

Care and Consensus Smooth the Errors Away

Selectivity and Discord: Two Problems of Experiment

Allan Franklin
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Reviewed by Benjamin Bederson

Selectivity and Discord is a careful study of conflict and controversy in experimental physics. Drawing from his extensive writings on controversial experiments and on the epistemology of science measurement, author Allan Franklin sums up many of his ideas concerning how measurements are made and how they relate to theory.

In introductory and concluding chapters, Franklin distinguishes rationalists from constructionists. He aligns himself squarely with rationalists: mostly mainstream physicists, philosophers, and historians of physics who really believe in—forgive me for saying so—reality. In contrast, constructionists believe that scientific truth is shaded by social, political, and economic context. Franklin carefully and fairly explains the constructionist case, but then politely skewers it. These sections are more for philosophers than for bread-and-butter physicists, who generally need no convincing about the choice between objectivity and subjectivity.

Most of the book comprises nine case studies of controversies in experiment that were gradually resolved: K-meson branching ratios, detection of gravity waves, the Milliken oil drop experiment, purported observations of the 17-keV neutrino, low-mass electron-positron states, the fifth force, early observations of monoenergetic beta rays, neutrino oscillations, and atomic parity violations. Franklin and others have published much of the material elsewhere, but Franklin has done readers a service by summariz-

ing it here in sufficient detail to convey the subtleties. Each study has a different object lesson. Franklin chose the studies partly to illustrate ways in which experiments can be in error—or, more subtly, ways in which one can make experiments more reliable. Such ways include properly analyzing the data, considering background effects, carefully analyzing theoretical assumptions, and avoiding preconceptions and other pitfalls.

The easiest case to explain, the gravity-wave coincidence measurement, is one in which the experiment was just plain wrong. It involved a simple recording blunder that offset by hours the observation times at two separate locations.

Beyond such simple errors, experimenters encounter innumerable pitfalls, particularly when they are searching for small deviations from accepted results. Here the first half of the book's title, selectivity, comes into play. When should one question the theoretical tools one uses to interpret data? For example, how reliable must heavy-atom wavefunction computations be to allow interpretation of experiments in nonconservation of parity? When should an experimenter watch out for a tendency to take data preferentially in a region where a peak would reveal a sought-for resonance or particle? (I myself have been guilty of this transgression.) One way to avoid such biases is to conduct a blind experiment in which all the data is shifted by an amount that is unknown to the experimenter until after all the data are taken. That technique, occasionally used by large high-energy collaboration teams, would be difficult for smaller groups that could not afford the inordinate time needed to search where there is nothing of interest.

Franklin also exhaustively explores when to discard data. For example, in the famous Milliken oil drop experiment, surprisingly, even if Milliken's rejected data had been included in his results, the conclusion that all electrons have the same charge, and the value of that charge, would not have changed significantly.

Franklin analyzes many variations of experiments that do not agree with each other or that appear to violate an accepted theoretical canon—

two examples of the discord in his title. Virtually always, the physics community eventually reaches consensus on the “correct” results, informed by an emerging awareness of experimental subtleties. Franklin describes, painstakingly and sometimes painfully, how the consensus evolves. In a way, he is describing physics democracy at work. Of course, if there are many wrongs and one right, physics cannot be truly democratic.

Implicit in Franklin's analysis is the need to understand as fully as possible all the intricacies of difficult experiments. He rightly indicates that there are no incorrect experiments, in the sense that Nature is always at work and does not deceive, provided one takes all its subtleties into account. However, one can carry the principle of “no incorrect experiments” too far. My favorite example is an appeal of a rejected paper at *Physical Review*. The author purported to have observed the scattering of one photon beam by another, but the beam intensities seemed far too low. It turned out that the beams were “interacting” with each other with the help of a small background gas. The author argued that, although that might have been true, he was certainly observing a true phenomenon, and therefore the work merited publication.

Skilled experimenters know through experience and instinct the many lessons that are carefully articulated in *Selectivity and Discord*, but can still benefit from reading the case studies. I also found it great fun to read about those famous cases with the enormous benefit of hindsight and with the careful assistance of a skilled guide.

Quantum Physics: A Text for Graduate Students

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Roger Newton has had a distinguished career in physics, with several significant contributions to scattering theory and high-energy physics. He has also written noteworthy physics books, both technical and

Benjamin Bederson, an experimental atomic physicist, is a professor of physics emeritus at New York University and an editor-in-chief emeritus at the *American Physical Society*. He has been the victim, over the years, of many of the experimental pitfalls described in the Franklin book.