of oxygen by his "Atmungsferment" (cytochrome oxidase), while Wieland argued that the activation of the substrate by dehydrogenases was the primary event in oxidation. Through brilliant experiments Szent-Györgyi demonstrated that both were correct. Using minced pigeon breast muscle, he demonstrated that dicarboxylic acids, such as fumaric acid, were an essential coupler between the dehydrogenase and cytochrome oxidase for biological oxidation. Thus, activation of substrate à la Wieland and the activation of oxygen à la Warburg—the so-called Szent-Györgyi cycle—were both essential for biological oxidation. This discovery was later used by Krebs in his brilliant work describing the citric acid (Krebs) cycle.

Szent-Györgyi's later work on muscle biochemistry could also have been the basis for a Nobel Prize. He and his co-workers Ilona Banga and F. Bruno Straub prepared myosin threads on a slide and observed them under the microscope when adenosine triphosphate was added. The threads began to contract and shrink to a third of the original size. Szent-Györgyi described this observation as "perhaps the greatest excitement of my life." Subsequent developments in work on myosin A and B, actin, and ATP interactions are described in some detail in the book. The excitement is best summed up in Szent-Györgyi's own words: "Muscular contraction is one of the most wonderful phenomena of the biological kingdom. That a soft jelly should suddenly become hard, change its shape and lift a thousand times its own weight, and that it should be able to do so several hundred times a second, is little short of miraculous. Undoubtedly, muscle is one of the most remarkable items in nature's curiosity shop." Szent-Györgyi soon decided that muscle behavior could not be described in terms of orthodox chemistry. Rather, the distribution of electrons over the entire molecular structure must be understood if one is to answer the question What is life? Thus his beginnings in the study of quantum biology.

Among the many other aspects of Szent-Györgyi's life covered in the book is his move to the Marine Biological Laboratory at Woods Hole, Massachusetts, which initiated an interesting phase in his career. He bought a wonderful home, Seven Winds, on Penzance Point, where he had regular sessions with visiting scientists. This was where a number of ideas concerning quantum biology were developed. Szent-Györgyi's ideas on the electronic states and protein structure and organization in relation to cancer were discussed extensively at these sessions.

During this period Jane McLaughlin played an important role in Szent-Györgyi's life, as did his cousin Andrew and Andrew's wife, Eva. He needed good people around him to challenge the many "wild" ideas that came along. Michael Kasha recalled his visit: "Life with the Szent-Gyorgyis was colorful and gay. Swimming in the cold ocean, fishing for flounder, daring motor boat rides through narrow channels in the nearby islands, night fishing for a striped bass in the swift tidal currents around the peninsula, volley ball—all these things were part of the informal life of Albert Szent-Gyorgyi. Mornings of intensive science and late afternoons of intensive recreation became the delicious summer diet at Woods Hole."

Many scientists will be interested in reading the details about how "Prof" supported his research, including his interaction with Stephen Rath, and, in particular, the role of Franklin C. Salisbury and his wife, Tamara, in starting the National Foundation for Cancer Research. His interaction with Warren Weaver at the Rockefeller Foundation and with Armour and Company are classic examples of grantmanship, which Moss covers in a wonderful way. Prof could not write a grant. He didn't know how to write down his ideas and what he might anticipate in the way of results. If he could do that, then he didn't think it was worth doing.

Moss has done a remarkable job in capturing the spirit of this "free radical" whose motto was "Long live imagination."

W. D. MCELROY
Department of Biology, University of California at San Diego, La Jolla, CA 92093

Books Received

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