

# STARS

University of Central Florida  
STARS

---

PRISM: Political & Rights Issues & Social Movements

---

1-1-1957

## Man and the atom

Max Born

Find similar works at: <https://stars.library.ucf.edu/prism>  
University of Central Florida Libraries <http://library.ucf.edu>

This Book is brought to you for free and open access by STARS. It has been accepted for inclusion in PRISM: Political & Rights Issues & Social Movements by an authorized administrator of STARS. For more information, please contact [STARS@ucf.edu](mailto:STARS@ucf.edu).

---

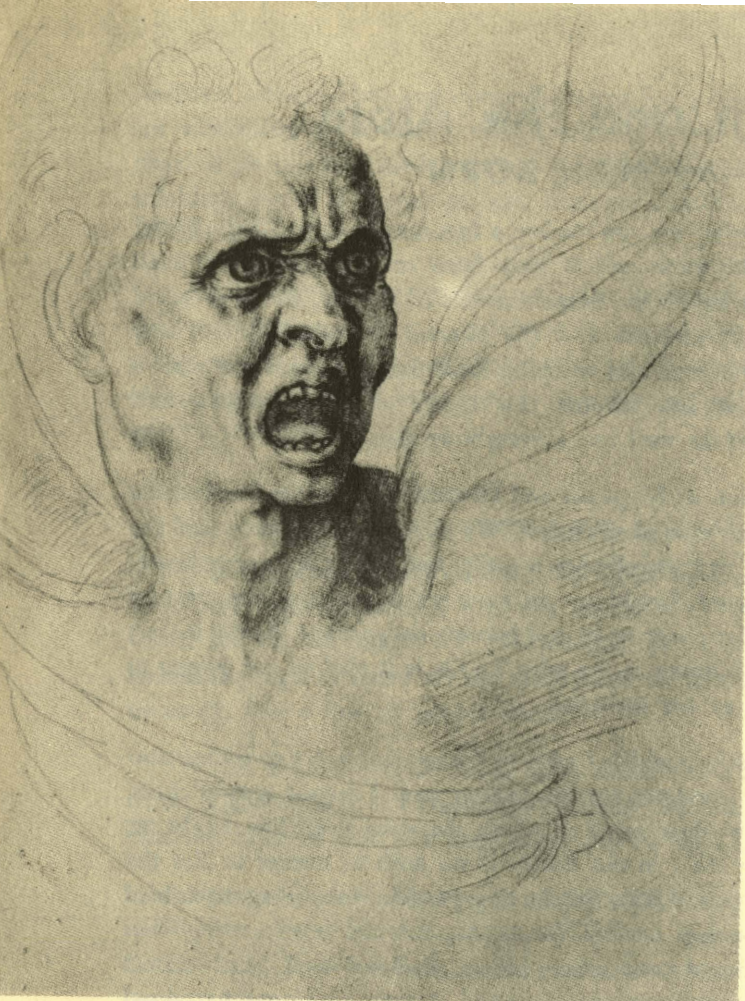
### Recommended Citation

Born, Max, "Man and the atom" (1957). *PRISM: Political & Rights Issues & Social Movements*. 213.  
<https://stars.library.ucf.edu/prism/213>

# MAN and the ATOM

by  
MAX  
BORN

AFSC-9



After Michelangelo  
Head of the Lost Soul

Copyright reserved

## INTRODUCTION

By Victor F. Weisskopf

*Professor of Physics, Massachusetts Institute of Technology*

Professor Max Born is one of the few men who conceived the great ideas upon which rests our fundamental knowledge of the laws of nature. He was one of the men who discovered the strange laws of quantum mechanics which govern the microscopic world of the atom and the electron. In 1955 he received the Nobel prize for this work. His scientific discoveries are only a part of his achievements. He is well known as an inspiring teacher and team leader. Every student of physics reads his books, and the list of his pupils and collaborators includes the most brilliant physicists of all countries, such as Oppenheimer, Teller, Heisenberg, Condon, von Neumann and many others.

Everybody who had contact with him remembers him not only as a brilliant scientist but also as a man of human warmth and greatness. The problems of mankind are as pressing to him as the problems of the atom. In the following article he addresses the world from the place of his retirement after many years of struggle against the secrets of nature and the injustices of men. It is a warning against the misuse of mankind's great discoveries and an appeal to every one for clearer thinking and acting in the struggle against self destruction. It is an optimistic appeal of a man who has seen much evil and abuse but who never lost his belief in a brighter future of mankind.



# Man and the Atom

By MAX BORN

TO begin with a special case, let me say a few words about "Myself and the Atom." We, the atom and I, have been on friendly terms, until recently. I saw in it the key to the deepest secrets of Nature, and it revealed to me the greatness of creation and the Creator. It supplied me with satisfactory work, in research and teaching, and thus provided me with a livelihood. But now it has become the source of deep sorrow and apprehension, to myself as well as to everybody else.

Since the destruction of Nagasaki and Hiroshima the atom has become a specter threatening us with annihilation. We ourselves have exorcised the phantom, it has served us faithfully for a while, but now it is insubordinate. How has this come about? Should we not have anticipated that the creature bred by us could one day outgrow us and become dangerous? Would it then not be better to have nothing to do with it? Or is it still in our power to tame it and to use it as our servant?

These are the questions which I wish to discuss and to try to illuminate: They are fundamental questions for the human race. I cannot answer them, but I can express a few ideas, some of which the atom itself has taught us; we have to keep these ideas in our minds if we wish to master it. For the word "atom" does not stand here for the tiny particle that, when assembled in large numbers, exercises terrible forces, but for the science which has discovered this particle and its collective power. And the word "man" stands not only for the rational being that has created atomic science and harnessed atomic power, but also for the man in the street, who knows nothing of all that and who reads in his newspapers of a danger which he does not understand.

## I HAVE TO DEAL WITH HUMAN PROBLEMS

In fact, it is only a manner of speech to say that the atom has become dangerous, or that the atomic physicists have brought its danger into being: The source of the danger is in all of us, because it is the weakness and passion of ordinary human beings.

Therefore, the physical and technical aspects will play only a small part in my considerations. I have to deal with human problems, both historical and political. However, I am a physicist, and in thinking about history and politics I cannot help using methods which I have learned in my science. True science is philosophical; physics, in particular, is not only a first step toward technology, but a way to the deepest layers of human thought. Just as three hundred years ago physical and astronomical discoveries dethroned



medieval scholasticism and opened the way for a new philosophy, today we are witnessing a movement which, starting from apparently insignificant physical phenomena, leads to a new turn in philosophy. It is just this way of thinking, rooted in atomic physics, that may contribute to an understanding of the dangers of the atomic age and thus to preventing them.

Fatal dangers they certainly are: The human race has today the means for annihilating itself — either in a fit of complete lunacy, i.e., in a big war, by a brief fit of destruction, or by careless handling of atomic technology, through a slow process of poisoning and of deterioration in its genetic structure.

### COULD THIS CRISIS HAVE BEEN AVOIDED?

Was this development unavoidable? Were human beings not able to live very well without probing into the mysteries of the structure of matter which led to the danger of self-destruction? In more general terms: Is technical progress, based on the knowledge of natural laws, an inescapable necessity, like a law of nature itself?

If this should be true, what sense could there be in our endeavor to direct it and to give it a reasonable purpose? Should we not better accept a fatalistic attitude and live gaily from day to day? . . .

Averaged over all the nations of the earth, the increase in the degree of civilization is undeniable. From 1700 on, it has become rapid and breathtaking. In the end, it has led to the discovery of atomic forces and of nuclear energy, and, in this way, to a crisis in the life of the human race.

In my opinion, . . . the question whether this crisis of existence could have been avoided must be answered with a clear "No." A short review of the history of atomic science will corroborate this conclusion. . . .

In 1938, Hahn and Strassmann found that when a uranium isotope absorbs a neutron it becomes unstable and splits into two parts of almost equal size. The detailed investigation of this "fission" process revealed that a few neutrons are emitted at the same time; if other uranium nuclei are hit by these neutrons, a chain reaction results which sets free an enormous amount of energy.

In 1942 a group of physicists in Chicago led by Enrico Fermi succeeded in constructing a reactor (or "pile") in which this process went on in a controllable manner.

At this point, I am tempted to allow some free play to my imagination: How would things have turned out if there had been no war at that time? I presume that everything would have gone in essentially the same way,



though somewhat slower. The first reactor might have been built 5 or 10 years later, somewhere in the civilized world. The politicians and military leaders would, of course, have gotten wind of the thing. But the difficulties and expenses of producing an atomic bomb are so gigantic that it may be doubted whether anything would have been achieved without the acute pressure of war. The Western parliaments would have hesitated before voting colossal sums for a project the feasibility of which could only be proved on paper. There might have been time to consider the consequences and to attempt an international arrangement for avoiding the danger of atomic war.

### **A HISTORICAL ACCIDENT**

But it did not happen like that. The process was accelerated by a historical accident, like a chemical reaction by a catalyzer. The accident consisted in the fact that the discovery of nuclear fission was made in Germany during the initial period of national-socialistic rule.

I had to leave Germany, like many others, and I have witnessed the terror which engulfed the rest of the world when Hitler's initial successes made it appear possible that he might subjugate all the peoples of the world. If Germany were able to construct an atomic bomb before the other nations there was no salvation. Even Einstein, who had been a pacifist all his life, shared this fear and was persuaded to warn President Roosevelt. That was the beginning of a startling development. Enormous means were provided, a gigantic organization was created, and the best scientific and technical brains set to work. The result was the first explosion of an atomic bomb at the experimental station at Alamogordo in the United States (July 1945).

Up to this point everything went quite "normally," in view of the political situation: The politicians and soldiers were acting with circumspection according to their duty; and the physicists, chemists, and engineers did their national service at the place where they were most useful; they were having unlimited means available for the investigation of a new, fascinating branch of science and were promoted in the social scale to the rank of VIP's.

### **THE TRAGIC TURN**

The tragic turn was the decision to use the new weapon by dropping two bombs on densely populated Japanese cities. Who was responsible for this decision? President Truman gave the order after listening to many advisors. Amongst these were not only politicians and soldiers but also leading scientists. It is true that a group of atomic scientists gave warning and correctly predicted the consequences in a report sent to the Secretary of War;



the report bears the name of the chairman of the committee, James Franck, my old friend and colleague from bygone peaceful times in Göttingen. But another group of eminent physicists were in favor of the dropping of the bombs.

I have used the word "responsibility" — not "guilt." For who would be presumptuous enough to judge men who, under the stress of war, acted according to their best knowledge and conscience? The justification for the horrible decision which is usually offered is that it speeded up the end of the war and saved the lives of hundreds of thousands of soldiers, not only Americans but also Japanese. Not mentioned are the hundreds of thousands of Japanese civilians — men, women, and children — who were sacrificed. Or, if they are mentioned, it is said that their destruction was not essentially different from what all belligerents were doing in ordinary air attacks. And, indeed, nobody can deny this. But can a big crime be justified by the statement that we are accustomed to committing many smaller crimes?

### OUR COLLECTIVE GUILT

I am not afraid to use the word "crime," but I shall not call any single person a criminal. What we are concerned with is collective guilt, the decay of our ethical consciousness, for which we are all to blame, myself included — though I have had nothing to do with the development of nuclear physics. A few of my colleagues in different countries will agree with me, but many more will contradict me sharply and say: "That is sentimental nonsense"; or "you have to serve your country and not ask questions"; or "you have convinced yourself that all this has been a necessary development, hence spare us your moral indignation."

The last objection is a serious one: how can you speak about guilt and collective crime when you have recognized the inevitability of the development from the savage with bow and arrow to the airman with an atomic bomb? . . .

### THE DUAL NATURE OF THE WORLD

We believe in natural laws and rely on their validity in everyday life. But we human beings are part of Nature and subject to her laws. Therefore, what we do should be just as predetermined as any natural process. But we regard ourselves as creatures capable of forming opinions and of acting on the basis of free decisions; we therefore pass judgment on human actions, calling them good or bad, just or unjust. How can we do this if every human action is nothing but a part of predetermined, automatic process? The contradiction seems insoluble. Only two possibilities seem to exist: either one must believe in determinism and regard free will as a subjective



illusion, or one must become a mystic and regard the discovery of natural laws as a meaningless intellectual game. Metaphysicians of the old schools have proclaimed one or the other of these doctrines, but ordinary people have always accepted the dual nature of the world. Bohr's idea of complementarity is a justification of the common people's attitude, because it directs attention to the fact that even a rigorous science like physics has reconciled itself to the use of complementary descriptions, which provide a true image of the world only when they are combined.

I am convinced that Bohr is right, and therefore I am not afraid to regard certain features of human history as governed by laws, and at the same time to speak of responsibility and guilt. . . .

### **A SECRECY ILLUSION**

During the eleven years since the first atomic explosion, the alliance directed against Hitler has dissolved and the cold war started between the two groups of states which are usually called the East and the West.

How little the essence of scientific knowledge has penetrated into men's consciousness, was revealed by the period that followed the end of the war. Many American politicians believed that the technical advantage of the West could be preserved by secrecy. The effect of this was to hinder the progress of research on their own side and, through the ensuing witchhunt, to bring about a serious danger to those civil liberties which are the pride of their country. Nothing could prevent the Russians from confirming a known fact of nature and from exploiting it technically. The explosion of their first uranium bomb in 1949 broke the American monopoly, and when the development of the hydrogen bomb began, the Russians drew level with the West.

### **LESS CLEVERNESS AND MORE WISDOM**

The hydrogen bomb is based on quite a different nuclear process from that used in the uranium bomb, for instead of the fission of heavy nuclei use is made of the fusion of light ones: a helium nucleus is produced from two protons and two neutrons. It is well known that this reaction is the source of the energy of the stars, which they radiate into space. It is the process which keeps the sun shining and so makes life on earth possible. In the central regions of the stars, temperature and pressure are so high that the fusion process goes through a chain of intermediate reactions. Similar conditions of temperature and pressure can now be produced on earth by using a uranium bomb for ignition, and the result is the so-called thermo-nuclear explosive device. The energy set free in such an explosion can be a thousand times greater than in the case of a uranium bomb, and it is possible



to make bombs of any size, and comparatively cheaply. The hydrogen bomb is an absolutely devilish invention, and there was opposition to its manufacture in the USA. The man who had directed the production of the first uranium bomb, Robert Oppenheimer, tried to resist the production of the hydrogen bomb, but without success. . . . The principal promoter of the hydrogen bomb was Edward Teller, who not only developed its theory, but also agitated for its production. Thus he has inscribed his name in the book of world history — whether on the debit or on the credit side the future will reveal. Teller's own justification, of course, is this: if we do not make this bomb, the Russians will. As a matter of fact, the first H-bomb explosion in Russia took place only a short time afterwards. Both of these men, Oppenheimer and Teller, as well as Fermi and other participants in this work, including some of the Russian physicists, were once my collaborators in Göttingen long before all these events, at a time when pure science still existed. It is satisfying to have had such clever and efficient pupils, but I wish they had shown less cleverness and more wisdom. I feel that I am to blame if all they learned from me were methods of research, and nothing else. Now their cleverness has precipitated the world into a desperate situation.

#### **NOT MUCH WOULD BE LEFT**

Both camps, East and West, have a sufficient number of bombs to destroy mutually all big cities and industrial centers with the help of airplanes and of guided and ballistic missiles. I shall make no attempt to compete with novel writers and journalists in describing the horror of atomic war. Yet, it is necessary to remember that the unrestricted application of atomic weapons would lead not only to the destruction of definite targets, but also to the radioactive poisoning of the atmosphere, which will spread over the whole globe. Even the few experimental bombs which have been exploded for "research" purposes in remote corners of the earth have increased the radioactivity of the atmosphere significantly. After actual nuclear warfare, not much would be left of our civilization. The survivors of the bombs would suffer agonizing death through radiation sickness: friend and enemy, belligerent and neutral, man, animal, and plant.

The leading statesmen of the big atomic powers are in the habit of declaring that a great war has become impossible. But neither their own Foreign Offices, nor the governments of smaller states take much notice of such declarations. The old diplomatic game, the bargaining and quarreling about small advantages, continues as if nothing had happened. The reluctance of the Great Powers to be involved in serious conflict is used by smaller nations for blackmail. East and West are pursuing atomic armament because they distrust one another and are under the illusion that they can gain



security by intimidation. The word "war" is avoided, but warlike actions, the breaking of international law, and the application of brute force, are perpetrated under other names — as we have recently witnessed in Hungary and in Egypt.

### **SUCH IS THE CRAZY SITUATION**

Immensely expensive preparations are constantly being made for a war which must under no circumstances be allowed to come about.

Such is the crazy situation in which we find ourselves. It looks as if our civilization were condemned to ruin by reason of its own structure. . . .

There is no doubt that the human race is in an acute crisis. At the present time, fear alone enforces a precarious peace. However, that is an unstable state of affairs, which ought to be replaced by something better.

### **THE ONLY WAY OUT**

We do not need to look far in order to find a more solid basis for the proper conduct of our affairs: it is the principle which is common to all great religions and with which all moral philosophers agree; the principle which in our own part of the world is taught by the doctrine of Christianity; the principle which Mahatma Gandhi had actually carried into practice, before our own eyes, in liberating his own country, India, from foreign domination: it is the renunciation of force in the pursuit of political aims.

Fifty years ago, when I was young, this statement would have been regarded as utopian and foolish. Today, I am able to express it without raising doubts as to my sanity. It is very likely that tomorrow, not the pacifists, but the bellicose will be regarded as fools, for the experiences of the last fifty years have left an impact on the minds of men. Yet, I feel unequal to the task of analyzing and discussing this immense problem in all its aspects. What would I be able to add to the words of the great poets and prophets of our time? I have in mind the address given by Albert Schweitzer when he received the Nobel Peace Prize; the declaration published by Albert Einstein, a short time before his death, together with Bertrand Russell and other scholars of many nations; the Mainau manifesto signed by 52 Nobel laureates; and many other similar declarations. Today, these voices no longer die away unheard, for the man in the street — and perhaps also some of the great of this world — listen to them.

### **SOME WHO ARE CAUGHT IN THE GEARS**

I am not blind to the difficulties of current policies: the conflict of interests and the clash of ideologies, of races, and of religions. But when in



human history have such problems ever been solved by war? Usually, one war has only led to the next one. Is there any possible political aim which would justify the risk of atomic war? There are a great many politicians and journalists who reply to the warnings of the experts with catchwords such as "atomic hysteria," and "bomb defeatism." Such politicians and journalists are either shortsighted, or fanatics and therefore evil, or else they represent one of the numerous groups of people to whose advantage it is — or seems to be — that wars be prepared for, or even fought: Such people are the industrialists who profit from the production of armaments; soldiers who like military life with its romantic tradition, and who prefer blind obedience to personal responsibility; officers, generals, admirals, and air marshals, whose profession is the preparing and fighting of wars; and, lastly, physicists, chemists, and engineers, who invent and manufacture new kinds of weapons. It is impossible to stabilize the present state of precarious peace based on fear, without giving these people other aims in life.

There is no general recipe for doing this. However, I am able to say a few words about the physicists, whose mentality is known to me. . . . The physicists are not the mysterious, sinister figures they are represented to be in a certain popular literature, but ordinary people gifted with a particular talent. Their ethics have nothing to do with their science. They regard as good what is beneficial to their country, just as all other citizens do. But at the same time they are strongly conscious of a particular mission — and this leads me to a question of supreme importance which I have so far omitted from my consideration.

### CREEPING DANGERS

The discovery of nuclear energy is not only a threat, a danger to the existence of mankind, but also the means of deep penetration into the secrets of Nature, and thereby of technical progress. It is, indeed, without exaggeration, the salvation of human civilization from another creeping danger, namely, the exhaustion of the fossil fuels — coal and oil.

The atomic reactors produce not only explosives but also two other things which are of the utmost importance: radioactive isotopes and energy.

A discussion of radioactive isotopes would be beyond the scope of this article, and therefore I shall say only a few words about them. As far as I can see, there are four important fields for the application of radioactive isotopes: (1) As natural clocks in the investigation of geological, cosmological, and archaeological chronology. (2) As highly sensitive indicators or "tracers," to show the presence and the movement of various substances in physical, chemical, metallurgical, and physiological processes. (3) As a means of accelerating the rate of mutations and thereby producing



new species of organisms for theoretical study of genetics and practical use in agriculture. (4) As a powerful tool in medical diagnosis and therapy, particularly in the treatment of cancer. Each of these fields has been revolutionized by the use of isotopic methods; much has been achieved already and much more can be expected. But all this belongs only indirectly to my subject.

The question of energy production, however, bears on my subject directly. Our civilization rests entirely on the exploitation of the fossil fuels, coal and oil, with a small contribution from water power. These fuels are at present still being produced — or rather, extracted — from their limited deposits in sufficient quantity. But the day is approaching when the output will not equal the demand. In spite of numerous wars, the number of human beings has increased tremendously during the last 150 years, in a roughly exponential manner, with a doubling period of about 100 years, as the following figures show:

In the year	1800	1850	1900	1950
existed about	900	1250	1600	2500 million people.

The demand for energy — and that for foodstuffs too — must increase at least at the same rate, and actually increases considerably faster than the world population, since the populations of vast territories, mainly in Asia and Africa, still live under conditions which lag far behind those of the more advanced countries, and are keen to catch up.

Since the total store of fuel is limited, one needs no great gift for prophecy to predict the approach of a fuel crisis for civilized man.

#### JUST IN TIME — IF . . .

How the long-term problem of the supply of food is to be solved, is probably unknown even to the experts in nutrition; but as to the problem of the supply of energy, the discovery of methods for liberating nuclear energy has come just in time to avert a catastrophe. The deposits of uranium and thorium are sufficient for many generations, even if the demand for energy, made by the backward nations, should increase to the level of those made by the Europeans, Americans, and Australians. Vigorous research is also being made into the problem of how to make the fusion of hydrogen a controllable reaction; the raw material for this process is available in unlimited quantity. The technical difficulties, such as the removal of radioactive waste products, are great, but presumably surmountable.

The atomic physicists are conscious of their responsibility for this development, without which our civilization would collapse miserably from lack of energy; and they are working devotedly in order to solve the scien-



tific, technological, economical, and social problems connected with the new source of energy. But these special problems are outside my subject, which is how mankind as a whole is reacting to the new situation.

### THE KEY — ON ONE CONDITION

It is as if fate were putting man to the test, saying to us: You want to live, to increase in number, and to improve your conditions — I am giving you the key to your future, but on one condition: that you give up your quarrels, suspicions, and brute force. If you refuse, woe betide you.

Will the warning be heeded? . . .

Amongst Christians . . . it should be sufficient to take the teaching of Christ seriously and to measure good and bad not with a national, but with a human gauge. Never in history was this demand so pressing, never the punishment for refusing it so obvious.

These considerations have naturally led to powerful propaganda for the abolishment of nuclear weapons by international agreement. To be frank, I do not think much of these efforts. For even if a war between Great Powers should break out and be conducted initially with conventional weapons — with increasing stress, no nation can be expected to renounce the use of any weapon it may see necessary for its salvation. In fact, military leaders in the USA have declared they would not wait for extreme emergency, but that in case of attack, they would strike at once against the Eastern bloc with nuclear weapons. I am convinced that the only way to avoid general destruction is the general renunciation of the use of force in political conflict, combined with progressive disarmament. Instead of the propaganda for the prohibition of atomic weapons, I recommend a vigorous campaign of enlightenment about the nature of total war. The beautiful idea of the hero who fights and dies for his country, his wife, and his child, is out of date. Very likely, wife and child will be victims of the atomic bomb long before the soldier, who is better protected in his dug-out or tank; and the mother country, after being saved from aggression, will look like a landscape on the moon.

### THE IRON LAW OF NATURE

Now if we assume that in the future the Great Powers will avoid war, at first from fear, and later perhaps from better motives; and that they will prohibit or at least restrict warlike conflicts between minor nations: what kind of a peace will it be?

Hardly a comfortable peace, a paradise on earth, of which I, like many others, have often dreamed. Even if organized and industrialized mass



murder should be stopped, there will be no end to conflict, because of the iron law which Nature has decreed for all living beings. Science and technology will then follow their tendency to rapid expansion unhampered, and in an exponential fashion, until saturation sets in. But that does not necessarily imply an increase of wealth, still less of happiness, as long as the number of people increases at the same rate, and with it their need for food and energy. At this point, the technical problems of the atom touch social problems, such as birth control and the just distribution of goods. There will be hard fighting about these problems; if not with deadly weapons, then with the more civilized weapons of the mind. Even if the specter of the atomic bomb is successfully exorcised, the specter of the exponential growth will see to it that a completely carefree and restful life will never be achieved. In the background, there will always be the danger of self-destruction through the release of nuclear energy, as punishment for relapse into political barbarism.

We have just witnessed with horror such a relapse. For once, we have been saved by the reaction of public opinion throughout the world: public opinion — that means ourselves. And every one of us can contribute to its becoming more powerful every day.



Reprinted, with permission, from the June 1957 issue of the *Bulletin of the Atomic Scientists*, as an educational service by the American Friends Service Committee, 160 North 15th Street, Philadelphia 2, Penna.