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Some Contributions of Pure Math to Science

Herbert B.E. Case
University of Rhode Island

SOME CONTRIBUTIONS OF PURE MATHEMATICS TO SCIENCE.

Science, as it is known at the present day, is the result of centuries of earnest investigation and persevering purpose. With most of the sciences a few fundamental truths were at first discovered, which, increased from time to time, finally assumed an importance justifying the name of science. In this progress the sciences have had to a great extent a common dependence, the security of one often being determined by the truth of another. Perhaps of all the sciences, mathematics has done most in establishing the foundations of general science. In looking at this side of mathematics, one is impressed with the magnitude of the service rendered, but only a few striking illustrations can be mentioned here.

There is no more inviting field for the investigation of this subject than that of astronomy, for it is in this science that mathematics has won some of its greatest triumphs. The immense importance of mathematics to astronomy must be considered in detail to be thoroughly comprehended, but a general idea may be obtained from a few references to some prominent facts. In all astronomical observations

mathematics takes a prominent place, for it is only by its use that astronomers are able to arrive at any definite conclusions. It is through mathematics that we are able to estimate the distance of our earth from the sun or from some of the remotest stars. It is possible to calculate so exactly that the times of the eclipses of the sun and the satellites of the different planets can be accurately determined. A comet may appear in the heavens and then suddenly disappear; but it is not necessarily lost to earth, for it is possible to calculate the date of its probable return, if indeed it is destined to reappear. In fact, it may well be said that but for mathematics observational astronomy could not exist as a science.

From many notable examples which might serve to illustrate this statement may be taken one which stands preeminent, that of the discovery of the planet Neptune. For a long time irregularities had been observed in the revolutions of Uranus around the sun to which astronomers failed to assign any probable reasons, and which threatened to shake the very foundations of the science. Finally it was suggested that some other body outside the orbit

of Uranus must by its attractive force produce the recognized irregularities. Such proved to be the case, and it was through the mathematical calculations of Adams and Leverrier that its mass and situation in the heavens were determined. Leverrier made a series of computations on the Uranian difficulty, and on Sept. 23, 1846, instructed Prof. Galle of the Berlin Observatory to direct his telescope to a certain point in the heavens; and there was found the object sought, the planet Neptune, already analytically proved to exist.

The science of physics is perhaps of next importance in treating the subject under consideration. This science has been notably one of advancement from its earliest stages to its present wonderful development. One theory after another has been presented, mathematically proved to be true, and finally accepted as fact. What would be the value of all those laws and facts supposed to be fundamental and so dear to the heart of the true scientist, if mathematics did not establish their truth forever? Mathematics may well be regarded as a supporting frame-work to physics, which if taken away would cause the downfall of the science.

The power of figures is especially evident in physics under light, where it is the life of theory and the strength of fact. There is one instance of so great importance that it must have special mention; the discovery that light is propagated with a finite velocity, that its transmission is not instantaneous. A new era opened in optics when the astronomer discovered what seemed to him sufficient proofs of the propagation of light in time. The inequalities noted in the recurrence of the eclipses of Jupiter's satellites were from careful observations accounted for by the simple hypothesis that light is propagated with a finite velocity. The mean motions of the satellites around the planet were estimated and the times of the eclipses accurately determined. It was found that the eclipses occurred earlier or later than was calculated, according as the earth was on the same or opposite side of the sun from Jupiter. The conclusion easily drawn from the observations was that the discrepancies were due to the time taken by the light in traveling across the earth's orbit, or, in other words, that light is propagated in time. Since then the velocity of light has been found by direct methods to be about 186000 miles per second. This is only one of a legion of instances that

might be cited, many of which are practical; as the investigations in polarized light and the calculation of wave lengths of different impulses. Others are perhaps more amusing than practical; as the determination of the thickness of soap-bubble films from the interference of light on their surface.

The science of mechanics is under obligations to mathematics in a more utilitarian way than are the two sciences already considered. It is in the planning and designing of machinery, bridges, etc., that mathematics is most useful to mechanics. The competent engineer can sit in his office and calculate the strength of the different parts of his machine, and know beforehand its working efficiency, the character of the materials necessary to build it, and its probable cost. The value of mathematics to all branches of mechanics cannot be over-estimated; in fact, it is the basis of all engineering work.

Nor must the department of chemistry be overlooked; for the discovery of the substance called Argon is perhaps as striking in its realm as that of the planet Neptune in astronomy. Until recent years it was supposed that the principal constituents of the air were oxygen, nitrogen,

and carbon dioxide. Lately, however, investigators finding evidences of another gas in the air have attempted to discover its true nature. Nitrogen obtained from its compounds is practically pure, while that obtained from the air manifests more strongly the nitrogenous qualities; hence the belief that some other substance must be acting with the nitrogen. Success finally crowned the efforts of scientists and the discovery has been well called "the triumph of the last place of decimals"; that is, the work was so accurate that the worker knew that the small differences which he obtained were due to an unknown substance and not to a mathematical error.

The field which might have been traversed is wide and inviting to the interested searcher, but, from the facts here presented, one cannot but see the important relations between mathematics and science. And in advancing science mathematics has conferred on humanity an obligation whose greatness can be realized only from an earnest study of science in all its phases. It is equally interesting to know that in their progress toward perfection mathematics and science have gone hand in hand; and as the years pass, they will continue to advance each depending upon the other.

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