Letters

Detonation-Wave Phenomena

Study of detonation-wave phenomena in high explosives is a necessary adjunct to the understanding of explosive effects and their practical applications. The phenomena associated with a single detonation wave are complex; the collision of several may be spectacular. The sequence of ultra-high speed photographs on the front cover of this issue of *Science* shows the collision of eight waves. These photographs, made by the Naval Weapons Laboratory, Dahlgren, Virginia, are a by-product of a general study of initiation, propagation, and interaction of detonation waves undertaken as an aid to explosive system design. The action which occurs in just a few microseconds shows a symmetry in the detonating explosive which rivals that of the snowflake. When photographed in color, the growth and fading of this rather strange explosive "snowflake" give an appearance of unreal beauty.

These photographs were made with a Beckman and Whitley model 189 framing camera operating at about 600,000 frames per second, with individual exposure times of about 0.6 microsecond. A disk of DuPont EL 506C sheet explosive 25.4 centimeters in diameter by 0.379 centimeter thick was mounted on plywood. The explosive was initiated simultaneously at eight equidistant points on its rear surface with exploding bridge-wire detonators.

A frame-by-frame description (beginning with the upper left-hand corner and reading downward) follows:

1) A still shot of the disk mounted on plywood.

2–3) Detonation begins simultaneously and expands uniformly.

4–9) Extreme pressures at the collision of wave fronts produce lines of intense luminosity resulting from the ionization of the air.

10) Collision lines reach the center.

11–15) Reflected shock waves produce secondary collision lines bisecting the angles formed by the original waves.

The remarkable uniformity of initiation time and detonation rate is shown by the geometrical symmetry of the pattern formation and expansion, even though the detonation speed is approximately 6700 meters per second. Some idea of this may be obtained if one realizes that a time interval of only 1.65 microseconds separates the adjacent frames.

David D. Abernathy
U.S. Naval Weapons Laboratory, Dahlgren, Virginia

Data and Hypothesis

I wish to take issue with John Platt's article, "Strong inference" (16 Oct., p. 347). I agree with him that it is incomparably better science to set up alternative hypotheses, and then to devise procedures for excluding all but one, than it is to propose a single hypothesis and then to set about "proving" that the hypothesis is true. My own area of science has suffered much from the latter approach. However, I do not share the view that this is the only worth-while method of scientific research, and that government agencies should use adherence to the method as a criterion by which to judge the effectiveness of scientists. More particularly, I disagree strongly with Platt's disparaging remarks about survey studies and single-instrument scientists. I think a strong argument can be made for the proposition that the advance of scientific understanding depends primarily on the skillful and intelligent acquisition of new experimental or theoretical data, without previous formulation of hypotheses, and that a scientific problem is in principle already solved when enough information exists to permit alternative hypotheses to be devised.

The question I have posed might well be approached by Platt's own method, for we have many recent examples of spectacular advances in science, so that the question lies in an information-rich field where intelligent hypotheses can easily be formulated. Let us propose just two hypotheses:

1) That spectacular advances in science depend primarily on the development of new methods and on the intelligent use of both new and old methods to stockpile information relevant to a particular problem. The experience and skill required to gather such information often dictates that a scientist must devote most of his career to a single method or type of instrument.

2) That spectacular advances in science depend primarily on the purposeful setting up and destruction of hypotheses.

To test these alternatives (and to exclude one), I shall consider the first example cited by Platt, the Watson-Crick proposal for the structure of DNA. This proposal rests on two experimental facts: the x-ray diffraction patterns of Wilkins and the remarkable regularity in the base composition of DNA's from a variety of sources ($A/T = G/C = 1$). The acquisition of this experimental information occurred by procedures of which Platt would not approve. X-ray diffraction is a complex technique, and practitioners of it are by necessity single-instrument scientists. Moreover, x-ray crystallographers as a class do not normally begin with alternative structural hypotheses, but work from the knowledge that structural information is certain to emerge from their studies if they are sufficiently expert and persistent. In the determination of base compositions, too, the method of strong inference was surely not involved. Such analytical data are simply an integral part of the initial survey of the chemical properties of any substance. And let it not be forgotten that accurate and usable data of this kind depend on considerable skill in purification of the material to be analyzed and in the execution of the analysis.

To judge from Platt's description of the typical day in Crick's laboratory, it may be supposed that the method of strong inference was used to arrive at the final structure of DNA. In any event it was certainly used in the subsequent steps forward which have capitalized on this structure. Thus both data-gatherers and hypothesis-destroyers have been involved in achieving