Astromony In A Changing World

A noted astronomer answers the question —
"What good does astronomy do the average man?"

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WHY INVESTIGATE and teach astronomy? How can we justify the very large expenditure of funds for great research telescopes, for laboratories and classrooms for instruction, and for salaries of large staffs of instruction and research?

When questions of this type are under discussion we have been asked many times, "What is the practical value of astronomy? Can any past or expected astronomical discoveries be used to make better radios, automobiles or atomic bombs?" To such questions we must answer that the direct application of recent astronomical observations to practieal affairs is very small. There are exceptions, such as the use of observations of sunspots and solar flares for the prediction of radio transmission, but these cases are rare.

But does this mean that astronomy is of little value to the average man, in comparison to some of the sciences that have found great direct application to technology? I would go even further and raise the question of whether we are as sure as we once were of the enormous human value of the great scientific and technological development of our present civilization. Thus present historians of civilization point with a certain amount of contempt at Greek and Roman philosophers and scientists because they attempted to reach an understanding of the world about them from reasoning alone and failed to develop the experimental method. We are told therefore that these early efforts led chiefly up a blind side road rather than along the great highway of scientific and technological advance of modern civilization.

But if our own civilization should follow these of the past, and be replaced by another a millenium or two hence, can we be certain as to how the historians of this new civilization will evaluate the scientific efforts of our own age? Will our efforts be considered a real advance along the road to a better world for mankind— or will they be listed as but another diversion up a blind alley? Obviously we are too close to our own period to have the necessary perspective for such an evaluation of our own science and technology. Lest we be too complacent about our present position, however, let us examine a very few effects of the impact of science and technology on our civilization.

A century or two ago most of the world had an agricultural economy. A large fraction of the people were small land-owners producing their own necessities of life. While many examples of tyranny and abuse of power could be found, various groups — notably in America, Switzerland, and to a large extent in England— had developed social and political institutions in which great individual freedom and security had been attained.

To this agricultural economy our great scientific and technological advances were added during the last century. To exploit these advances great industries were developed and an increasingly large fraction of the population left their farms and became factory workers. But as factory workers they no longer retained the security of being able to produce their own food and other necessities. The continuance of their livelihood depended on the goodwill of their employer and the stability of demand in their particular industry.

The insecurity and hardship that this situation can produce was acutely brought home to all of us during the depression of the 1930's. In an effort to counteract this insecurity the governments of most industrial nations have, by popular demand, moved rapidly toward job insurance, old age pensions, the detailed control of industry and many other steps toward state socialism. These steps, along with the attendant large increase in taxation, have already gone a long way toward eliminating individual freedom of action and incentive to individual effort.

Even more directly we have seen in the past decade

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many of the beneficial effects of technological advance nullified by the application of these advances to the destructive purposes of warfare, often with truly appalling results.

Undoubtedly the early application of science to technology brought many physical comforts and freedom from drudgery and disease. On the other hand it is rapidly becoming evident that these technological advances are more and more being accompanied by the loss of security, freedom and incentive and are in many cases unleashing destructive forces which, unless controlled, may become a real menace to our civilization.

These questions are not raised in a spirit of pessimism and disillusionment. They are raised to emphasize that mankind may still have failed to find the one sure road to a better and happier world in the uncontrolled advance of science and technology. We still may profitably look for other criteria of value besides the applicability of a given discovery to technology.

The Value of Astronomy

What, then, may be some of the important values of astronomical discovery? Before attempting an answer let me review very briefly some of the concepts that have come from astronomy.

Until the time of Copernicus men thought of the universe as consisting of a stationary earth around which the sun, moon, planets and stars revolved in a complicated series of cycles. As the one intelligent inhabitant of the only tangible part of the universe, man and his doings were of very fundamental importance in this universe.

But Copernicus moved the center of the universe to the sun. His immediate successors found this newly-devised solar system to have dimensions measured in billions of miles. In 1838 refined instruments allowed Bessel to fix the distance of a nearby star. The next half century saw this and similar direct trigonometric measurements of the distances of the nearer stars push out the diameter of the measured universe to a few hundred light years. (It will be recalled that a light year is six million million miles.)

The measurement of still greater distances awaited the development of new methods in the present century. These methods depend on the comparison of the absolute and the apparent brightness of a given object, and were based on the discovery that the absolute brightness of a star can be determined from its spectra or, in the case of certain variable stars, from the period of its light variation. Using these methods the dimensions of our own Milky Way system were outlined during the first quarter of the present century. These investigations showed that the Milky Way contains some billions of stars, many of them larger than our own sun, arranged in a flat disklike structure some 100,000 light years in diameter.

Previous to this, astronomers had noticed a large number of faint nebulous objects often having a spiral structure. With the advent of the 100-inch telescope on Mount Wilson it was possible to resolve a few of the nearest of these into stars and apply these same methods for the determination of the distances and dimensions of these objects. These measurements showed that each of these spiral nebulae, or galaxies, is another system made up of many millions of stars, and is comparable in size and structure to our own Milky Way system. It is estimated that the 200-inch Hale telescope could photograph about 100,000,000 of these nebulae extending out to distances of one billion light years.

Further studies show that all of these galaxies are moving away from us at velocities which increase proportionally with their distances. The most distant objects thus far measured are receding at a velocity of 25,000 miles per second. If these measurements are correctly interpreted it means that all of these objects started from one place about two billion years ago. It is interesting to speculate that the universe, as we know it, may therefore have started off with a huge atomic explosion at that time which imparted to these objects their present velocity.

Other studies, particularly those using a spectrograph, have told us about the temperatures and the chemical compositions of the stars. Some of the surface temperatures are over one hundred thousand degrees, while in the interiors temperatures of several tens of millions of degrees are reached. At these interior temperatures nuclear reactions occur, similar to those that give the atomic bomb its tremendous power. This provides the sun and most of the stars with the enormous energy which they require to enable them to continue to shine with their great brilliance. From the determination of the chemical composition of the stars we can estimate the amount of fuel remaining to keep these nuclear fires burning. Again we arrive at stellar lifetimes measured in billions of years.

All of this has obviously had a very great and very humbling effect on our concepts of man's place in the universe. Thus, instead of man's home—the earth—being the center of the universe, we now find it to be a minor planet moving about one of the smaller of some billions of stars that make up our galaxy—which in turn is only one of many millions of such galaxies. Likewise, instead of man dominating the earth throughout its existence, we find that the history of civilized man has only extended for a few thousand years out of the billions of years that the universe has been developing.

A Matter of Perspective

This, I believe, is the great value of astronomy: More than any other science it has given us a true perspective of man's place in the universe. Possibly this is illustrated in a simple way by a request that came to the Mount Wilson Observatory shortly after the war. It came from a civilian high up in the War Department. He asked for one of our photographs of a spiral nebula. In explaining his request he said ,in effect, "These days of reconversion are very hectic, particularly here in the War Department. In a continually tense situation it is often very difficut not to take ourselves and our immediate problems very seriously. I would like to have this photograph of a nebula to frame and hang in my office opposite my desk so that, when the going gets tough and the immediate problem seems unusually important and urgent, I can just take a look."

I wonder whether we would not find some of our present problems and tensions somewhat relieved if a few more heads of states, and labor and industrial leaders were in a position to take an understanding look now and then.

Certainly, if our civilization is to continue to prosper and advance, it is evident that man must obtain a much broader understanding than he now has of the technological, social and political structures that are most conducive to his continued happiness and well being. Furthermore he must have not only the knowledge but the will to attain this goal. I cannot help but believe that the understanding of man's true place in the universe which we are slowly obtaining from astronomy is a significant step toward this end.