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SCIENCE AND CIVILIZATION

By Niels Bohr

The possibility of releasing vast amounts of energy through atomic disintegration, which means a veritable revolution of human resources, cannot but raise in the mind of everyone the question whether the advance of physical science is leading civilization. While the increasing mastery of the forces of nature has contributed so prolifically to human welfare, and holds out even greater promises, it is evident that the formidable power of destruction which has come within reach of man may become a mortal menace unless human society can adjust itself to the exigencies of the situation. Civilization is presented with a challenge more serious, perhaps, than ever before, and the fate of humanity will depend on its ability to unite in averting common dangers and jointly to reap the benefit from the immense opportunities which the progress of science offers.

In its origin science is inseparable from the collecting and ordering of experiences, gained in the struggle for existence, which enabled our ancestors to raise mankind to its present position among the other living beings which inhabit our earth. Even in highly organized communities where, within the distribution of labour, scientific study has become an occupation by itself, the progress of science and the advance of civilization have remained most intimately interwoven. Of course, practical needs are still an impetus to scientific research, but it need hardly be stressed how often technical developments of the greatest importance for civilization have originated from studies aimed only at augmenting our knowledge and deepening our understanding. Such endeavours know no national borders and where one scientist has left the trail another has taken it up, often in a distant part

of the world. For long scientists have considered themselves as a brotherhood working in the service of common human ideals.

In no domain of science have these lessons received stronger emphasis than in the exploration of the atom, which just now is bearing consequences of such overwhelming practical implications. As is well known, the roots of the idea of atoms as the ultimate constituents of matter go back to ancient thinkers searching for a foundation to explain the regularity which, in spite of all variability, is ever more clearly revealed by the study of natural phenomena. After the Renaissance, when science entered so fertile a period, atomic theory gradually became of the greatest importance for the physical and chemical sciences, although, until half a century ago, it was generally accepted that, due to the coarseness of our senses, any direct proof of the existence of atoms would always remain beyond human scope. Aided, however, by the refined tools of modern technique, the development of the act of experimentation has removed such limitation and even yielded detailed information about the interior structure of atoms.

In particular, the discovery that almost the entire mass of the atom is concentrated in a central nucleus proved to have the most far-reaching consequences. Not only did it become evident that the remarkable stability of the chemical elements is due to the immutability of the atomic nucleus when exposed to ordinary physical agencies but a novel field of research was opened up by the study of the special conditions under which disintegrations of the nuclei themselves may be brought about. Such processes, whereby the very elements

are transformed, were found to differ fundamentally in character and violence from chemical reactions, and their investigation led to a rapid succession of important discoveries through which ultimately the possibility of a large-scale release of atomic energy came into sight. This progress was achieved in the course of a few decades, and was due not least to most effective international cooperation. The world community of physicists was, so to say, welded into one team, rendering it more difficult than ever to disentangle the contributions of individual workers.

The grim realities which are being revealed to the world in these days will no doubt, in the minds of many, revive terrifying prospects forecast in fiction. With all admiration 'for such imagination, it is, however, most essential to appreciate the contrast between these fantasies and the actual situation confronting us. Far from offering any easy means to bring destruction forth, as it were by witchcraft, scientific insight has on the contrary made it evident that use of nuclear disintegration for devastating explosions demands most elaborate preparations, involving a profound change in the atomic composition of the materials, found on earth. The astounding achievement of producing an enormous display of power on the basis of experience gained by the study of minute effects, perceptible only by the most delicate instruments, has, in fact, besides a most intensive research effort, required an immense engineering enterprise, strikingly illuminating the' potentialities of modern industrial development.

Indeed, not only have we left the time far behind where each man, for selfprotection, could pick up the nearest stone, but we have even reached the stage where the degree of security offered to the citizens of a nation by collective defence measures is entirely insufficient. Against the new destructive powers, no defence may be possible, and the issue centres on world-wide cooperation to prevent any use of the new sources of energy which does not serve mankind as a whole. The possibility of international regulation for this purpose should be ensured by the very magnitude and the peculiar character of the efforts which will be indispensable for

the production of the new formidable weapon. It is obvious, however, that no control can be effective without free access to full scientific information and the granting of the opportunity of international supervision of all undertakings which, unless regulated, might become a source of disaster.

Such measures will, of course, demand the abolition of barriers hitherto considered necessary to safeguard national interests but now standing in the way of common security against unprecedented dangers'. Certainly the handling of the precarious situation will demand the good will of all nations, but it must be recognized that we are dealing with what is potentially a deadly challenge to civilization itself. A better background for meeting such a situation could hardly be imagined than the earnest desire to seek a firm foundation for world security, so unanimously expressed from the side of all those nations which only through united efforts have been able to defend elementary human rights. The extent of the contribution which an agreement about this vital matter would make to the removal of obstacles to mutual confidence and to the promotion of a harmonious relationship between nations can hardly be exaggerated.

In the great task lying ahead, which places upon our generation the gravest responsibility towards posterity, scientists all over the world may offer most valuable services. Not only do the bonds created through scientific intercourse form some of the firmest ties between individuals from" different nations, but the whole scientific community will surely join in a vigorous effort to induce in wider circles an adequate appreciation of what is at stake and to appeal to humanity at large to heed the warning which has been sounded. It need not be added that every scientist who has taken part in laying the foundation for the new development, or has been called upon to participate in work which might have proved decisive in the struggle to preserve a state of civilization where human culture can freely develop, is prepared to assist in any way open to him in bringing about an outcome of the present crisis of humanity worthy of the ideals for which science through the ages has stood.