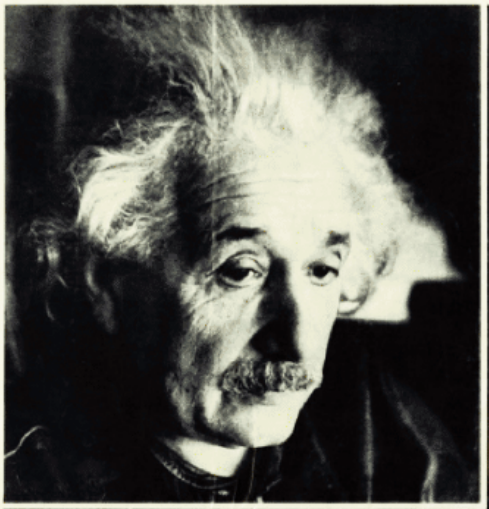

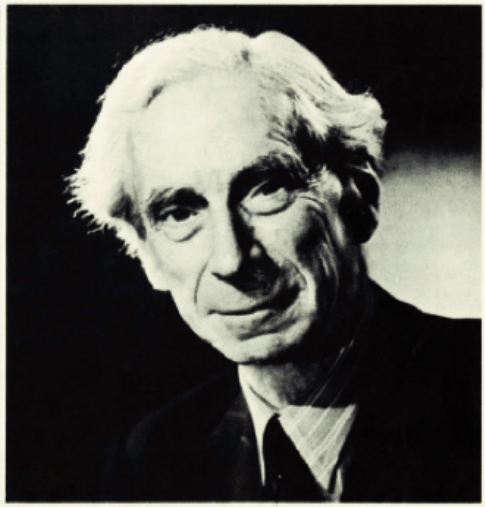

Albert Einstein *Bertrand Russell*

NOTICE TO THE WORLD

. . . renounce war or perish!

. . . world peace or universal death!

AUDIO MASTERWORKS LPA 1225

Atomic ABC

David Alexandre Ellwood

Dr Ellwood is a theoretical physicist and former research director at the Clay Mathematics Institute. He serves on the Executive Committee of British Pugwash and was recently elected to the Pugwash Council. This excerpt is from Dr Ellwood's introduction to our new edition of Bertrand Russell's The ABC of Atoms*, which offers a substantial scientific update to Russell's 1923 work.*

Bertrand Russell remembered vividly where he was at that moment— it must have been one of those moments that struck many people that way — but not so deeply as it affected Russell. He was flying over the Alps from Rome to Paris when the pilot made the announcement:

Einstein est mort!

Russell's heart sank a 1000 feet. The date was 18 April, 1955, and for Russell the sense of loss was both personal and universal — a foreboding sense of doom for the entire world.

In many ways the story began with the book *The ABC of Atoms* — a jewel of science writing in which Russell reveals the secrets of the atom with clarity and verve. As a public intellectual, Russell formed an in depth understanding of the latest scientific discoveries and saw the importance of communicating his insights to the public at large. In his age as well as ours, the people and their governments must not become estranged from the work of scientists lest fear and insecurity may guide them blindly toward disaster. Perhaps nobody understood this better than Russell, and he dedicated his immense skill to bridging every new chasm that might alienate people from power.

In *The ABC of Atoms* Russell tells us about the structure of atoms as they were understood in 1923. There had been two decades of startling revelations that ruptured the foundations of a scientific order that seemed both definite and eternal. The age of innocence was past, and the fundamental constituents of matter were

revealing an inner complexity that few could fathom. The simplest atom, and the only atom that had proved amenable to theoretical analysis at the time, was Hydrogen, the lightest amongst all the elements. Still today, students are introduced to the theory of atoms by first working out the detailed structure of Hydrogen, and Russell does not pull any punches in explaining what we now call the Rutherford-Bohr model of the atom and the Bohr-Sommerfeld quantisation rules. This theory was remarkably successful in explaining the hydrogen spectrum as well as some properties of *hydrogen-like* systems. Russell's book provides a fine introduction to these subjects, infused with the additional thrill of reading science in the making. For the story which Russell tells of the atom was far from complete, but it's one that is indispensable reading for anyone who would like to trace the wild century of discovery that was to follow. Indeed, clarifying his ideas and writing this book certainly afforded Russell a special vantage point from which to view the scientific adventure that was unfolding before his eyes, but unseen to almost everyone else at that time.

After the terrifying use of nuclear weapons to bring a sudden end to the war with Japan, a grim foreboding hung over the new world peace concerning what such weapons would mean for the future of the world. And so it was that Bertrand Arthur William Russell (3rd Earl Russell) addressed the House of Lords of the United Kingdom at just after 4 o'clock on Wednesday afternoon, November 28, 1945. It was the first time Russell had spoken at length to the upper house, but it was not to address the terrible tragedy that had befallen the inhabitants of Hiroshima and Nagasaki just three months prior. Rather, Russell saw penetratingly into the future thanks to his keen interest in atomic physics and the ominous possibilities nature allowed for weapons of even greater destructive capacity:

> *... I should like to begin with just a few technical points which I think are familiar to everybody. The first is that the atomic bomb is, of course, in its infancy, and is quite certain very quickly to become both much more destructive and very much cheaper to produce. Both those points I think we may take as certain ... There is a further point which perhaps relates to the somewhat more distant future. As your Lordships know, there are in theory two ways of tapping nuclear energy. One is the way which has now been made practicable, by breaking up a heavy nucleus into nuclei of medium weight. The other is the way which has not yet been made practicable, but which, I think, will be in time, namely, the synthesizing of hydrogen atoms to make heavier atoms, helium atoms ... In the course of that synthesis, if it can be effected, there will be a very much greater release of energy than there is in the disintegration of uranium*

atoms. At present this process has never been observed but it is held that it occurs in the sun and in the interior of other stars. It only occurs in nature at temperatures comparable to those you get in the inside of the sun. The present atomic bomb in exploding produces temperatures which are thought to be about those in the inside of the sun. It is therefore possible that some mechanism, analogous to the present atomic bomb, could be used to set off this much more violent explosion which would be obtained if one could synthesize heavier elements out of hydrogen.

Quite incredibly, the journey that began with *The ABC of Atoms* had led Russell to conceive of the possibility of a Hydrogen bomb —or thermonuclear weapon — just months after the great secret of atomic energy had been revealed to the world in the obliteration of two Japanese cities. But Russell was more than a prophet, he was a statesman for all humanity. In this maiden speech to his peers he already set himself about the task of precluding the inconceivable horror that might follow if steps were not taken to outflank the suicidal folly of a society blindly setting alight a fuse to its own destruction:

We do not want to look at this thing simply from the point of view of the next few years; we want to look at it from the point of view of the future of mankind. The question is a simple one: Is it possible for a scientific society to continue to exist, or must such a society inevitably bring itself to destruction? It is a simple question but a very vital one. I do not think it is possible to exaggerate the gravity of the possibilities of evil that lie in the utilization of atomic energy.

Russell went on to explain that the institution of war must ultimately be abolished. This was not naive, but a logical conclusion given that scientific progress had already furnished weapons that can destroy cities, and will no doubt endow men with an ever greater capacity to realize their total annihilation. The first step, Russell explained, must be an honest appraisal of the current situation, leading to a sincere and open dialogue about the future for the sake of all humanity. In achieving this, Russell suggests the *scientists* might play a special role:

I think one could make some use of the scientists in this matter. They themselves are extremely uneasy, with a very bad conscience about what they have done. They know they had to do it but they do not like it. They would be very thankful if some task could be assigned to them which would somewhat mitigate the disaster that threatens mankind. I think they might be perhaps better able to persuade the Russians than those of us who are more in the game; they could,

> *at any rate, confer with Russian scientists and perhaps get an entry that way towards genuine co-operation. We have, I think, some time ahead of us. The world at the moment is in a war-weary mood, and I do not think it is unduly optimistic to suppose there will not be a great war within the next ten years. Therefore we have some time during which we can generate the necessary genuine mutual understanding.*

Time was of the essence and, unfortunately, Russell's speech failed to imbue those in authority with the necessary courage to put the genie back in the bottle. The United Nations could not agree on international control of atomic energy and the USSR successfully detonated an implosion-type plutonium bomb on August 27, 1949. The arms race had begun.

On October 3, 1952, the United Kingdom tested its first atomic bomb in the hull of *HMS Plym*, a river class frigate that had seen extensive service on escort missions during the Second World War. *Plym* was moored about 400 metres from the island of Trimouille in the Montebello Islands, Western Australia. The device was another implosion-type plutonium bomb and realized the expected yield of 25 kilotons of TNT. The blast left a saucer-shaped crater on the seabed 6 metres deep and 300 metres wide, but nothing remained of the frigate save a few chunks of metal that fell like rain from the sky and a "gluey black substance" that washed up on the beaches nearby. However, Britain's day in the sun was short lived when Russell's nightmare arrived the following month in the form of a monstrous US experimental H-bomb called *Ivy Mike*. The yield was a foreboding 10.4 megatons of TNT, an astonishing increase just as Russell had predicted. The Soviets soon countered with the test of a more modest H-bomb on August 12, 1953.

The peoples of the world remained in an uneasy slumber while their leaders softly whispered to themselves the grim fairytale that '*the annihilating character of these agencies may bring an utterly unforeseeable security to mankind*.' This childish fantasy soon became untenable when the United States detonated its first prototype of a deliverable thermonuclear weapon at Bikini Atoll on March 1, 1954. The yield was an *unexpected* 15 megatons of TNT, three times what the designers had predicted, destroying much of the instrumentation set up to monitor the blast. *Castle Bravo's* fireball towered up into the sky, and within one minute of detonation reached a height of 14 km and a diameter of almost 11 km. After 10 minutes the mushroom cloud was 40 km tall and 100 km wide, and in its wake left 18,000 square kilometres of the surrounding Pacific Ocean contaminated, affecting inhabitants of the small islands of Rongerik and Rongelap in the Marshall Islands.

Castle Bravo was not only more powerful than expected, it was also dirtier, and a shift in the wind cast a great deal more exposure to radiation than had been predicted. The Americans were initially dismissive, but the test soon became an international incident when the crew of a Japanese fishing boat, the *Daigo Fukuryū Maru* (Lucky Dragon No. 5), arrived back in port with her 23 strong crew showing signs of serious radiation exposure. While fishing outside the official exclusion zone, they had been showered with the remains of coral that had been heaved up and transformed into a white powdery ash. The blast had gouged a crater nearly 100 metres deep and over 1.5 km wide, whose contents rained down on the *Fukuryū Maru* and neighbouring islands with pernicious effect. Embedded in the coral were highly radioactive fission fragments from the uranium tamper that surrounded the device. All the crew suffered acute radiation syndrome soon after the incident, and the boat's chief radioman, Kuboyama Aikichi, died on September 23, 1954 from complications of radiation sickness. The remaining 22 crew members stayed in hospital for 14 months, regaining their freedom on May 20, 1955, but forever cursed by the incident.

Man's ability to destroy had now surpassed a thousand times the hideous proportions wielded by the first atomic bomb on Hiroshima, and the universal concern about the H-bomb was addressed by the BBC's flagship news programme *Panorama*. The broadcast included debates on the military, strategic, political and ethical dimensions of nuclear weapons, the latter pitting Russell against the Archbishop of York. Of most interest to Russell was an introduction to the relevant science by Joseph Rotblat, a Polish-born British physicist who had worked on the Manhattan Project but resigned on moral grounds. The BBC Director-General hosted a dinner after the recording where Russell had the opportunity to converse with Rotblat in depth and was thoroughly impressed. In 1949 Rotblat had turned his attention to the medical and biological uses of radiation and took up a position as Professor of Physics at St Bartholomew's Hospital ("Barts"), London. After obtaining data from a Japanese professor on the coral ash that showered down on the *Fukuryū Maru*, Rotblat realized the actual fallout was 40 times greater than expected, and deduced *Castle Bravo* was likely a three-stage fission-fusion-fission design.

Rotblat became Russell's go-to expert on nuclear matters, and as his knowledge deepened ever further, Russell realized he must take on the arms race as his primary concern. After some difficulty, he convinced the BBC to broadcast *Man's Peril* — a sombre 'dirge for the human race' in which he said 'exactly how dreadful the prospect was unless measures were taken.' The programme was aired two days before Christmas 1954,

and helped allay some of Russell's personal anxiety, knowing that he had finally 'found words adequate to the subject.' The public response was encouraging, and Russell was overwhelmed with letters and requests for speeches and articles. Two groups stood out as noteworthy. On the political side, the most promising were the *World Parliamentarians* and the *Parliamentary World Government Association*, who invited Russell to speak at a joint meeting they were organizing in Rome in April, 1955. The other group were the scientists, particularly the French nuclear physicist Frédéric Joliot, who praised Russell's efforts and urged his support for an international conference of scientists to independently assess the full ramifications of the atomic age. Joliot's initiative chimed well with Russell's own idea of mobilizing the scientific community, but his Communist affiliations precluded Russell from overtly supporting Joliot's efforts. Instead, Russell returned to his original thought of engaging eminent scientists to affect an independent dialogue that might engender the essential trust and co-operation between nations. He began reworking the text he had written for *Man's Peril*, and simultaneously wrote to Albert Einstein to ask if he would be willing to co-operate. On February 11, 1955, Russell wrote:

> *In common with every other thinking person, I am profoundly disquieted by the armaments race in nuclear weapons. You have on various occasions given expression to feelings and opinions with which I am in close agreement. I think that eminent scientists ought to do something dramatic to bring home to the public and governments the disasters that may occur. Do you think it would be possible to get, say, six "scientists" of the very highest repute, headed by yourself, to make a very solemn statement about the imperative necessity of avoiding war? Those chosen should be so diverse in their politics that any statement signed by all of them would be obviously free from pro-Communist or anti-Communist bias.*

Russell went on to describe what he saw as the essential points. In particular he stressed:

> *The thing to emphasize is that a future war may well mean the extinction of life on this planet. The Russian and American governments do not think so. They should have no excuses for continued ignorance on this point. And although the H-bomb at the moment occupies the centre of attention, it does not exhaust the destructive possibilities of science ... this reinforces the general proposition that war and science can no longer coexist.*

Einstein replied within the week offering his full support for the initiative. Russell's final letter to Einstein was dated April 5, 1955. In that letter Russell included a draft of his statement for Einstein to endorse. And so it was that Russell left the conference of World Parliamentarians in Rome, eagerly awaiting a response from Einstein when he boarded his flight to Paris on April 18, 1955. His whole plan depended on Einstein's signature, since Niels Bohr, whom Einstein had urged to assist Russell, had refused to show any interest. It goes without saying that Einstein was the most famous scientist in the world, and commanded a degree of respect — one might even say awe — amongst even his most accomplished peers. And so when Russell heard the news that Einstein had died, he felt shattered, fearing that his plan would fall apart without Einstein's support. But on arrival at his hotel in Paris Russell miraculously found a letter from Einstein awaiting him. He had arranged for his mail to be forwarded from London, and was no doubt ecstatic to find Einstein's response, dated April 11, 1955, just four days before Einstein's passing:

> *Thank you for your letter of April 5. I am gladly willing to sign your excellent statement. I also agree with your choice of the prospective signers*.

Einstein's signature on Russell's statement was to be his last. He became fatally ill just two days later. The statement, which is now known as the Russell-Einstein Manifesto, was released at a press conference at Caxton Hall, London on July 9, 1955. Russell recruited Joseph Rotblat, who was also the youngest signatory, to organize and chair the meeting. The room was packed to capacity, and Russell read out the manifesto which ends with the resolution:

> *In view of the fact that in any future world war nuclear weapons will certainly be employed, and that such weapons threaten the continued existence of mankind, we urge the governments of the world to realize, and to acknowledge publicly, that their purpose cannot be furthered by a world war, and we urge them, consequently, to find peaceful means for the settlement of all matters of dispute between them.*

The intervening years, between then and now, can hardly be described as peaceful. While we have survived a Cold War, the *Doomsday Clock* ticks ever closer to midnight. While our future may be less certain than ever, we must remember agency exists only in our present ...