MEN AND IDEAS

SCIENCE FOR POETS

PHYSICS

“Have they ambition to become physicists?”
“Not!”

“Are they embryonic chemists, geologists or biologists, or perhaps mathematicians?”
“Not!”

“Aha! They must be engineers, architects or doctors?”
“Not!”

“Why then do they want to learn physics?”
“It is not a question of whether they want to or not. They are not scientists at all; but physics, or some science, is considered good for their souls!”

Embellishment of the soul was not one of the missions of science that I was accustomed to hear so openly acknowledged. Here then was enlightenment indeed: mentors, albeit anonymous, who far from fearing the censure of Lucretius—that “he had limed the wings of his swift spirit in the dregs of the sensible world”—endow science with a nobler aim; and an audience to befit it—the poets. I had always found it a worthy office, and one that fully taxed my resources, to teach students what they wanted to learn. To teach them to want to learn, or to learn what they might not want to know would certainly be novel, but formidable indeed.

In hundreds or maybe thousands of colleges throughout the land, as many teachers address themselves to the task of teaching physics to poets—or something slightly less poetical. And the practice is ever spreading and the purpose ever more loudly declared. Scarcely a week passes without the appearance of a book to end all books, a course to replace all courses: physics with joy—or at least without tears—for everyone, everywhere. Here at Columbia physics—poets—née Physics I, and prosaically listed now as soulless C1001—is more than ten years old, and many of the physics department’s most distinguished faculty have succumbed to the lure of its challenge. We still occasionally ask why, but mostly we are concerned with how we should meet it.

Everyone who has accepted the challenge has set out his own path, hopeful that some at least of students will be able to follow him, and that he will even find pleasure in the journey and delight the new vistas it reveals. But we all set out from the same base: a hundred or more students, mostly of science and innocent of all physics, except by hearsay or vulgarization, and happily spared any earlern to face its awful (and unworthy?) rigors. A compound the issue there is the language bar to the terrors of mathematics, which, whether in the era of Ancient Euclid or the New Math, is still for many the pons asinorum on the road to science. This obstacle derives largely from fear in the mind the student helps little: most obstacles to learning of this nature.

Faced with this problem, and a paltry few means in which to resolve it, some have concluded that physics cannot be physicists’ physics. The land of mathematics is too formidable a barrier to be penetrated. Rather than struggle with physics in arcane original, let it suffice to appreciate it in vernacular. Just as one can, without facing the facts of Greek and Latin, derive some profit and pleasure from the classics—in translation—so in our physics we cannot be content with the generalities, the development of method and ideas, the historical energies that molded them, and their impact in our society. Let us leave the actualities of the science to the professionals. Unfortunately the analogy is imperfect. Mathematics is an inherent part, as well as means of expression, of physical science. It may be possible to translate from the particular language of geometry to that of algebra, but mathematics itself is inescapable: to portray the development of physics without it would not be a characterization a caricature. How, for example, can one omit recurring, and at times dominant, Pythagorean truths that base science and mathematics merge in a single mystery of pure number?

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All physics is quantitative, but this does not mean that there is not much physics—even great physics (Faraday's is the supreme example)—for which the new and important concepts are primarily qualitative, capable of expression with only the simplest of mathematical vocabularies. With a little judicious selection, much actual physics could be learned and done with virtually no formal mathematics. But to understand the nature of physics as a whole its relation to mathematics must be appreciated. To sense the spirit of physics (or its power, range, potency or limitations) demands this understanding no less, but perhaps even more, than to exercise oneself in some detailed part of it. To appreciate the conceptual creations of Newton, or Maxwell, or Einstein—and who can conceive of physics without them?—one must be prepared to extend one's thoughts into the territories they explored. One cannot, alas, so tenderize physics that it becomes (in Samuel Butler's phrase),

A Liberal Art, that cost no pains
Of Study, Industry or Brains.

Fortunately a little mathematics goes a long way. Indeed, in science, that is its great virtue! Provided that little is thoroughly mastered, that the familiarity of practice has banished all fears; provided also that the teacher makes the most arduous efforts to eschew all unnecessary formal sophistication; then there seems no reason why any of the great developments of physics, from Galileo to the 20th century, no less than from the Ellatics to Kepler, should be beyond reach. After all, once one has surmounted the great wall of unfamiliality, almost all great ideas are extraordinarily simple.

How then to proceed? There is not time enough to do as the neophyte scientist would and follow through the whole development of physics and thereby, albeit incidentally, retrace in one's own development some of the subject's historical growth. Nor will opportunity present itself in a later professional career to gain direct awareness, through scientific activity itself, of the ever-moving frontiers and changing understanding. To bring out the innate historical element, time must be telescoped and historical perspective heightened. Both permanence and change must be dramatized.

I have tried to do this myself by choosing two great epochs of physics: the late seventeenth century and the contemporary period. In each there is a comprehensive view of the physical universe, allied to powerful analytical methods and principles. In each the legacy of the past has been absorbed and transformed into something new and revolutionary, which in its turn becomes the endowment for the future.

Physics inexorably seeks out the basic physical principles underlying all phenomena; to understand not only “that which lies before us in daily life” but “to know at large”—of things remote from use, obscure and subtle.” It recognizes no fixed, impenetrable boundaries, beyond which it is impotent or invalid; it probes ever deeper and further into the physical basis of all things; but by avoiding any claim that the physical is the basis of all things, its progress is unimpeded by challenge or controversy on metaphysical terrain. Three centuries have witnessed an almost immeasurable extension in the range, scope and precision of our perception of the physical world; and each extension of our knowledge and understanding yields in turn new instruments and new technologies, which magnify still further our power of observation. Yet in all this flux and growth and change, the dominant themes of science, apparently imperishable, from antiquity to today, are clearly discernible. We might epitomize them thus:

- To explore the infinitesimally small, hopefully the simplest, universal elements of the physical world;
- To encompass and to comprehend the infinitely large, the universe as a whole, its nature, its origin and its destiny;
- To master and to understand the limitless complexity and variation of the actual world, not only the world of “Nature,” but also that of daily life, which in ever increasing degree we make to suit our will;
- To attain these goals by formulating the most general, powerful and abstract principles—laws which govern the physical world in all its aspects, relating the infinitesimally small to the infinitely large, which reduce the complex to its simplest elements, and which relate permanency and change.

What, perhaps, characterizes the modern era of science is more the method than the goal. In contrast to the gentler natural philosophy of antiquity, science is, in Humphrey Davy's prophetic words, now the massive drive “to interrogate Nature with power, not simply as a scholar, passive and seeking to understand her operations, but rather as master, active with his own instruments.”

Some of the consequences of this mastery of nature are known all too well. In the active pursuit of these age-old goals of human enquiry, both science and the world that contains it have been profoundly altered. To Galileo science was as much a challenge to dogmatic authority, and the eradication of ignorance and prejudice, as the search for truth. But today science is dominated by the positive will to extend the realm of knowledge. To dispel what ignorance or prejudice do we explore the distant galaxies or build new giant accelerators to probe still deeper in the sub-atomic world? At most only that of a handful of physicists and astronomers! although perhaps the future may reveal how the exploration of such realms will remove from a broader world-view misconceptions and limitations of which we are now not even aware.
Meanwhile, the basically philosophic thrust of science, accompanied in its wake by the much more massive onrush of technology which both sustains and is sustained by science, leads the scientist, with his ever more powerful and subtle means of penetration, into regions far from the philosophical concerns of the majority of men.

Have then the frontiers of science, after first "bringing down the heavens to the earthly realm," now ascended to those remote parts—"those eternal regions where the owl-winged faculty of calculation dare not ever penetrate"—to which Shelley so confidently asserted only poetry could ascend?

No matter how vast and impersonal its province, science itself is the creation of man. The creation of science is now part of the history of man, and as such belongs to the whole of mankind. Science may have suppressed poetry or supplanted it, or made our need of it greater than ever before. It may have earned the poet's admiration or aroused his bitter hostility, but it can hardly leave him indifferent.

So there may be a Poets' Physics after all. Is it truly worthy of his attention and endeavors? Should he be led to it by academic injunction, by moral pressure, or by his own curiosity? These questions I leave unanswered, but I might finally ask one other: Is physics-for-poets in practice successful?

For practical considerations we might turn to the College catalogue. There Physics C1001x-1002y is listed as worth eight points, and as fulfilling part of the much-maligned "science requirement." I suspect that to many a student it is a means of getting science out of his system rather than of absorbing a little into it. Moreover it is described, with eschatological forbidding as a "terminal course." There is no moratorium; whereas my own measure of success for poets' physics would be the interest in science it stimulates, rather than the effort it terminates. In any event many students take the course and, for the record, most complete it successfully. To do so they may, inter alia, write a brief essay on any subject in physics relating to the spirit in which the spirit moves them. They have ranged from "Ideological and Scientific Implications of Quantum Mechanics," and "Aristotle's Physics and Objectivity," to "Free Radicals and Interplanetary Travel": and many have been most edifying to me.

But real success in the course is I suspect ultimately elusive. For suppose it were possible to portray to a layman science in all its manifestations, in all its beauty and power, the whole splendid intellectual edifice. Suppose a grudging interest could be concerted into a complete captivation, and our layman becomes so bewitched with science "as the expression of the imagination" that, if not actually forsaking poetry, he at least divides his attention between the two muse. In the process of demonstrating that the essence of physics can be comprehended by the layman, the poet himself will have ceased to layman! Physics itself has paradoxes of this sort:

A profound principle that teaches us that classical abstract perfection is never attainable in reality.

In physics-for-poets, I would be contented with much less. The most heart-warming success I can recall is in the remark of a student at the end of one course who wrote to me: "Physics will never be the same for me again!" Perhaps physics is good for the soul after all!

—SAMUEL DEWY

ASTRONOMY

That scientists should be concerned about revealing the beauty and excitement of their subject to poets is only natural, since the roots of modern science are contained in the words of many early poets. The atomic theory of Democritus was the source of some of the best poetry of Lucretius, who had a remarkably modern view of the formation, the evolution, and the ultimate dissolution of stars and stellar systems. The following lines from his poem "No Single Thing Abides" show how close his ideas were to our current picture of stellar evolution:

Globed from atoms falling slow and swift,
I see the suns, I see the systems lift
Their forms, and even these, the systems and the suns
Go back to the eternal drift.

The real excitement and poetry of astronomy is found in its concepts and in the remarkable unity of nature that it reveals to us. The emphasis is on "astronomy for poets" course must therefore be on basic scientific concepts and on the intellectual excitements that lead from the laws of nature as we know them here on earth to an understanding of apparently diverse phenomena as the motions of the planets around the sun, the structure and evolution of stars, the structure of galaxies, and the cosmos as problem itself. Such a progression of ideas leads from the simple concepts of space and time to an expanding universe is possible only because

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