

## Making Physics: A Biography of Brookhaven National Laboratory, 1946–1972

by R.P. Crease

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In *Making Physics*, Robert P. Crease has produced an interesting and readable history of Brookhaven National Laboratory during its first 25 years. While one can infer from the title that research in nuclear and elementary particle physics is prominently featured, there is also a fair amount of attention given to other fields, particularly the biomedical. The author has organized his work according to three major themes. The development of major experimental facilities to be operated for users both inside and outside the Laboratory – nuclear reactors like the Brookhaven Graphite Research Reactor (BGRR) and the High Flux Beam Reactor (HFBR), and particle accelerators such as the Cosmotron and Alternating Gradient Synchrotron (AGS) – forms a major part of the narrative, being the original *raison d'être* for the Lab. itself. A second emphasis is on the scientific results of the research programmes carried out at these facilities, described in some detail. The author also focuses on wider science and society issues by examining the relations between BNL and government (through its funding agency the Atomic Energy Commission) and between the Laboratory and the citizens of the surrounding community.

The Laboratory had its origins in the post-WWII recognition by universities in the northeastern US that the primary facilities for nuclear research developed in the wake of the Manhattan Project were located in other parts of the country, and that faculty and staff were being lured away by the opportunities available elsewhere. Furthermore, the cost of constructing and maintaining the kind of facilities required led to the idea of a laboratory funded by the Federal Government and operated by a consortium of Universities. Sited at Camp Upton, an Army base on Long Island, NY, its first major instrument, the BGRR, came on line in 1950. The book describes in detail the construction of the reactor and how AEC insistence on relying upon an outside contractor (part of a policy to provide private industry with experience for the anticipated construction of commercial nuclear power

reactors) resulted in serious delays and cost overruns nearly sinking the project.

As the first major Brookhaven facility, the BGRR became a symbol of the Laboratory, appearing on its official logo. Both unclassified and classified research could be performed at the reactor: a steel wall, which naturally became known as the 'iron curtain', isolated the unclassified experiments on the west face of the reactor. The book describes in some detail the major research programmes at the BGRR. The development of instrumentation for neutron measurements (choppers, crystal spectrometers) is discussed as well as the experimental programmes in nuclear and solid state physics and the (ultimately unsuccessful) attempts at treating malignant brain tumours using reactor neutrons.

The need for a second-generation research reactor led to the HFBR, which came online in 1965. A team of BNL physicists developed the concept of using tubes located tangentially to the reactor core to extract neutrons. By varying the position of the beam tubes the spectrum and flux of the extracted neutrons could be adjusted. A total of nine beamlines and seven irradiation ports were available to experimenters. The reactor supported a productive research programme until shut down in 1997 owing to a minor tritium leak at the spent fuel pool of the reactor.

Accelerator development is another fascinating aspect of the Lab's history described by Crease. Like the reactor, the earliest machines built at BNL experienced cost overruns, delays and engineering problems, again due in part to AEC preferences that outside contractors be used for machine construction, with Lab. scientists responsible only for installation and operation. The first BNL accelerator, a 4 MeV electrostatic machine, was never able to achieve its full design energy. The 60-inch cyclotron suffered from similar difficulties but eventually both accelerators were put to productive scientific use.

With the Cosmotron and AGS accelerators Brookhaven became a world centre for both high energy physics and accelerator research and development. The Cosmotron was the first accelerator to produce beam energies in excess of 1 GeV. The strong-focusing concept which was to revolutionize accelerator design was invented at BNL by Courant, Snyder, Livingston and Blewett about the time that the Cosmotron was coming on line in 1952. This principle used focusing and defocusing quadrupole lenses arranged to produce a net vertical and horizontal

focusing effect in a circular accelerator, unlike the Cosmotron and other earlier machines which relied on the weak focusing of the edge fields from their bend magnets. The net result was to enable high energies to be attained with significantly smaller magnet apertures (and correspondingly lower cost). The importance of this work was immediately recognized and planning began for the next Brookhaven machine, which would eventually become the 30 GeV AGS.

The accelerators at BNL made possible the scientific achievements of the Laboratory in elementary particle physics that are perhaps its most significant. The Cosmotron and AGS programmes produced numerous discoveries in particle physics of the highest order (parity violation, the Omega-minus, neutral Kaon mixing, CP violation, two neutrino flavours, to name just a few). The author succeeds in conveying both the conflicts and the excitement of that heroic age.

Another major theme explored by the author is the relation of federally funded research institutions with the citizens of the local community and with society as a whole. The spectre of the tritium leak at HFBR that resulted in the firing of Associated Universities Inc., the consortium that had managed the Laboratory from the beginning, is present throughout the entire work. Community relations were rocky from the start. Following the practice of the time the siting decision was made without prior community involvement. The inability of the public to dissociate the research at BNL from nuclear weapons development and the fear of radiation (fuelled in part by sensationalist media) led to apprehensions not easily ameliorated by the Lab's attempts at public outreach. Crease provides a sobering, in-depth analysis of the successes and failures of these efforts relevant to the present situation at Brookhaven and at the other National Laboratories.

The book is well researched. The physics is popularized but without any major technical inaccuracies. There are some important topics (like Raymond Davis' pioneering solar neutrino experiment) which are referred to only in passing but the text points the interested reader to more complete accounts. *Making Physics* is recommended to anyone with an interest in the history of particle and nuclear physics, or of the relationship between Federally funded science and society.

Paul Schoessow