"Flying Saucers Space Travel & Atomic Energy"

by Dr. Daniel Q. Posin

Chairman Department of Physics
North Dakota State College

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Introduction

"There are two things which fill me with eternal wonder," wrote the philosopher Immanuel Kant, "the starry sky above us, and the moral law within us."

I think that recent discoveries in science are helping to show that the two wonders which held Kant enthralled---the Universe with its starry sky and Man, with his soul---are intimately connected. Kant, intuitively, perhaps, seemed to grasp the two elements of wonder--Man as a responsible being, and the Universe, his abode, but he grasped them as two separate entities. New facts of science, yielding as they do a vastly deeper knowledge of the starry sky above us, show clearly why it is that Man, at his best, has a conscience, experiences humility, and strives for nobility. Some men arrive at this feeling of what Einstein calls "religiosity" through formal religious training; some arrive at it through a life of "hard knocks" and experience; others through some intuitive urge. But it is also possible to come to it through a mere physical understanding of the "starry sky" above us, and all that its detailed study implies.

In this book we might begin our study of that starry sky by paying serious attention to the devices called "flying saucers," for, presumably, they come out of that sky and might bring us knowledge of it. We shall see to what extent these flying saucers merit attention, but one thing can be said at once in their favor: men have become more conscious of the existence of space other than space on our Earth, than they have been before. And just as it is all to the good that one is aware of the existence of countries other than one's own, so is it all to the good to become aware of regions in the Universe other than one's Earth. Men, nowadays, often wonder whether there is life in space somewhere--they wonder if there are other habitable Earths...Therefore, in view of the fact that the flying saucers have at least, even though indirectly, forced us to extend our thinking to include the Universe rather than confine it to the Earth alone, they have been of some value, as we have said, and for this reason alone deserve a scientific analysis, rather than superior and contemptuous dismissal. Furthermore, as we shall see, the study of the flying saucers will lead us in a natural way to ask other questions about the Universe, and in the answers to those questions we may find some surprises.

D.Q.P.
September 1952

FLYING SAUCERS,

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Chapter 1

FLYING SAUCERS AND LITTLE GREEN MEN

Perhaps one of the most exciting subjects of conversation in recent years has been the so-called "flying saucer." This term came into popular use in July, 1947, after an airplane pilot in the state of Washington saw nine objects in the starry sky near Mt. Rainier which puzzled him and which he described as looking "like saucers that were flying." Shortly thereafter, one after another, several observers in quick succession, reported to newspapers that they, too, had seen "one of those flying saucers."

It need hardly be said that it was not long before almost any puzzling object in the sky was described as a flying saucer. Although the first objects seen apparently bore some resemblance to saucers, those seen after that were called by that name even though there was nothing saucerish about them. In fact, one of the early objects seen looked like a great flaming sphere. Another looked like a huge cigar. Still a third looked like a huge wing. Nevertheless, the die had been cast, and every strange object was tagged by the name of "saucer."

Many people today are inclined to say that flying saucers do not exist and that they are merely the product of someone's excited imagination or of mass hysteria; but this, of course, is not so. Flying saucers <u>do</u> exist and have been seen on a great many occasions by very competent observers as well as others. Einstein, for example, in writing a reply to a clergyman who asked him whether the saucers were real, replied, "These people have seen something. What it is I do not know, and am not curious to find out." Many of the saucers are, of course, real, and not imaginary; and we may or may not be curious about them. In this book we assume that we are. However, most people, when they use the term "flying saucer" are trying to imply that they are discussing something which has come from outer space--perhaps from the planet Mars or from elsewhere in the great outer distances. This is the crucial matter in a discussion of flying saucers: In general, people do imply that they are talking about something which has come from another planet. Perhaps, they say, these devices from another planet even carry human beings of one type or another. Presumably these creatures would have to be of a more advanced type than those which inhabit this earth, for they are able to come near Earth in a device from their planet; whereas we on Earth have not been able to leave in any device, whether saucer or not. (Some people, it is true, think of the saucers not as devices from other planets, but as objects of war sent over the United States by a potential enemy. Only a moment's reflection should show that this could not be so: Would the potential enemy risk having such a fabulous secret discovered by the U.S. in advance of war? What if one of the objects crashed and we learned how it was constructed? The potential enemy might practice over its own territory, but not over ours.)

The desire to believe readily in the existence of flying saucers which carry "little green men" from another planet springs from a number of psychological causes such as the desire for excitement in this life or the desire for escape from this earth. All this, of course, is highly understandable; and no one can deny that a visit from space by intelligent beings would serve as a shot in the arm to all of us and would excite our lives in many ways. Also, the possibilities inherent in such a visit--namely, that we too might build a space ship and go somewhere else--has a tremendously appealing element in it for most people on this earth--assuming, of course, that the escape from this planet's tribulations would be in a comfortable vehicle that would reach its destination safely. It might be said that not only must a space ship help us to escape from earth and be able to direct us safely to another planet, but it must also be capable of bringing us back to our sorry earth in spite of our troubles which had first prompted our escape. (Somehow, it would seem, no matter how evil the earth or its inhabitants may sometimes appear to be, and no matter how vigorously we may wish to escape to outer space, nevertheless , nearly all of us make a mental reservation that we go only if assured that we could someday come back. After all, we are inhabitants of this planet and belong to it and will eventually want to become permanently identified with it for better or for worse, time without end.)

But to return to the question of flying saucers--what are they? We have said that they have actual existence in most cases. This is so, and by now it is quite clear what they are.

To date, the saucers may be listed under the following headings:

1. Many of the saucers are meteors or "shooting stars," which actually do come from outer space though without bringing us any little green men. Not only do they come from parts of our Solar System other than our earth, but a very great many actually come from regions beyond our sun and his planets. The meteors, of course, are largely chunks of iron and stone and not shooting stars at all; even though they do give the appearance of stars in rapid flight; and, as almost everyone knows, when the meteors enter the atmosphere of the earth, the friction created due to their great speed causes them to burn, usually with a yellowish or greenish color. The meteors ordinarily appear to have the shape of luminous or fiery balls moving at high speed across the sky, frequently silently because they are so high up, often leaving no trail behind them since the flames which are exhausted and fall away turn to smoke and rapidly vanish.

This type of "saucer" is perhaps most nearly the kind which could qualify as a device from outer space. In the Solar System there are many hundreds of millions of meteors flying helter-skelter and generally considered as "cosmic debris"--odds and ends left over at the time of Creation. Many of these meteors travel in regular orbits around the sun, and many in inclined orbits which eventually lead them to collide with the earth, or its atmosphere. These meteors are of varying sizes ranging from that of a dust particle of iron to pieces of rock and iron, nickel, and other elements weighing thousands of tons. They are called meteors while they are in space, and "meteorites" when they hit the ground. Many of these do hit the ground, although most of them are completely consumed by friction in the atmosphere of the earth before they can land. Some of those which have hit the earth have done so with tremendous impact because of their speed and size, as, for example, the meteorite which struck in Arizona some millions of years ago and left a crater almost a mile wide and several hundred feet deep. Another huge meteorite struck ages ago in northern Canada leaving a crater two miles in diameter which subsequently has filled with water and produced a lake. A third meteorite struck a great forest in Siberia only 50 years ago, leveling a large part of the forest, killing a great many cattle, and causing widespread damage. Much of the damage due to a large striking meteorite is due to an onrush of fast-moving compressed air, the heat and force of which may be enough to topple trees and depress the earth. The rest of the damage is due to the direct impact of the stony iron itself. Many meteorites have been found and are now on display, in various museums over the world.

There is no doubt whatever that meteors have been called flying saucers on numerous occasions and will continue to be so called. They certainly are there, in the sky, and people who have seen them are perfectly justified in calling them flying saucers if they want to, although the term "meteor" would be slightly more accurate. There is, of course, available a great deal of fascinating information about meteors, their origin, and their orbits to amplify this brief account, and anyone interested in furthering his knowledge on the subject should consult a good encyclopaedia.

2. Many of the "flying saucers" are actually balloons which are sent up by the armed forces or by various universities and research groups in order to make studies in the upper atmosphere. Usually these balloons have instruments attached in order to investigate conditions of temperature, humidity, and cosmic-ray intensity as well as other factors of interest to the various agencies which liberate them. The balloons are of various sizes--some of them being thirty or more feet in diameter, and as they rise to great heights, observers on Earth may have a difficulty in determining what it is actually that they are seeing. Occasionally, when the red shafts of light from the setting sun illuminate a distant balloon, a sensitive observer on the ground may be awe-struck with the exciting "saucer-like" vision. As a matter of fact, not too long ago the Navy showed a photograph of one of its balloons and the dark material which reinforced its middle gave the balloon an aspect of some sort of shallow punch bowl or saucer when seen from a great distance.

3. Some of the flying saucers are jet-propelled airplanes flying at night at great speeds and leaving spurts of flames behind them as they streak in between clouds. Of course, jet-propelled airplanes make a roaring noise, but naturally an observer can think he saw a noisy flying saucer. This would be all the more interesting and sure to find space in at least the local press.

4. Many of the flying saucers are guided missiles--that is, devices launched by the armed forces in their practice preparations for a saucer war.

Presumably, some day various nations on this earth will pit their respective types of flying saucers against foreign flying saucers and the battle of the saucers will be on. One of the guided missiles, at least, has been publicly revealed. It is called the "Matador," a fast-rising, pilotless airplane capable of carrying bombs and guided entirely by remote control radio signals. Of course, a shape such as that of an airplane would not likely be mistaken very often for a "peculiar" object, but guided missiles come in a variety of sizes and shapes; the Navy's "Loon," for example, is cigar-shaped. Some of these missiles are guided erratically, whether on purpose during practice in "evasion" tactics, or by accident due to mechanical failure; some disintegrate in space, again either by accident or by plan in order to test some exploding mechanism. The people standing on earth craning their necks toward the mysterious starry sky above them scarecely have an inkling of the goings-on in the atmosphere overhead, all engineered by various secret groups preparing for the great conflagration that presumably is coming. It is, in fact, remarkable that the innocent by-standers, who peer at the sky, have not come up with anything more foreboding than the notion that there are saucers flying about them with or without little green men. We earthlings have yet to pay the price that a third World War would exact, and our saucer confusion is nothing but fantasy and play. Would that it could remain that way.

5. Some of the flying saucers are nothing more than reflections of city lights or of the lights of beacons of various types. For example, there is no doubt that in a number of cases the huge searchlights operating from a number of airports in the United States have given the illusion of luminous devices flying through the heavens as these beacons play across the sky, here and there touching occasional clouds. Certainly such a performance by a searchlight would make a confused observer testify that the saucer was flying at tremendous speeds. True, the light of a searchlight flashing across the sky can be made to travel at tremendous speeds, thus accounting for some of our fastest "saucers." Dr. Donald Menzel, Astronomer associated with Harvard University, has shown by laboratory experiment how a beam of light can be made to reflect from various layers of air in a surprising variety of fashions giving an appearance such as is reported by many "saucer-seers."

6. Some of the flying saucers have turned out to be, on closer study, white-bellied geese or ducks flying peacefully along across the sky unmindful of the fact that they are the center of international interest, and hoping, doubtless, to keep as far from a sauce-pan as possible. In one case, in Fargo, the geese were flying at night and the city lights were reflecting spasmodically from their bellies. At first the observers were certain that they were seeing saucers, but when these saucers emitted sounds like, "Honk! Honk!", the observers became dubious that these were objects of mystery. True, some of them mistaking the sounds for "Honk! Kong!," thought that they were observing Chinese flying saucers. However, more level-headed observers in the assembly were certain that the saucers were not subversive. (And one of them, in fact, remarked, "I'm going to get my gun and get me a brace of them flying saucers.")

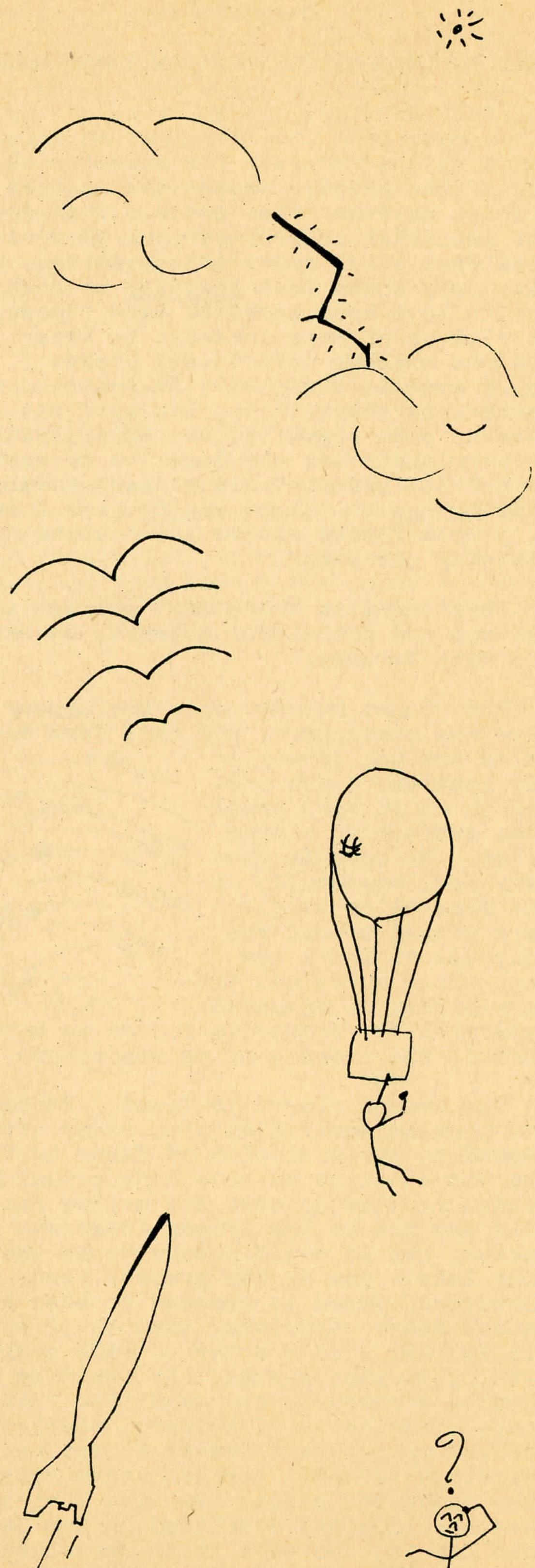
7. Some of the flying saucers are genuine, and indisputable frauds. There are those who deliberately, for some peculiar reason, perpetrate a hoax on their already-confused fellow-man. It is understandable when a magician fools the people at a carnival--he is known to be fooling his audience and moreover he is being paid for it. The saucer frauds, however, are not paid for their perpetrations-except in the case of certain writers who have hit the best-seller lists with profitable fantasies passed off as "truth"-but they go about their work with astounding zest nevertheless. No doubt part of the hoaxers' reward is the consequent notoriety over the radio and in the newspapers; and perhaps in a world where everyone struggles for either subsistence or recognition, or both, the publicity attendant upon having seen exceptional saucers must be rewarding. Cases have been known in which people have not only given false information by word of mouth, but have actually produced fake photographs purporting to show various gadgets in flight or hovering over a barn or crowded city. One of the most flagrant but thoroughly planned hoaxes was that in which crashed saucers with little dead men were reported. A thorough account of this case, together with the commercial angle by which one deceiver expected to make thousands of dollars, is thoroughly reported in "True" magazine, of September, 1952. The sleuthing of reporter Cahn, incidentally, is more fascinating than the saucer fairy-tale itself.

8. In addition to the guided missiles which we have previously mentioned in an almost casual manner, we should also reserve a section to a great host of

devices--some of them publicly known, some highly secret--which are launched into the sky by the Army, the Navy, the Air Force, or by civilian scientists. These devices are in large measure launched from the regions of Arizona and New Mexico where, in fact, as everyone knows, the armed forces have numerous and varied installations for launching gadgets of various types. As a matter of fact, many of the saucers observed have been seen just precisely in the regions mentioned above and for the obvious reasons. One need only say that inasmuch as the rocket, guided missile, and propelled gadgets programs have been operating since about 1940, it certainly should not be too surprising if devices of various types now begin to appear in the heavens above us. After all, many millions of dollars have been spent exactly for such purposes and it would be astounding indeed if the spending of the tax-payers' money did not manifest itself in some form or other, be it the bewildering heavenly apparations or what have you?

9. Still another type of saucer is exemplified by the exciting saucer-siege of several days' duration which occurred not long ago when airport radar men in Washington, D. C., reported "contacts." A number of "blips" were clearly observable on the radar screens, at several different stations, and when airplanes were dispatched aloft to investigate, several luminous blobs were actually seen, which however, defied capture, and managed to vanish. There was some reason to believe that Air Force pilots were not overly excited while taking part in this chase, arriving late and reporting "Nothing," but civilian pilots did sight the luminous blobs, and reported them. One might be led to believe that the Air Force was testing the defenses around the nation's Capitol, by releasing certain devices and then tracking them by radar as would be done if enemy bombers or guided missiles were coming at us from the starry sky.

If the Air Force was as genuinely puzzled as the civilian airport operators, the saucers could have another explanation: electrified or ionized air can reflect radar signals; moreover, a play of lightning can assume various forms besides the common stroke type; one can have sheet lightning, and, even, on occasion, ball lightning, which rapidly disintegrates.



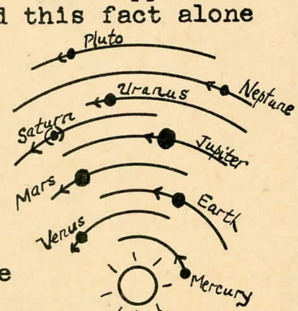
Chapter 2

ARE FLYING SAUCERS FROM MARS POSSIBLE?

We have seen thus far that no evidence exists whatever for assuming that any of the saucers except the meteors come to us from outer space. This does not mean that there never can be visitors from outer space to our earth. We have only shown that thus far no such visits have been known to take place. It will be of some interest to examine now whether or not such visits could ever be expected. In order to examine this possibility, let us first take up each planet of our Solar System in turn and raise the question of whether or not the planet could possess advanced-type beings who might manufacture a space ship or a flying saucer in which to come visiting our earth.

Starting with the planet nearest to the sun and proceeding outward, we begin with Mercury.

The planet Mercury does not appear to have any atmosphere, and this fact alone rules out the possibility that there are creatures on it that could have evolved to a high order. Mercury is also very hot, especially on the face which is always turned toward the sun; but it isn't the heat which rules out the possibility of advanced type of life, rather is it, as we have stated, the absence of an atmosphere.



The second planet is Venus. Perhaps the best scientific opinion today with regard to the condition of Venus is this: the planet seems to have a perpetual heavy sandstorm blowing over its entire face. This may not be the proper interpretation, but it would appear to be the most likely one at the present time. If, therefore, Venus is assumed to have a perpetual heavy sandstorm, then it is not likely that a high order of life could develop on that planet. It would be comparable perhaps to the condition that our earth would be in if it were utterly enveloped by a Sahara Desert in violent ceaseless turmoil, the sandstorm reaching high above the plain. We know that no advanced life has developed in our Sahara Desert; and were it in ceaseless turmoil, the chances for such development would be considerably less.

The third planet in distance away from the sun is Earth. True, Earth, we like to say, has developed advanced beings who are almost capable of building flying saucers or space ships which could go out to another planet. However, at the present time we are discussing visitors from other planets to Earth and not the possibility of Earth visits to other planets. (It is estimated that if a strong concerted effort were made on Earth to fashion a space ship for a trip to the Moon or to Mars, that such an effort could be successful perhaps within 50 years or less. Obviously, at the present time the scientific resources are channeled toward other activities on Earth.)

The fourth planet in distance from the sun is the planet Mars. In the case of Mars a number of favorable characteristics may be sighted which may indicate, collectively, the possibility that some type of life exists. First of all, Mars does have some atmosphere. True, this atmosphere is not very heavy, and in fact would be insufficient for comfortable existence for Earthlings who might land there. However, the thin atmosphere there may not be much worse than the thin atmosphere which exists on some of the taller mountain ranges of Earth. And, in fact, in South America, in the Peruvian Andes, there are tribes of Indians who live rather comfortably at the height of 14,000 feet. These Indians have developed unusually large chests which indicate that they take in a greater volume of air at a breath, thus making up for the fact that the air is thin. As a matter of fact, when these Indians descend to the valley regions below, they, for their part, find breathing a rather uncomfortable process and always long to return to the upper reaches for which they are physically fit. Therefore, one could visualize a Martian, possibly barell-chested, and developed in accordance with his particular environment.

Naturally, one should also ask whether or not there is water on Mars. The answer is "yes." In fact it is possible to see through a telescope snow caps at the Martian north and south poles. The snow at these places is not very thick and in fact it melts at one pole when the planet is inclined towards the sun while the other pole is in a winter state. Conversely, when the planet receives summer rays at the second pole, the snow melts there while freezing takes place at the opposite pole. Such an event, of course, does not happen on Earth because the Earthian ice caps are extremely thick whereas the Martian snow or ice caps seem to be only a few inches thick. However, the fact remains that there is snow on Mars which turns to water and therefore we now have two important characteristics: Namely, the existence of atmosphere and of water. Thirdly, it may be mentioned that Mars appears to have vegetation. This we deduce from the fact that at one part of its year Mars has a green coloring which slowly turns deeper, changes to yellow and orange, finally seeming to turn brown during the Martian fall. If then the planet has some atmosphere, some vegetation, and some water, one might be led to expect that life of some type does exist and it is only a question of how advanced that life would be. The planet Mars is presumably of about the same age as the earth--namely, about 3½ billion years--and so enough time has existed for a considerable amount of evolution to take place which might have led to the production of living beings of a fairly high order. No one can say, however, whether or not its beings would be as advanced as the Earth creatures. The best estimate today is that the Martians, if any, would be of a lower order of development than the Earth beings because of the insufficiency of the Martian air, water, and vegetation.

In passing, one might make a remark concerning the so-called "canals" on Mars. Most astronomers do believe that some types of canals or channels are to be seen on Mars, but they no longer believe these are "man-made," and are for such purposes as irrigation and navigation. Very likely the canals are some sort of fissures or breaks in the ground and have no connection with Martian engineering feats, if any.

We would conclude then, with respect to Mars, that no space ships or flying saucers are to be expected from them for some time to come at least.

The next planet from the sun, beyond Mars, is Jupiter. This planet, though large and impressive, cannot be the home of any advanced type of life inasmuch as it is a seething mass of methane and ammonia gases, and these are incompatible with the development of heart, lung, and blood systems.

The next planet is Saturn and this, too, is not expected to be the home of superior beings in view of the fact that it has an atmosphere of noxious gases where life would not be likely to develop.

Beyond Saturn we have the planets Uranus, Neptune, and Pluto; and in all these cases one cannot expect advanced types of beings to exist largely because the atmosphere, if any, is unfavorable. In fact, on Pluto, which is so distant from the sun and so cold, the atmosphere must be frozen, lying like a blanket of ice over the dead ground.

We see, therefore, that no flying saucers are to be expected from any of the planets in our Solar System and yet we must state here that it is possible that some visitors from space may some day arrive on Earth.

At first glance this may seem like a contradiction, but we will hasten to explain that although it is extremely unlikely that any visitors could come from any of the other planets in our Solar System, there is more to the Universe than our Solar System. It appears, therefore, that we are here thinking of the possibility that visitors from space may come from some other Solar System. This is, in fact, what we have in mind...

Chapter 3

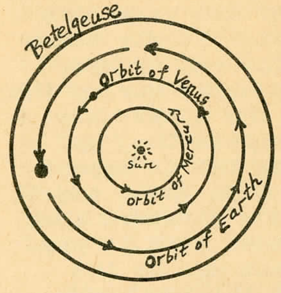
ARE FLYING SAUCERS FROM SOME OTHER SOLAR SYSTEM POSSIBLE?

As we look into the sky on a clear night we see a great many stars. Most people would say we see "millions of stars." Actually we see only about three thousand stars with the unaided eye. True, with the use of binoculars or opera glasses thousands of other stars come into view, and with the use of telescopes of higher and higher powers literally millions and millions of stars actually do become visible. The Milky Way is, of course, a vast region containing billions of stars. And each one of these stars is like the star which we call our sun. Or to put it conversely, our sun is nothing more than an average star. Obviously what we are trying to do here is to indicate that while the sun may have planets and at least one of them--Earth--has advanced human beings capable of building flying machines, other suns or stars can have planets with human beings capable of building flying machines.

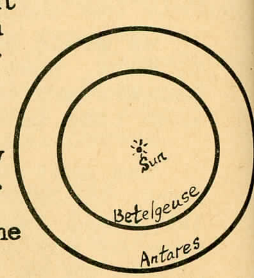
We want to examine this question of other suns--that is, the stars--and their possible planets a little more closely. First, we want to reiterate that the sun is just an average star. Naturally it looks different to us, but that is only because Earth is closer to this particular star called the sun. Anyone can easily visualize what the appearance of another star would be from a planet which is associated with that star. From that planet, the other sun would look as our sun does to us from Earth. This hardly needs any elaboration.

Now to return to the size and condition of our sun. The sun is a flaming body busy with the production of energy by atomic processes, giving out warmth to the planets around it, though not very much to the distant Uranus, Neptune, and Pluto. The size of the sun may be indicated in terms of its diameter which is about 866,000 miles. So here we have a luminous energetic body, spherical, and not quite one million miles in diameter. Now is this very large? Is this very impressive? Obviously these words "large" and "impressive" are relative terms. To us on Earth the sun seems large and its heat-producing ability seems impressive. But what we are trying to do really is to compare our sun to the other suns--that is, to the stars--for a moment. The fact of the matter is this: There are a great many stars which are much smaller than the sun and there are a great many stars which are larger than our sun and there are a great many stars which are about the same size as our sun.

For example, the star--or sun--called Betelgeuse (which is the arm-pit star in the constellation of Orion) is much larger than our sun. In fact, Betelgeuse has a diameter of about 250 million miles. One can see therefore that our sun could be placed within the disk of Betelgeuse and would then be like a grain of sand lying on a silver dollar, for it would take about three hundred of our suns to fit in a line across the diameter of Betelgeuse. If our sun is placed at the center of Betelgeuse then the planet Mercury would be revolving around our sun and still within the disk of Betelgeuse. Furthermore, the planet Venus would be revolving around our sun and it, too, throughout its orbital revolution still would lie completely within the disk of Betelgeuse. Even our own Earth in its "great" yearly travel around the sun would have its orbit lying entirely within the disk of this massive star, Betelgeuse, inasmuch as Earth moves on a circle which is 93 million miles in radius and here we have the disk of Betelgeuse with a radius of 125 million miles.

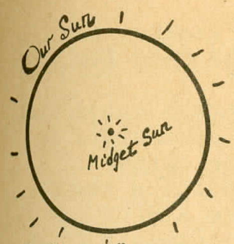


Betelgeuse, however, is not the largest of all the stars. Far from it. One might mention, for example, the star Antares which is in the constellation of Scorpius. Antares is about 4 hundred million miles in diameter. Therefore, Betelgeuse itself could be dropped into Antares with lots of space left. And there are, of course, many stars larger than Antares. But for a moment to pass in the other direction, one might make mention of the fact that only recently a midget star was discovered whose diameter is only 2,500 miles. Compared to this midget star our sun is a giant whereas compared to Antares our sun is a midget. That is why we have referred to our sun as about an average star.



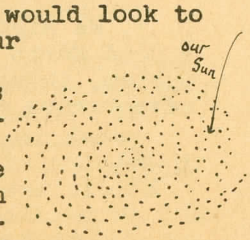
We are now ready to discuss the possibility of the existence of other Solar Systems or families of planets surrounding some of the other suns--that is, stars. It is not possible to make dogmatic statements with

Two Suns, a Comparison ↑

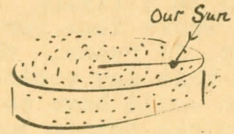


regard to the existence of Solar Systems for other suns, but from the laws of probability or pure chance it should be evident that if an average star such as our sun can have a family of planets, then other suns whether "average" or not could conceivably have families of planets of their own. No doubt in certain cases all of the planets of some other sun would be much too close and therefore too hot to make existence of life possible, and no doubt in many cases the planets would be too far from their sun and therefore far too cold to make existence of life possible. And no doubt in many cases though the planets may be just right in position, there still may be an absence of atmosphere--especially if the planet is too small so that the gravitational hold on its atmosphere would not be large enough and the atmosphere escaped.

No doubt, in many cases the planets would be at just the right distance and have atmosphere, water, and vegetation, just as is the case on the planet Earth circling around its own star, the sun. There is a way, in fact, of making an approximation as to the number of possible "Good Earths" which could exist surrounding the stars all about us. By "Good Earths", of course, we mean planets having air, water, and vegetation suitable for supporting life. But before we make the estimate, we want to return to the question: how many stars are there? or, how many suns are there in the heavens? Counting the stars which we see and the stars of the Milky Way and all the stars which are in a kind of group all together, one can say today that we belong to a collection or a congregation of stars numbering about one hundred billion. That is to say, our sun (and, of course, his family of planets) is a member of a large collection of stars grouped together in a large family of stars which we now call "Our Galaxy." Our Galaxy, consisting of this host of one hundred billion stars, would look to an observer from outside Our Galaxy like a flat pillbox of stars. Some astronomers have described it as a circular watch-case of stars. In any event, the stars are clustered together with an approximately circular diameter of considerable width (one hundred thousand light years; that is, a distance which light would travel in one hundred-thousand years, at the rate of 186,000 miles per second. One light year is about 6 trillion miles.) The thickness of this cluster, that is, of Our Galaxy, is about 20 thousand light years. That is why we have described it as a pillbox: a cylinder of greater diameter than depth.



Now where is our sun in this collection of stars which we call Our Galaxy? Our sun can be located about as follows: Start at the center of the pillbox and go out a distance about 3/5 of the way towards the end. So it turns out that we are about 20 thousand light years from the circumference of the pillbox. In any case, the point of interest here is that our sun with his planets is not at the center of the galaxy, nor is our sun an unusual star in size or in any other way. We see once again that our sun is just an average star and located in just an average spot within Our Galaxy.



It is considerations of this type which lead us again to remark that other stars or suns have as much chance of having a family of planets of their own as our particular sun. Now we are ready to make an estimate as to how many of these suns (and we have said there are about a hundred billion of them) have Good Earths of their own. We repeat first that we are not counting those Earths which either are too hot, too cold, or too lacking in other properties necessary for the maintenance of life. In this spirit the British mathematical astronomer Fred Hoyle has estimated that in Our Galaxy there are about one hundred thousand Good Earths with living beings on them, some as advanced as we are, some far less advanced than we are, some more advanced than we are. Insofar then as expectations of flying saucers from outer space are concerned, it is from some of these Good Earths which surround other suns that our visitors might come, if at all. We repeat: we do not expect visitors from the members of our own Solar family like Venus, and Mars, but we could expect visitors from another star's family, from one of the Good Earths among the one hundred thousand estimated.

Naturally, the question immediately arises, why haven't some of them arrived here already? And the answer in part may well be: it is pretty far from another Solar System to us. In fact, the nearest sun after ours, that is the nearest star to us which might have a Good Earth around it is Alpha Centauri which is about 24 trillion miles away.

Astronomers would say that it is about 4 light-years away--that is, that light would take 4 years to reach us from Alpha Centauri (light from our sun reaches Earth in about 8 minutes).

Therefore, as we have said, the nearest possible Good Earth outside of our Solar System lies at a distance of about 24 trillion miles and a space trip from such a Good Earth to us in a flying saucer or a space ship would take perhaps, at the very least, 75 years. When one considers the fact that any visitor from another Good Earth would have to reserve 75 years more for his return journev. we can see that there may not be a great many enthusiasts when it comes to leaving on a trip which would take 150 years in total. How much fun would there be in setting out and traveling through space and space and space for approximately 150 years even though admittedly there might be some excitement in landing on another Good Earth? (Or is our Earth really Good?) How many enthusiasts on <u>our</u> Good Earth would set out on a trip through emptiness which might take even only 20 years for a total journey?

Thus it becomes fairly clear why our Earth has not been the goal of a vast army of space travelers. Furthermore, what if the nearest sun, that is a star, Alpha Centauri, does not have a Good Earth? Then, perhaps, one might receive visitors from the next sun or star, and this one--the second nearest to us--is at a distance of 54 trillion miles or 9 light-years. A round trip journey from a Good Earth to this star then would take over three hundred years. And what if even this star did not have a single Good Earth? Then one might hope to expect a trip from a Good Earth of the third nearest or fourth nearest or fifth nearest star. After all, our estimate has been that there are about one hundred thousand Good Earths belonging to about one hundred billion stars. This is a ratio of one in ten thousand and so perhaps there is no Good Earth surrounding even the sixth, the seventh, the eighth, the ninth nearest sun...Accordingly one sees that the nearest Good Earth might be one which revolves around the thousandth star away from us or the ten thousandth, and in such an event, a round trip journey might well take many thousands of years.

So do we expect visitors from space?

It might well be, and in fact it is very likely, that space ships or flying saucers do travel from planet to planet and even from one Solar System to another but it is quite clear that our particular Solar System is not near another one where there is an advanced Good Earth.

And now we come to another intriguing question. Are there any more stars in space than those which are contained in Our Galaxy of a hundred billion stars? The fact is that there are a great many other galaxies in space visible through Our Telescopes. In fact, one billion such galaxies as Ours have been already photographed and it is expected that with the improvements in telescopes at least another 7 billion will become visible. So we see that the space which we know at the present time contains multitudinous congregations of stars or groups called galaxies separated from each other by vast distances, each galaxy containing about one hundred billion stars and in each galaxy about one hundred thousand Good Earths, many of them doubtless having space ships or flying saucers flitting from planet to planet.

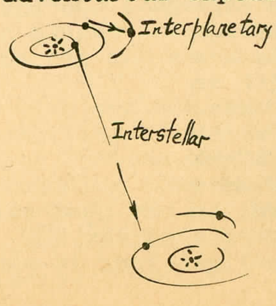
One might give some idea now of the distances between galaxies. For example, the nearest galaxy to Our Galaxy is about 8 hundred thousand light years away. (That is about 6,000,000,000,000 x 800,000 or 4,800,000,000,000,000,000 miles.)

To summarize then the question of flying saucer trips or space ship trips we can say the following:

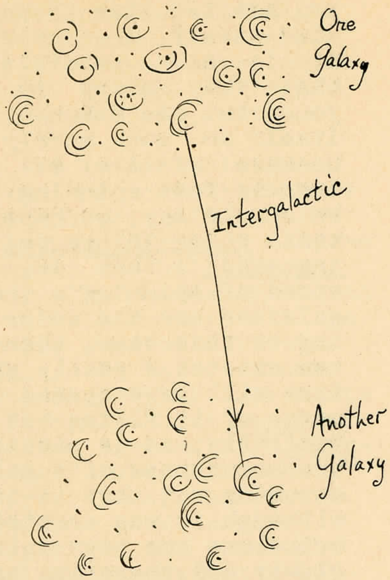
1. We do not expect any visitors from other planets of our own Solar System, that is, from Mercury, Venus, Mars, etc. These would be called "interplanetary trips."

2. Such visiting no doubt does exist among other Solar Systems where there is more than one Good Earth and sufficiently advanced civilization--at least slightly more advanced than Ours.

3. We might some day get a visit from a Good Earth belonging to another Solar System, though this would be a highly adventurous expedition for our visitors. Such a visit would be called an "interstellar trip," or "interstellar journey," meaning, of course, from one star to another star, although, more precisely, it would be from a Good Earth of one star to a Good Earth of another star.



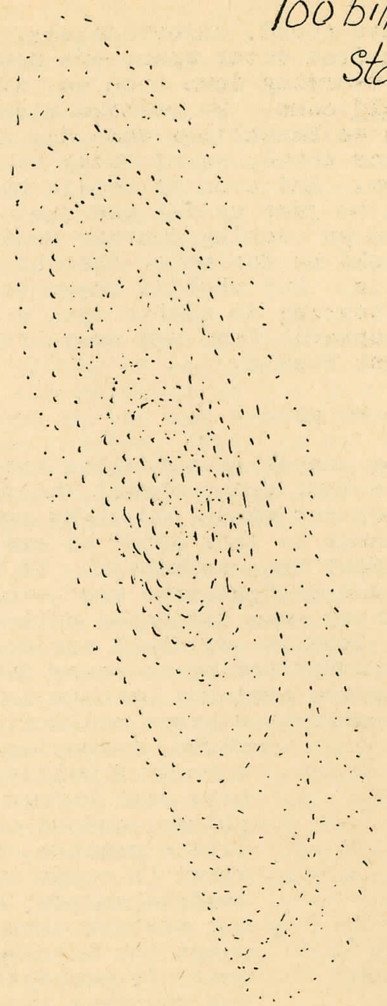
4. Finally, one might conceive of a "galactic trip" and that would be, of course, a visit from a Good Earth in one galaxy to a Good Earth in another galaxy. We hasten to remark, however, that an intergalactic trip in actuality seems like an impossibility at least insofar as a trip taken by living beings is concerned. Quite apart from the fact that a fantastic amount of energetic fuel would be required to escape from one galaxy to another, overcoming the pull of gravity, there is the question of the length of time the trip would take. Obviously, since the nearest galaxy to us is 8 hundred thousand light years away, a trip in such a case would require about 15 million years one way. Once again, in summary, we could say that for us an interplanetary visitor is not to be expected because advanced life does not exist on any of the other planets of our family, that an interstellar visit is not likely because of the great distance and finally that an intergalactic one is completely out of the question.



There remains, of course, that central possibility of an interstellar visit, in fact of many of them, if especially we make allowance for the fact that life on Good Earths of other suns may be of a very much longer span than life on our Earth. Thus if a life span on a Good Earth of say the sun Alpha Centauri is one thousand years then it may well be that some enterprising Daniel Boone of space might not mind a journey of 75 years for the purpose of exploration.

But must exploration of our Universe be conducted in person? Must we actually propel our bodies through space? Is there nothing more that we can do by means of telescopes, by calculations, by the use of the reasoning power of the human mind? Or, is there nothing we can accomplish by allowing flight to our imagination--a scientific imagination, propelled not by atomic energy but by the power that lies in the human spirit...

About 100 billion Stars



Rough sketch of Galaxy in Andromeda — much like Our Galaxy

A beam of light from the above galaxy takes about 800,000 yrs to reach us

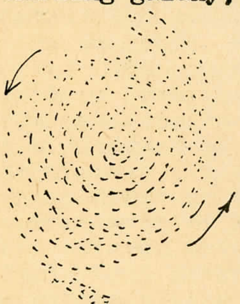
Chapter 4

THE GALAXIES

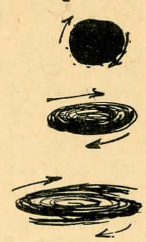
We have found, unfortunately, that visitors from outer space are not likely to come swarming down upon us, although they could come. We realize also, that although we Earthlings some day shall have space ships, as of today we do not have them. And even if we did have them it would be just as far and just as long for us to go seeking another Good Earth as it would be for other "Earthlings" to come to us. But what is there to prevent us from soaring in spirit upon a mental saucer--upward, far, and away, faster than light itself.

Shall we go?

Having propelled ourselves and our telescope into space aboard the flying saucers of our minds, we might now stop for a moment to look about us and wonder at the sight that we behold. If we look with a kind of "galactic eye"--that is, if we survey vast distances without peering into details--we shall see about us patches of luminosity in every direction. Each of these luminous patches is a whirling galaxy, a great collection of



stars, numbering about a hundred billion as we have said before. Each galaxy, shaped perhaps like a pancake, turns about in space at tremendous speeds, but from our distant vantage point the turning is scarcely perceptible. One complete revolution of a galaxy about its axis takes perhaps two hundred thousand years (as it does for Our Galaxy), but there are other galaxies which whirl more rapidly and some less rapidly than this. As we peer more closely at these galaxies we notice that in their terrific spinning the edges have been thrown out from the center as happens with water swirling in a pail of water or as happens with milk and cream in a centrifuge. At any rate, the edges of the whirling pancake are not smooth but have great numbers of stars spinning away like the arms of a spiral which is breaking up. In fact many of these galaxies are called "spiral nebulae." There is a theory concerning the connection between the appearance of such a galaxy and its age. Thus, for example, if a galaxy is very smooth around the edges one might suppose that only recently has it begun to whirl and therefore has only "recently" been created. Whereas if a galaxy has rough edges, many parts of which are flying away, then presumably it was created long ago and has had time to unwind itself. Of course, it is also possible that the galaxy is young but has unwound itself so much merely because of its extremely fast spinning.



We should say, perhaps, that other things being equal - that is, speed of spinning - the more unwound galaxies are the older ones. According to this view, then, a galaxy which has existed a really great length of time will have spread out very diffusely, parts of it flying out to great distances. Similarly, it is possible to explain the smoothness of a galaxy's edges by assuming not that it is young, but that although it was created long ago it nevertheless has been spinning comparatively slowly and therefore has not been able to shatter itself, and throw its edge stars far and wide.

As we adjust our telescope on our imaginary journey through space, and gaze more closely upon the galaxies about us, we are able to see much detailed structure and even individual stars, some of those hundred billion or so which make up each galaxy.

Having caught a glimpse of the myriads of dazzling galaxies about us and the greater myriads os stars, we are undoubtedly seized with wonder by many of possible questions:

1. How far do these galaxies extend?

2. How many of them are there?

3. Does this go on forever?

4. How does it come to an end?

5. Is there an end? And if so, what is beyond?

6. When did it all begin?

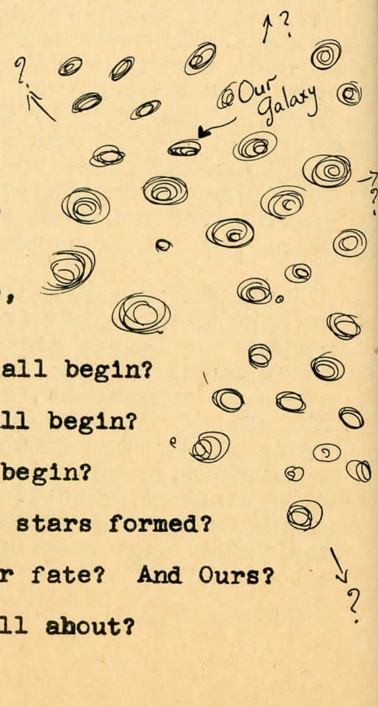
7. How did it all begin?

8. Did it ever begin?

9. How were the stars formed?

10. What is their fate? And Ours?

11. What is it all about?

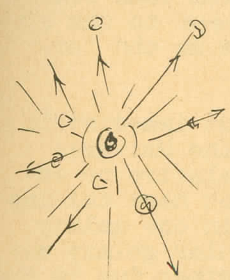


It is not possible to answer all of these questions at the present moment, if at all. We shall be able to answer a number of these questions but it will first be necessary to reach a certain stage in our study where we better understand the meanings of words like "begin," "creation," "infinity," "fate," etc.

For the moment, it is possible to state a few facts and proceed from there with at least some understanding of the things which puzzle us. First of all, we can restate that about one billion galaxies have been actually photographed and perhaps about seven billion more will be photographed some day when better telescopes are available. It is a curious thing, no doubt, to learn that scientists expect to find definitely about seven billion more galaxies instead of "countless numbers" in the future. But the fact is, that on present-day theory, which will be explained soon in this book, we do not expect to see countless billions more. Rather, we expect a definite number more: seven billion.

But let us return now to our situation in space, to the starry sky and beyond it, where a cosmic majesty surrounds us, and our hearts fill with a great wonder. All about us are galaxies in space and we now decide not to ask too much, but to seek at first only the answer to one question: How did the galaxies come into being?

Of course there are a number of theories concerning the origin of galaxies and we shall now take up one or two of these. There is a theory due to Abbe LeMaitre, a Belgian scientist and priest, to the effect that "it all began" when one large fat atom which contained all the matter of the Universe exploded. Abbe LeMaitre therefore starts us on the road to the explanation of galaxies and the Universe as a whole by beginning with one concentrated amount of matter which will disintegrate and give rise to all the material in the Universe. This original huge atom LeMaitre calls "the primitive atom." Presumably the atom once became unstable or radioactive; and, exploding in a mighty bang, threw pieces of itself throughout all space. These pieces are presumably still hurtling through space, exploding, or spinning, or cooling and constituting the galaxies, the stars, the planets, the meteors, and all cosmic matter. Of course one can immediately ask several questions when



this theory is suggested: Are the various galaxies moving away from each other as one would expect them to do according to the Abbe's theory? The answer is "yes." As a matter of fact, the Abbe proposed his theory after it became known that galaxies are flying away from each other. Therefore, to emphasize an important point, we may say that today we believe that the galaxies are indeed all moving away from each other. The evidence for this belief will shortly be discussed. However, the Abbe's theory still does not explain many questions, among them the following: What did we have before the primitive atom? Who put it there? Why?

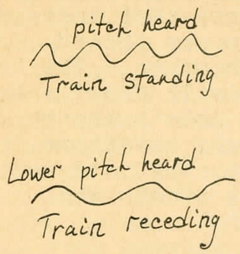
Thus we see that having started on a theory giving an explanation of the origin of the galaxies we run into more questions in the end than the number with which we started. This is not a bad state of affairs inasmuch as our inquiry has excited our curiosity and perception and filled us with wonderment.

Now to take up a second theory, this one due to the British Mathematician-Astronomer, Fred Hoyle, and some of his colleagues. According to Hoyle, the galaxies were simply formed from a gaseous material out in space, namely hydrogen. At this particular juncture we will not inquire into the obvious questions of where did the hydrogen come from and, why hydrogen? and, who put it there, and once again for what purpose? As we have indicated at the beginning of this chapter, such basic questions will be postponed to a later chapter to be considered after we have reviewed the meaning of certain words such as "creation," "purpose," and the like.

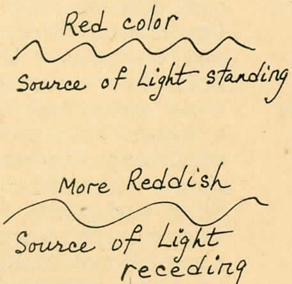
To play along then with Hoyle at the moment we need only to inquire as to how the galaxies were formed, and from what sort of material, and whether or not his explanation allows for the apparent action of the galaxies in running away from each other?

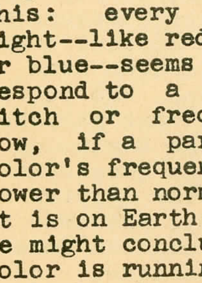
Before launching into an explanation of Hoyle's theory, we will stop for a moment to examine in more detail this question of the galaxies running away from each other, and how we know that they are. One might begin about as follows:

If we are standing at a railroad station waiting for an approaching train, we may pass our few moments listening to the high-pitched whistle of the train as it comes rushing toward us. When the train arrives at the station and comes to a halt, the pitch of the whistle will not be as high--always assuming, of course, that the train continues whistling for some strange reason. (Possibly to accommodate us in our experiment.) If now the train departs, gets up speed, and continues to whistle, the pitch of the whistling will be lower than it was when the train was at the station and still lower than when the train was approaching the station. This sort of phenomenon is called "the Doppler Effect." What we have here is this conclusion: A certain pitch or frequency sounds higher if the whistle is approaching us (or if we approach the whistle) and it sounds lower if the whistle recedes from us (or if we recede from the whistle.)



In the case of the galaxies, here is how we apply such effects or observations. In the first place we can fix our attention upon some particular color in some galaxy such as the color of a hydrogen "pitch" or frequency as seen through a spectroscope. The point is this: every color of light--like red, white, or blue--seems to correspond to a certain pitch or frequency. Now, if a particular color's frequency seems lower than normal--that is, lower than it is on Earth in our laboratory--then we might conclude that that particular color is running away from us. This would be the application of the Doppler Effect to the case of light instead of sound. Now it happens that the frequencies of the hydrogen color have been measured for a great many galaxies and they do come out to be lower than in the normal case. We therefore might conclude that the galaxies are running away from us and we in turn are running away from them--it is all a relative situation. One of the best ways perhaps to visualize this running away process or this "expanding universe," as it is called, is to think of the following model: imagine a black balloon with white spots on it. The balloon is supposed to be the "Universe" and the spots are the galaxies. Now imagine that the balloon is being blown larger and larger and larger. Then any two galaxies or spots move away from each other.





No matter at which spot one stands, all the other spots seem to be moving away. Incidentally, the spots which are further away from say the spot where we are, will be moving away faster than the spots which are nearer to us. This is quite easy to comprehend by the following calculation: if the two spots were one inch apart they may now be two inches apart, but if two spots were six inches apart they will now be twelve inches apart because all parts of the balloon stretch and contribute to the total increase in distance. We can therefore see that the near spot was moving away at say one inch per second whereas the further spot is moving away at six inches per second.

This might make us raise the following question: For the galaxies, do we have different rates of separation? Or to put it another way, are the hydrogen frequencies decreased more for some of the galaxies than for others? The answer is "yes" to these questions. The nearer galaxies move away at a certain "slow" rate and the further galaxies in our expanding universe are moving away at a "fast" rate if we interpret the evidence of the observations in the manner we have discussed.

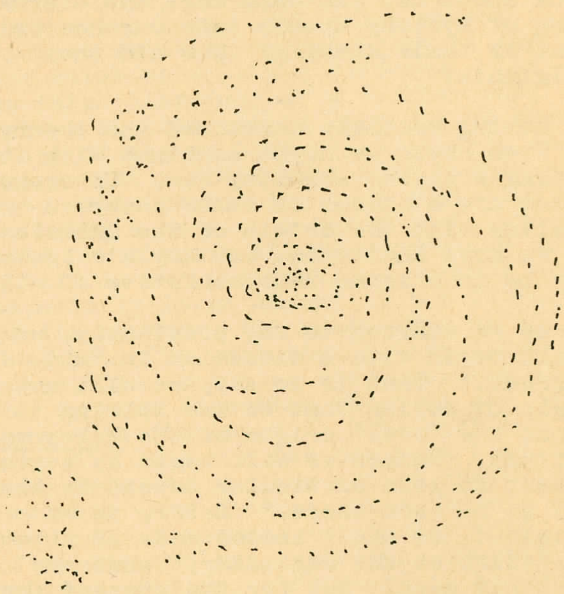
Now to return to the balloon--actually, in order to imitate the situation of space we should really visualize a "solid" balloon or let us say a black sponge ball with white spots sprinkled inside of it as well as on the outside. If it were possible now to make this solid ball expand, all the white spots would still move away from each other. This perhaps is much closer to the situation which we describe as the "expanding universe."

It must be pointed out immediately that this expanding of the Universe applies to one galaxy relative to another galaxy. We are not here talking about individual stars in one galaxy. The stars in one particular galaxy may be pretty well held together due to the over-all gravitational effect. Or if they are moving a little bit apart due to that centrifugal action we mentioned before, these speeds would not be very great. It is the movement of an entire galaxy away from another galaxy which is of considerable velocity and can be detected by the Doppler Effect as we look at one of our stars around us. But we do hope to detect the Doppler Effect as we peer through a telescope out into space and focus on another galaxy. The situation is perhaps something like that in which one dog with his fleas runs away from another dog with his fleas. Unpretty as this analogy may be, it may nevertheless be of some assistance. Each dog is a galaxy and the galaxies here are moving apart. The fleas of each dog are the stars and they do not move too much apart from each other, perhaps. At least not as far as the dogs move from each other, nor as fast.

But how is it that we have suddenly left our majestic vantage point among the exciting wondrous galaxies and come crashing to Earth, to speak of fleeing dogs? Life encompasses everything.

But now, if we wish, we may rise again and in a twinkle transport ourselves through space aboard our mental flying saucer, upward again to the starry sky above us--and even beyond.

Shall we try again?



Whirlpool Nebula, called Messier 51
About 3 million light years away

Very rough sketch

Chapter 5

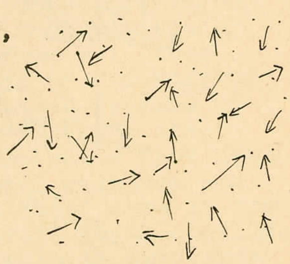
THE FORMATION OF GALAXIES, STARS, PLANETS, AND "GOOD EARTHS"

Aboard our imaginary flying saucer we have sailed upward through our starry sky, and now we are among the galaxies. We look about us, and once more the eternal song of mystery steals into our hearts: What is their meaning? How did they originate?

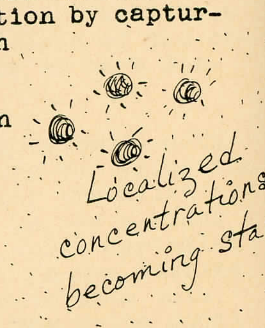
Having recently mentioned the theory of Fred Hoyle we might continue with it, making a closer scrutiny now. Of course there are a number of other theories dealing with the origin of the galaxies, as we have indicated, but Hoyle's ideas may be in a sense representative of all.

As we started to say previously, we shall begin with a situation in "mid-current." That is to say, we will not begin by saying that we are talking about the "real" origin of the Universe--not yet. Rather we will begin by saying "start at this particular moment in time and go on from there." Later, as we promised, we shall indeed make an attempt to "start at the beginning," whatever that may mean. But for the present then we proceed as follows: Consider a particular region of space containing nothing but that lightest of all gases, hydrogen. There are no lumps of matter here but there are, of course, atoms. The atoms of hydrogen are moving erratically, at random, in every-which-way. As time passes, some of the atoms congregate in a tiny region of space because of the force of attraction which exists between them. In another spot other atoms of hydrogen have congregated and continue to add to their bulk by snaring still other atoms of hydrogen that bump into them or pass very close to them. In still another region of space other groups of hydrogen atoms have congregated, have picked up stragglers, and have grown more and more massive as time continues to pass. What we now have is a region in space containing a background of hydrogen gas with localized spots of masses of hydrogen lumps. The larger these lumps of hydrogen masses grow the more atoms they catch by gravitational attraction, and the process continues to "snow-ball." As the catching and the growing continue, the lumps

turn about, move at random, collect more hydrogen gas, perhaps turn still more, and thus continue growing in mass and revolving about, always remaining in the thin sea of the original hydrogen gas. Clearly, as time continues to flow, and the lumps of concentrated hydrogen continue to grow, a moment may come when some of these lumps may begin to steal the surrounding hydrogen gas at a very great rate...By now we have a mass of concentrated hydrogen gas of really tremendous proportions and as this mass continues to steal the surrounding hydrogen gas the stolen particles of hydrogen fall into the attracting lump with greater and greater speeds, and the accumulation really becomes large.



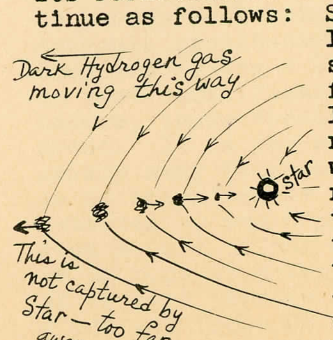
As the great lump of concentrated hydrogen gathers more and more material, within the lump itself, certain localized smaller regions in turn increase their concentration by capturing the particles which surround them. This type of localized increase in concentration continues throughout the lump mass, eventually giving rise to the formation of stars.



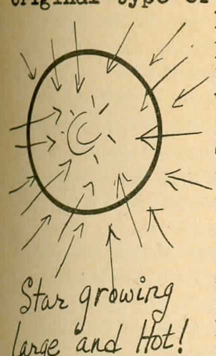
Of course, other large lumps of concentrated hydrogen gas undergo a similar fate and there again galaxies are born out of the original concentrated dark material, and in them, too, further localized concentrations produce stars.

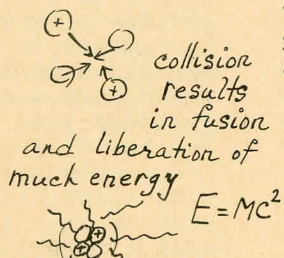
What follows next?

To take one of these galaxies after its formation as described we might continue as follows: Some of the smaller lumps which are now stars are blazing at full fury, some smaller ones are cooling rapidly. Those which are cooling rapidly in a relatively empty space--that is space devoid of hydrogen gas--will continue to cool and some day die while others which have been flung into a region



where they drift through some of the original type of dark hydrogen gas still have a chance to become prominent in this Universe. These stars which are drifting through some of the original type of hydrogen gas inevitably capture some of this gas and if the star is very large it will capture a great deal especially if it drifts slowly through the gas. Hoyle discusses this type of effect mathematically, showing that under certain conditions when the mass of the star is large and its drift through the hydrogen gas is slow a great amount of new gaseous material will be captured by the star and once again the close-gathering process begins on a very large scale. The falling captured particles of hydrogen gas rain in a flood toward the center of the star, create friction due to the collision that they suffer with parts of the star; the temperature is raised, and the star may then have a sufficient degree of temperature to promote an atomic reaction in which gas converts to helium and heat, light, and gamma rays are produced. What happens then is that the temperature of the star rises both due to the friction heat and the radiant energy which comes from the hydrogen to helium atomic process, and/ possibly, the increase in temperature internally is so great that the star explodes. This exploding star when seen from a distance is what the astronomers call a "Nova," or a "New One."

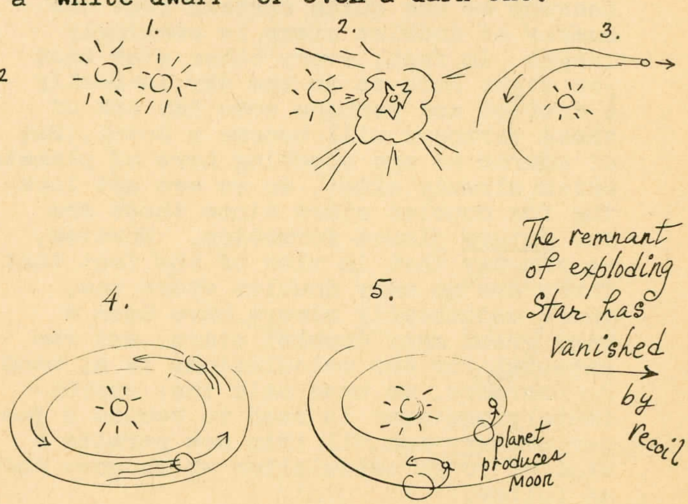




If the reaction is really extraordinarily violent, then the explosion is similarly violent and the star may be said to have become a "Super-Nova."

Novas and Super-Novas are of course actually observable throughout space and, in Hoyle's view, they play an extremely important role in the formation of planets as we shall see in a moment. We ought to mention at this point that about one or two Novas are seen in the heavens per century. While this may seem to be a small number, one must not forget that in the course of billions of years one or two per century can amount to a great deal.

Now in what sense are these Novas important insofar as the formation of planets is concerned? Before taking up this subject we must of course remind ourselves that we are here stressing only one theory, namely that of Hoyle. We now must mention an important fact: The stars which we see in the heavens are not all single stars. Many of them when seen and studied through a telescope turn out to be double stars--that is, two stars really "close" together, revolving around each other. These stars form a unit, they belong together, and they never leave each other except in violent celestial events such as the one which we will now describe. Let us think therefore of a double star; let us further assume that one of these stars of the doublet is very large and has caught a great amount of hydrogen gas. This particular star will wind up by being a Nova or a Super Nova. It will burst apart shooting portions of itself in every direction, perhaps an especially large amount in the direction of its partner, the other star of the doublet. The explosion having taken place, the exploding star will recoil, say in some direction which we may designate as "backward." This star has shot its bolt and has now torn itself away from its partner and is traveling backward away through space, bereft of much of its energy, relatively cool after its violent explosion, traveling, cooling, fading, disappearing, becoming a "white dwarf" or even a dark one.



But now to return to the second member of the original doublet. This second star has been left "standing," facing a barrage of material which came flying in its general direction from its explosive partner who is now no more. The standing star now captures some of this material directly; and it captures some of this material by bending it into orbits, whereupon the material continues to revolve around the star in an ellipse; and it misses some of the material completely--the part which has passed too far away from it.

The material which has been bent into elliptical orbits eventually coagulates, rounds out, starts to cool, and here we have the beginning of the planets. If all of the material is too far away from this particular star, these planets will be cold and no life will evolve, whereas if all of the material is too close to the standing star, these planets will be too hot and life again will not evolve. But if some of the material is at an appropriate distance, obviously the, the conditions of temperature at least will be right and if the other conditions are fulfilled such as the presence of atmosphere of the right sort and of water, life will develop.

What determines how many such Good Earths develop, then, are largely these two factors:

1. How many doublet stars there have been in, say, the last four billion years, and
2. How many of these doublet stars had a partner which became a Nova?

The first question has a very surprising answer. Today as we study the heavens we are quite certain that the number of doublet stars is amazingly large. In fact, every other star that you might look at in the sky is really a doublet and perhaps some day one of these partners will become a Nova...But of course we are speaking here of planets which already exist, so we are not looking for doublet stars since these are for <u>future</u> planet formation. However, we can say that in view of the fact that there are so many doublet stars now, there undoubtedly always have been a very great many doublet stars, and raw material for our calculations is at hand. Furthermore, we have said that approximately one star is seen to become a Nova per century and all this now permits a kind of rough calculation which goes about as follows:

One star has "novaed" per century, therefore in say four billion years forty million stars have novaed. Twenty million of these had partners. The question then is: how many of the twenty million which novaed and have partners, have novaed in the appropriate manner--that is, shooting out material, some of which at least would be caught in an appropriate orbit. Hoyle makes an estimate as to the random firing of material past a star and ends up with the rather conservative figure that at least one hundred thousand portions of material have landed in appropriate orbits so that Good Earths could develop. This is what we have said in a previous section, that in Our Galaxy alone, about one hundred thousand Good Earths are to be expected. By Good Earths, we recall, we mean planets with conditions favorable to the evolution of a high order of life.

When we recall that one billion galaxies have already been photographed, then we can see that it is entirely reasonable to believe in the existence of one hundred thousand Good Earths, for each of the one billion galaxies in our thus-far known Universe, and creatures on them, some without flying saucers, but others undoubtedly with.

We ourselves, have gone aboard the flying saucers of our minds, and, once launched successfully into space, we have decided to study everything that we see, and to wonder about time and space, and matter and energy, and shapes and forms, and sizes and infinities.

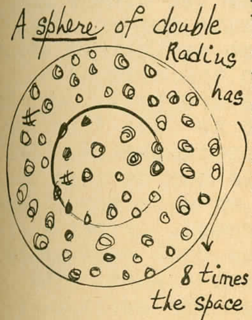
The ordinary saucers were but an unconscious pretext which have triggered us into flight aboard the saucers of our spirit, a flight on high where we can pause at leisure to contemplate the Universe and its omnipresent grandeur...

Chapter 6

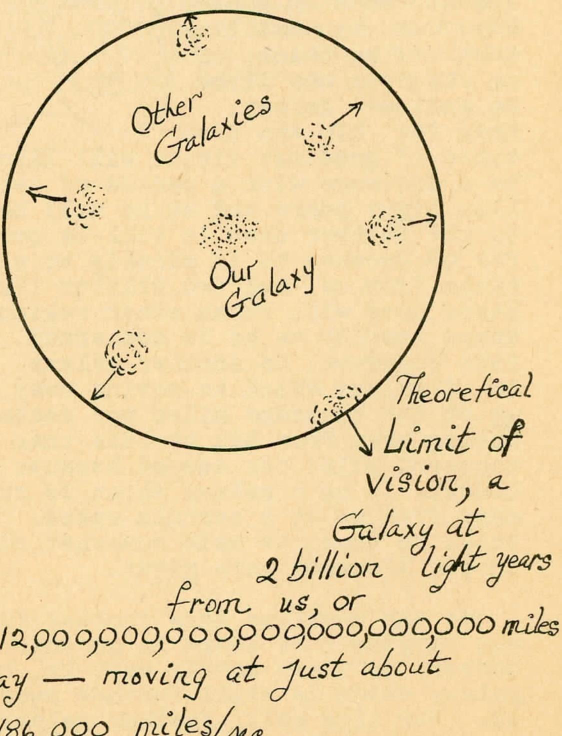
THE "SIZE" OF THE UNIVERSE

We have just recently spoken of the matter, or material, already known to exist in space--namely one billion galaxies which have been photographed, and vast amounts of gases, principally hydrogen, everywhere. It is commonly said that a vacuum exists between planets and between stars but this is not strictly so. It is now known that space contains the hydrogen gas just mentioned although in an extremely attenuated form, perhaps one atom to a region the size of a building. Obviously we on Earth would call this a vacuum, but when considered collectively throughout all the reaches of space, this amount of hydrogen gas nevertheless adds up to so much matter that it totals far more than the matter of which all the stars, planets, and meteors are composed.

But now we want to inquire about those other galaxies, those beyond the one billion already photographed through the best telescopes. We have already said that about seven billion galaxies more are expected, and now we shall explain this figure:



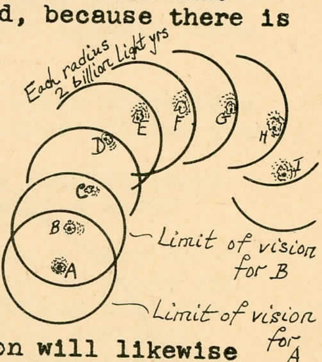
If we construct better telescopes than the best we have today, we may expect to see and photograph more galaxies, but there is a limit to this process. After building a telescope which might be, say "twice as good" as the one at Mount Palomar, we should profit little by attempting to construct a more far-reaching telescope. Now what is the meaning of this statement? It is that a telescope which can "see" twice as far as the Hale telescope at Palomar will be a telescope which sees the furthest possible into the Universe! The Palomar telescope can see to a distance of one billion light years and within that distance it is able to photograph one billion galaxies as we have said. The telescope which would be twice as far-seeing would look into a volume of space 8 times as large as the Hale telescope and accordingly we could expect to see 8 times as many galaxies, that is, 8 billion. So far so good, perhaps. But now why not build a still better telescope to see further? The answer is this: We can calculate that at a distance of two billion light years, that is, at the limit of vision of the "twice-as-good" telescope, we would be looking at galaxies which are rushing away from us with the velocity of about 186 thousand miles per second, which is the same velocity as that of light. Any galaxy which rushes away from us at the velocity of light presents the following situation: The space between us and such a galaxy is increasing at the rate of 186 thousand miles per second, and a ray of light which might leave the galaxy would start to travel toward us at the same velocity, but it could never make up for the stretching distance; it could only participate at best in a tie race; therefore the light coming to us from such a galaxy would never actually reach us, and therefore we would never see it, nor could we photograph it. Thus it is that the limit of far-seeing is a distance of two billion light years and the greatest volume that can be seen is the volume of a sphere whose radius is two billion light years (or two billion times 6 trillion miles.)



It should be clear now that any so-called superior telescope could not see any further into space than two billion times 6 trillion miles because from out there matter is moving away too fast and its light cannot reach us. On the other hand, it must be admitted that a superior telescope might conceivably be worth beilding not for the purpose of seeing further (which it couldn't) but for the purpose of seeing what we have already seen but seeing it more clearly.

One might say for a moment therefore that the "size" of the Universe so far as we on Earth are concerned is a size corresponding to a distance of two billion times 6 trillion miles, or a size corresponding to the volume mentioned above, that is a sphere with radius of two billion light years containing 8 billion galaxies.

One can ask, of course, do galaxies nevertheless exist beyond those which are receding from us with the velocity of light? To answer this question one might say that as far as Earthlings are concerned, it makes little sense to speak of any more of the Universe than that which we have described, because there is no way in which we can become conscious of this extra portion, if any; but instead of falling into an argument over this point, let us show an easier way out by admitting that if we think of an observer who lives on another galaxy, then for him the distance of greatest vision will likewise be a distance with a radius of two billion light years and so he will be able to see further than it will be possible for us because he is already at a distance from us, and two billion light years more will reach other regions of space insofar as he is concerned. For this observer, in another galaxy, a third galaxy which is moving away from us at 186 thousand miles per second, is moving away from him at less than 186 thousand miles per second because he himself is on a galaxy which is rushing away from us at a certain speed. All this, we hope, is made somewhat clearer in the diagrams here given.

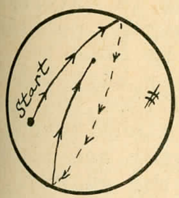


We can continue this process further and imagine that there is another observer, as there surely must be, on a galaxy which is still further away from us. For this still-further galaxy, again a limiting distance of two billion light years will exist and therefore this observer can see further than the previous one. On the other hand he cannot see as far in the backward directions...To summarize the situation, we can say that each observer, no matter on which galaxy, can see two billion light years away and this process can continue indefinitely. It might be indicated that on this basis there must be a galaxy and an observer who cannot see us because we are beyond his two billion light-year radius.

What is the outcome of all this? Where does it lead us? Does this go on ad infinitum?

As a matter of fact though it would seem that such a situation should go on indefinitely, there is reason to believe that it actually does not. There is reason to believe that eventually some distant observer on one of these greatly removed galaxies, while looking forward will actually see us from the rear. That is to say, the Universe seems to double up on itself or fold up on itself and make a closed space. To meet the inquiry of those who say, "but what is beyond this space" or "outside this space?" we will state that the situation has to be examined carefully and in detail to make sense. In order to give an explanation of the apparent dilemma into which we have led ourselves we will proceed by first giving an analogy.

Let us for a moment consider a special type of bug having only two dimensions, those of length and width but no dimension of thickness. Let us further assume that this bug lives in the skin of an ivory ball, say a billiard ball. Or, he lives on this ball but he fits into the surface since he has no thickness. Let us assume now that this bug decides to go exploring. He can move in any direction--left, right, forward, or back--but he cannot leave the ball because he has no three-dimensional powers. The bug goes exploring upon the surface of the ball saying to himself, perhaps, "I will go in a straight line. I want to see how big this Universe is in which I live." He sets out therefore along the surface of the ball and to him his advance is a <u>straight-line</u> advance. He has no feeling about the contour effect of the ball because he cannot lift his head. Therefore, as we say, he continues in his "straight" line and makes perhaps a complete circuit around the ball, possibly even returning to his starting point. But for the moment let us say he misses the starting point and is still to be seen plodding onward, pacing off his universe. So he goes round again at a somewhat different angle in his supposed straight line--over, down, around, and up again and looping once more and down and under and around and looping once again and again and again. The bug might decide after a sufficiently boring series of excursions that his universe seems like a universe without end--it seems like an infinite universe, and yet he cannot comprehend the meaning of infinity. For a moment let us assume that he stumbles upon the starting point. If this is the case and if he is quite brilliant, and Einstein type of bug, he might rejoice with the scientific light which dawns upon him and exclaim, "Why, it is remarkable! I must write a book about this. One can go in this universe in a straight line and come back to where one started from."



It may dawn upon the bug to regard his universe as a universe without a boundary but of definite size, because nothing stopped him, he came to no barrier, and yet he came back home. This Einstein-type bug may realize this full well and he may further realize that he can do nothing different; he might even say, "That which seemed to me like a straight line apparently is not really a straight line." He may even have some vague longing to go in a different kind of path such as along the cord through the billiard ball, but he can have no really genuine appreciation of such a possibility, because he is not built that way. He is built two-dimensionally and he cannot enter into a third dimension.

Those of us who are three-dimensional and who may look upon this billiard ball and the scientific bug, could understand his situation even as he himself almost understands it. We could easily in our superiority remark that the billiard ball or the universe of the bug is truly unbounded as he has guessed but at the same time of a finite or definite size. There it is, a mere handfull, a definite size but with no boundaries for the two-dimensional bug. Can he speak of, "What is there beyond?" He may speak of this but the question is without much sense for him because he cannot possibly experience the beyond. He is constructed differently. Therefore he should learn to understand that he really, as he is beginning to suspect, lives in a universe without boundaries which closes in upon itself and has a definite size.

Now it will be clear that the situation of us Earthlings is very similar to that of the bug on his billiard ball. We might set out in a straight line on a flying saucer, flying through space, endlessly forward, diligently clinging to a straight line flight and we could eventually return to the starting point in spite of our forceful determination to go "straight forward." We are three-dimensional beings exploring our Universe, traveling in our straight line, but a four-dimensional being--if there is one--could look upon us and realize our situation even as we realize that of the bug. The four-dimensional being could see that we who live in a three-dimensional world and who travel in what we call a straight line are actually, from the point of view of the four-dimensional observer, traveling in a curve. It will be recalled that that which the bug considered a straight line was to a three-dimensional observer clearly a curved line which led him back home; and similarly now, that which to us three-dimensional beings seems like a straight line is to a four-dimensional being actually a curve which could lead us back home. Thus it is that one might find a feeling of contentment with regard to the words "endless space," "infinity,""beyond," etc. We can find this intellectual contentment by realizing that our Universe is without boundaries but yet is of a definite or finite size.

So our Universe is a shining ensemble of galaxies which somehow doubles back on itself, leading us always home again, like a majestic shining mother watching over her straying children.

Chapter 7

THE POSSIBLE MEANING OF "BEGINNING" OR "CREATION," AND FLOW OF TIME

Now that we have some feeling of satisfaction with regard to the question of the Size of the Universe, we might think a little about Time, and how long it has gone on, or could go on...

Taking for the moment the views of the British Mathematician-Astronomer, Hoyle, we might proceed as follows to the examination of the idea of a "beginning of the universe" or the "creation of the universe," and comsequently the "beginning of Time"...

Hoyle and his colleagues believe that it is possible to think of a universe which never actually was created, never had a beginning, but always existed, merely undergoing changes. If we can understand this and believe it, then Time never had a beginning...Hoyle calls this kind of universe a "universe in flux." He means by this term that the universe is undergoing changes of various types such as the formation of galaxies and planets and the disappearance of galaxies and planets and the conversion of hydrogen to helium and the disappearance of mass and in its place the appearance of radiant energy. Hoyle has even made calculations as to just how much hydrogen gas must appear in a unit of volume per unit of time to make up for the loss of mass which occurs when the galaxies travel away with the velocity of light, as was mentioned in the previous chapter. Thus, according to Hoyle, matter remaining in our knowable Universe changes in amount when the galaxies go "over the border" at a distance of two billion light years: and on the other hand, hydrogen somehow appears within our reach or within our view to take the place of the lost galaxies. This particular aspect Hoyle calls "continuous creation," in a universe in flux.

But to return for the moment to the precise question of "was a universe ever created," or "when did it begin?" If pursued by this precise type of question, a Hoylian probably would ask a question in turn: If the Universe was once created, where was the creator located at the time? We are not here involved in a religious question or analysis, but merely in a problem in logic, and doubtless, from a religious standpoint an adequate reply can be made. To repeat, if something is created, it always is something external to the object which is observing the creation. If we say that we have created a sculpture, then obviously the sculptor himself is external to the object which he created. If we say that Someone has created the earth, then obviously that Someone is external to the earth, beyond the earth, outside of the earth, in order to be able to create the earth. If we say that Someone created a galaxy of 100,000,000,000 stars, then again this is visualizable and possible, for the creator has plenty of room to be external to the galaxy. He was outside of it, while fashioning it. In other words, it is always necessary to have space while creating objects in less space.

But if we try to say that the entire Universe was created, presumably the scientific logician would remark that here we leave the realm of logic because he, the logician, can ask us once again: where was the creator standing or located when the Universe was being created? If he was somewhere, then that somewhere was a part of the Universe which already existed and therefore the "entire" Universe could not have been created. What this all presumably leads to is the realization of the fact that, in the view of some unrelenting logician, the idea of "creation" or the idea of "beginning" of something applies only to portions of of the Universe like trees, children, sculpture, earths, and galaxies, which are smaller than the entire Universe. That is, the cold scientific logician would remark, the notion of "creation" or "beginning" does not apply to the entire Universe. He would further point out that that is why we fall into error and invent what might be called "meaningless questions," when we speak of "the beginning of all time," "the creation of the entire Universe", or "limitless distances in space," or "infinite distances."

To summarize then, we might say that here we are beginning to see a certain point of view: many of our conceptual difficulties arise from the fact that we pose for ourselves meaningless questions. It is not that the answer is "No." Rather is it that there is no answer and there should be no answer because, as a matter of fact, there is no question.

It is quite legitimate to claim that a man can ask anything that he chooses inasmuch as this is a free country, but at the same time there is no guarantee that he has asked a sensible question. It turns out, in fact, that to ask sensible and meaningful questions is an art in itself, and a productive art at that for it leads to fruitful answers which do increase the amount of meaningful sense about the Universe.

This slight excursion into the meaning of "beginning" or the meaning of "creation" may perhaps allow us to restate Hoyle's position when he speaks of a Universe in eternal flux: the Universe has always existed (for we have seen that it is not possible to raise the question "when was the Universe created?") The Universe merely experiences changes as when a star explodes or when radiant energy condenses into matter. The Universe has no beginning in time since he says that it was never "created;" the Universe has no middle in time since the idea of the instant of creation cannot be meaningful; and the Universe can have no predictable end in time because of the same reasons. Hoyle puts it succinctly: the Universe had no beginning, it has no middle, and it can have no end. It is only an assembly of things and events in flux or in eternal change. All this is interesting and also debatable, and everyone can search his conscience, or consult his reason, or reach for his faith, just as he pleases.

Chapter 8

A PARADOX

There is a kind of paradox that comes upon us when we consider the role of any individual in the Universe as a whole. First of all, if a man understands clearly the vast expanse of space which surrounds him, if he recalls that a tremendous number of other Earths must exist with people on them, and if he bears in mind that over one billion galaxies have been already photographed, then undeniably a feeling of littleness comes upon him, a feeling that one perhaps must walk softly, feeling like a small i, feeling like a tiny insignificant creature almost utterly devoid of ego. On the other hand it cannot be denied that this creature, small as he is, tiny in the vast Universe, feels as though he nevertheless is at the center of the Universe. Everything is "around him," all feeling of pain is his, all feeling of hunger is his own. He is the large I, the psychological center of it all, and he has difficulty escaping this feeling.

This is what we mean when we say a kind of paradox exists, a competition between the small i and the large I, a contest between man's place in the entire Universe and the place of the Universe around the man. By virtue of our reason the small i conception should win out, but by virtue of psychology and the so-called law of survival of the fittest, the large I makes constant effort to be dominant. There is this paradox and it is a profound one, a struggle between the most little and the most large. The resolution of the conflict of the struggle between the little i and the big I probably finds itself or should find itself in a final "division of territory," as it were. The large I perhaps must always assert itself in the immediate local special situations such as those which arise when an organism must eat to live and must clothe itself in order to survive, but the small i must come to the fore when larger problems are at stake such as the fate of a family, of a nation, of the world, and the place of a creature in his Universe.

If we then are able to understand the meaning of small "i"--an individual's place in the great Universe about him rather than his place in a local spot on the small rock called Earth--then we are able to see that the galaxies are peopled with countless small "i's" on vast numbers of planets and there dawns a feeling of simultaneity of "i", a continuity of "i"--I am of all men, I am of all time, I am of all space...

And even if all "i's" perish on the earth, on this particular Earth, they still go on existing on countless other planets in endless space...

Chapter 9

THE STARRY SKY AND THE MORAL LAW

We recall that Kant has spoken of the two wonders that filled him with awe. One was the starry sky above us, and the other the moral law within us.

We might gaze once again upon the starry sky above us and think long and in detail about the things which we have been discussing and seeing on our spiritual saucer journeys...

Each star is a great sun and each may have a family of planets and on many of these planets there are doubtless other creatures like ourselves...

In our own galaxy alone perhaps one hundred thousand Good Earths exist with beings on them...we know already of the existence of one billion such galaxies, each perhaps with its one hundred thousand Good Earths...

And now, there is something which steals into us, permeating our inner beings, touching perhaps the soul within us, and the moral law which lives within. How small we are, how tiny, how, in a sense, insignificant in the great curved Universe. Yet we can dream of this Universe, think of it, study it, reach for the very stars. In a sense perhaps the great starry sky above us pinpoints the moral law within us.

There is a grandeur about it all, a majesty, a magic that touches everything--if only the moral law, the conscience, the touch of divinity is allowed its full play and men behave like humble but noble creatures which they sense they can be and must be.

There is a mystery around us, an eternal unknown and yet a force that stirs us and is capable of kindling our spirit so that we long to become a part of the great Universe.

Why does a man dash into a burning building to save the life of a child, why does a mother rush into the path of a coming train to snatch her infant son, why does a soldier lay down his life for a comrade--why do we all feel at the zenith of our powers and of our spiritual life when we can make a sacrifice for a fellow-being?

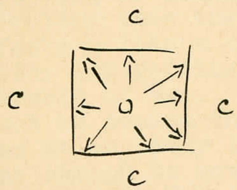
There is a moral law within us and the starry sky gazes down upon us, beckoning to this hidden spring of goodness...

Part II

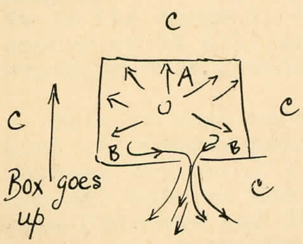
A Semi-Technical Treatment of Rockets, Space-Ships, Atomic Energy and Atomic Engines, as Well as Other Things and Ideas Mentioned in Part I Where We Did Not Wish to Interrupt Our Saucer Journeys and Speculations with Technical Arguments and Proofs.

__Item A.__ Regarding Rockets and Space-Ships.

1. The principle of a rocket may be illustrated as follows:

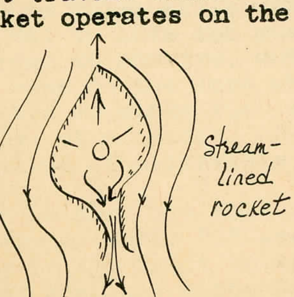


Here is a box with some fuel burning; the hot gases expand uniformly in every direction; the box will not move. (Of course, if the walls give way, we will have an explosion; but we are assuming here that the walls will hold.)



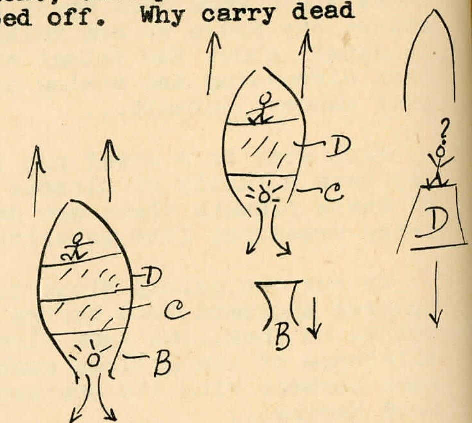
Here is a box with a hole in the bottom; some of the hot gases can rush out of the hole, and so there is not much pressure now on the __bottom__ of the box. But there is still a pressure on the top of the box, directed upward, due to the gases A. The box now has an unbalance of pressure--more urging it upward, A, than downward, BB. Therefore, the box will now move upward. If there is no air on the outside of the box, at the sides C C C C, then this box (with the hole) will move upward very nicely (if it is not too heavy.)

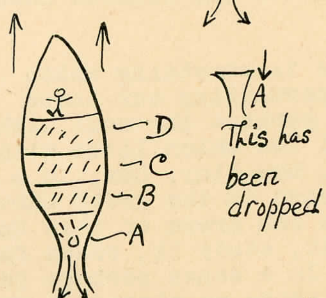
The point here is this: A rocket __does not__ need air on the outside "to push against," as so many people think. A rocket travels better through a vacuum. A rocket operates on the principle of recoil; or, on the principle that to every action there is a reaction. Similarly, if a gun fires a bullet, the bullet goes forward and the gun "kicks" back.



The external air has nothing to do with it. A firing gun would kick back even in a vacuum; in fact, it would kick back more. Of course, if the rocket is to travel through air, it should be streamlined, in order to have it encounter as little frictional opposition due to the external air as possible.

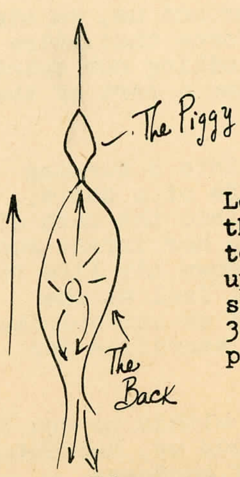
2. Here is a rocket or Space-Ship (this latter term is usually reserved for large rockets which can carry passengers) with several sections, each containing its own fuel compartment; when the fuel is burned up in one compartment, that part of the rocket can be dropped off. Why carry dead weight?

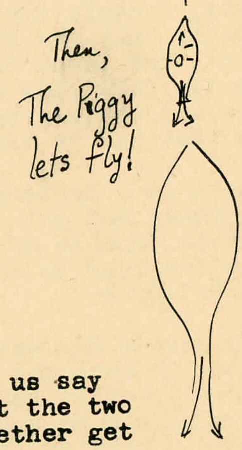




It is considered proper form in Space Travel not to drop off the passenger... But these are mere details; and SCIENCE comes first...

3. A Piggy-Back rocket is one that rides on another, then lets go with a bang, firing its own fuel:

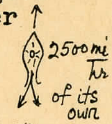


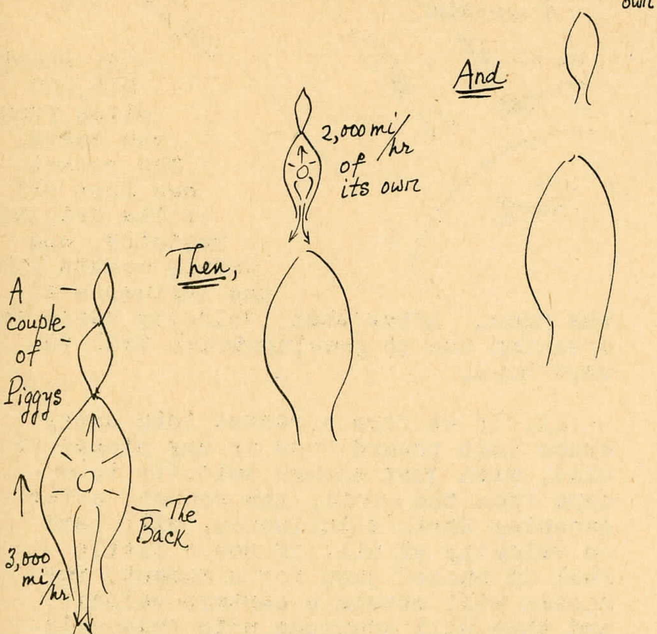


Let us say that the two together get up to a speed of 3,000 miles per hour...

If the Piggy can produce a speed of its own of 2,000 miles per hour, it will now actually have a speed of 3,000 plus 2,000 or 5,000 miles per hour relative to the ground. So, a Piggy-Back unit can give the Piggy a greater speed than either part could produce alone.

Why not a Piggy on a Piggy?

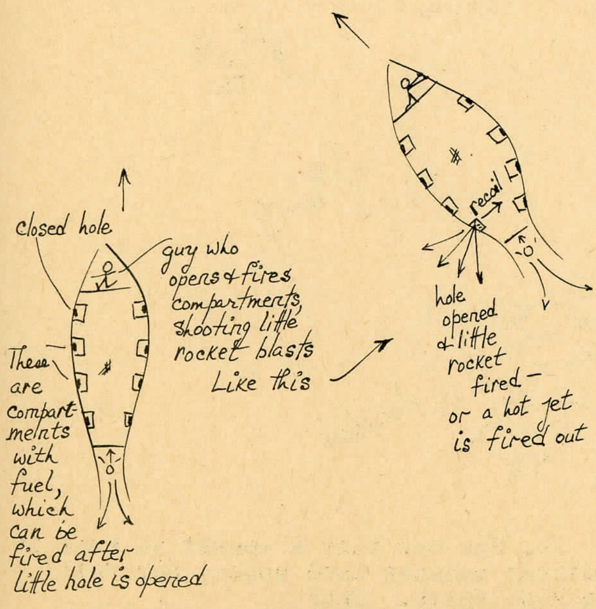




Result: 3,000 + 2,000 + 2,500 or 7,500 mi/hr.

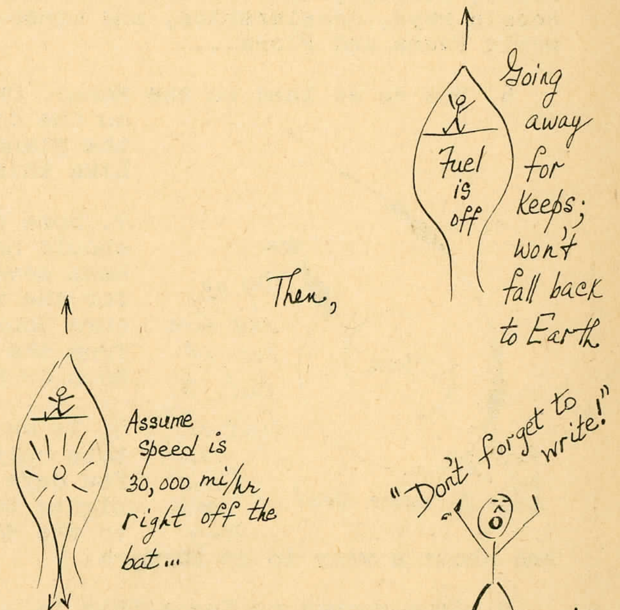
4. How do Rockets or Space-Ships turn?

Maybe like this:



The operator can have a keyboard in front of him and can open, fire, and close any chamber or chambers by just playing on the keyboard...

5. If a rocket is fired from Earth at better than 7 miles per second (a mere 25,000 miles per hour,) it will outrun the pull of the earth's gravity, and will get away completely. After that perhaps the Moon will capture it, or one of the planets. Actually, in order to overcome the friction of our atmosphere, the firing speed should be greater--say 30,000 miles per hour. One should emphasize that just one shot of fuel is required--then the fuel is cut off, and the rocket gets utterly away, on its momentum:



But a take-off at 30,000 mi/hr is very likely to kill the operator; this should not happen, because we need him for steering, thinking, and for SCIENCE.

Therefore, a slower take-off is recommended; in that case, however, the fuel must be burned longer. But now the Space-Ship is heavier--since the fuel is not all burned off at the very firing start. And since the Space-Ship is heavier, more fuel must be burned in order to lift it; therefore, more fuel must be carried in order to carry more fuel!!!???

Anyway, it can all be done. We should be able to go to the Moon in about 50 years.

What for?
Who knows?

There is no air on the Moon, no water, no vegetation...But we'll go. Someone is sure to do it. It's better than staying at home. Schopenhauer has said, "Most people prefer even death to boredom." And Bertrand Russell remarks, "People would rather die than think. And they do."

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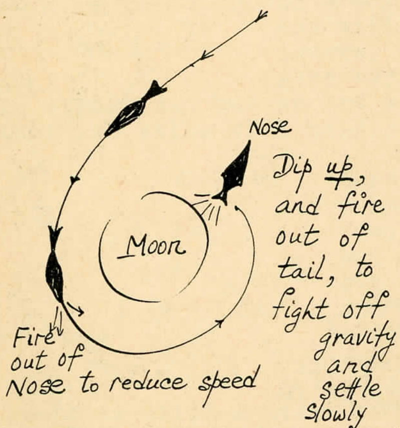
The journey will be made. And en route, perhaps, the travelers can study cosmic rays, acceleration, and other-world Fauna and Flora...

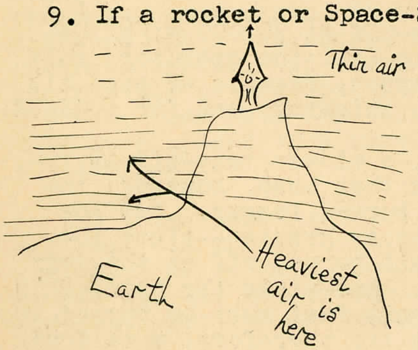
6. How do we land on the Moon? Or on one of the planets? Like this:



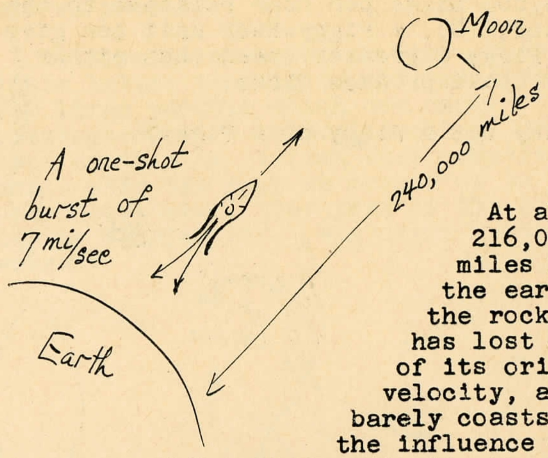
7. Some fuel should have been saved for the return journey from the Moon or Mars.

8. It should take only a few days and nights to go to the Moon. And about a year to go to Mars.

9. If a rocket or Space-Ship is fired from a high mountain-top, there will be much less friction, because so much of the air is already below the rocket:

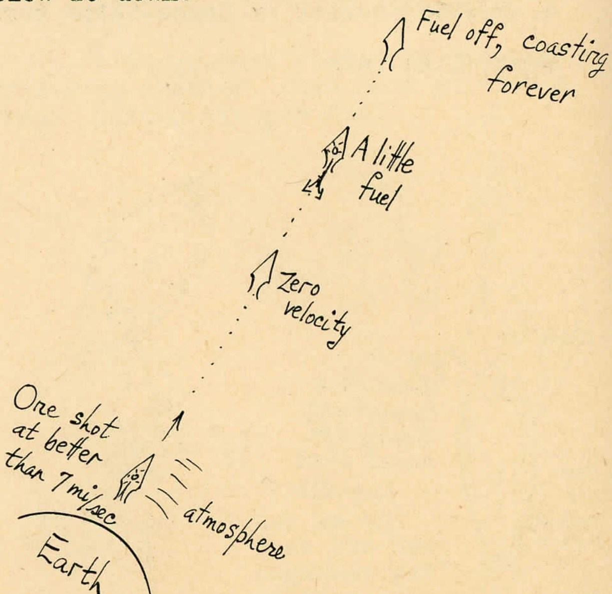


10. The velocity of 7 miles/sec with which a rocket must be fired if we want to have it escape from Earth on one fuel shot, is called the "escape velocity." The velocity (on a single shot) decreases and decreases due to the Earth's pull on the rocket as the rocket moves further and further from Earth; but, as we have said, the rocket will still get away--just barely:



At about 216,000 miles from the earth, the rocket has lost all of its original velocity, and barely coasts into the influence of the Moon. After that, velocity keeps increasing due to gravitational fall toward Moon.

11. If we fire a rocket into empty space (not toward Moon or any planet at all), with just enough velocity to escape from the earth, the rocket, after escaping Earth's influence, will have no velocity at all; if now a little fuel is burned just for a moment, the rocket will attain a certain velocity, and then will continue with this velocity forever since it is traveling out there in a vacuum, with no friction to slow it down:



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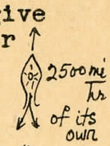

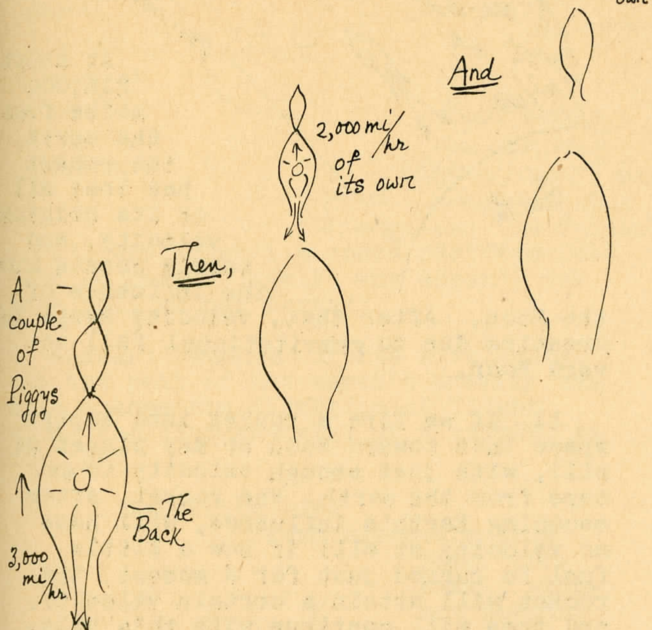

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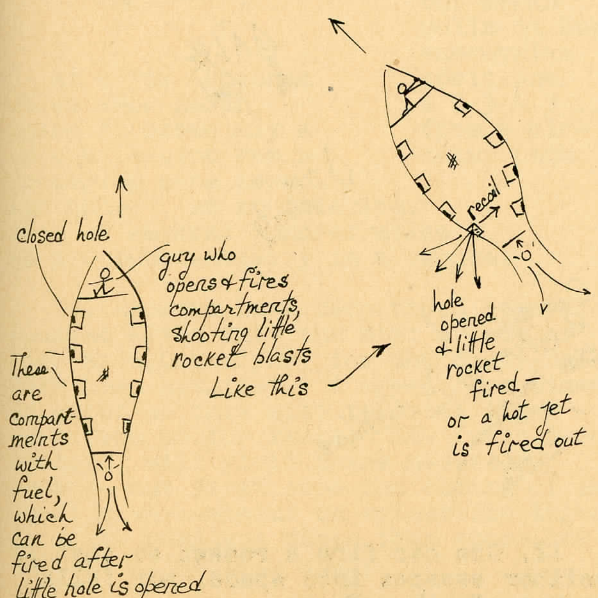

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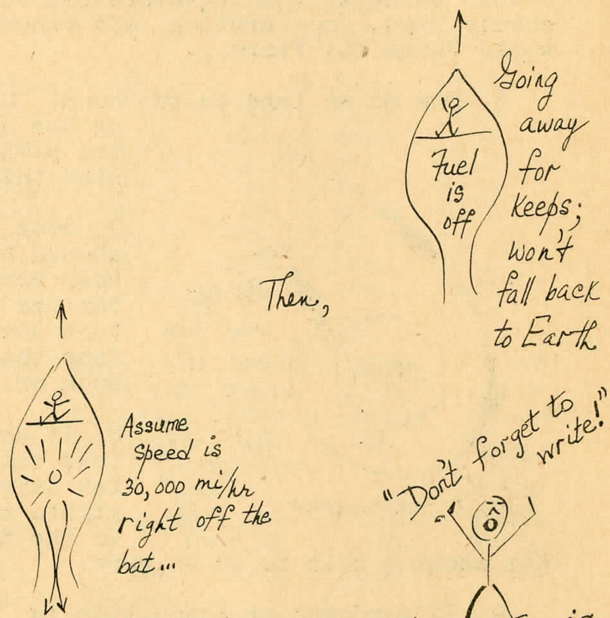

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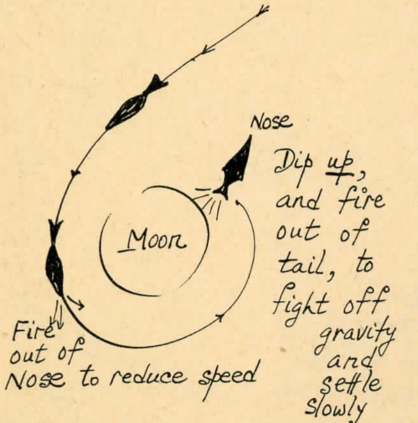

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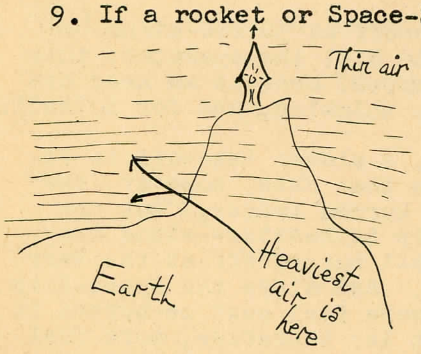

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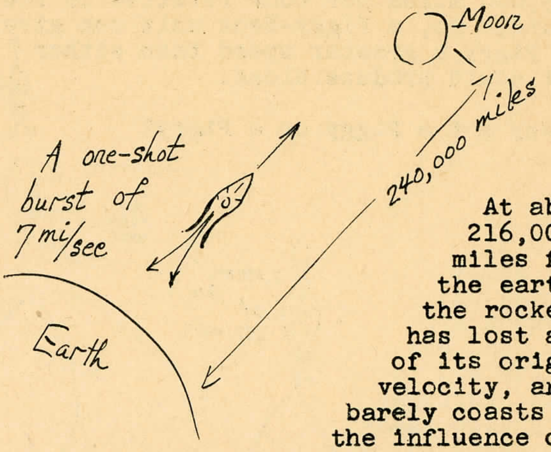

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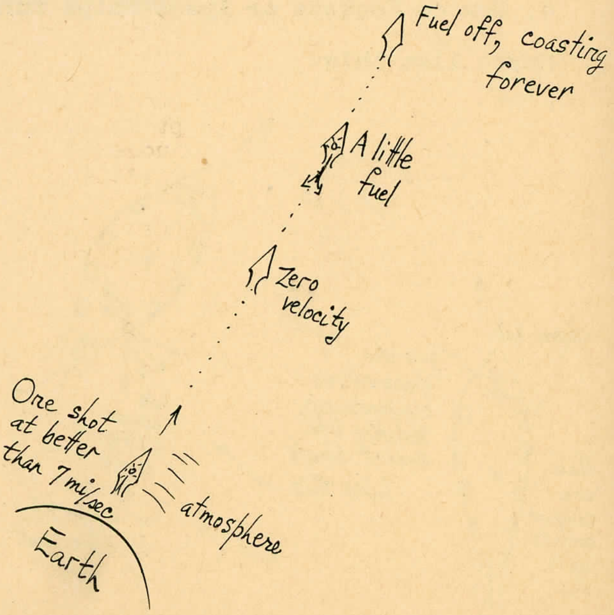

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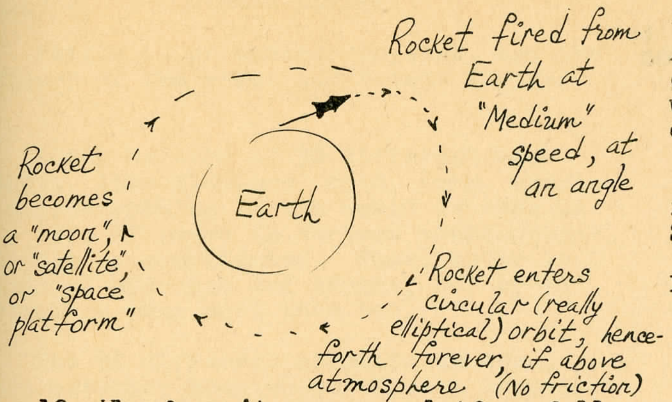
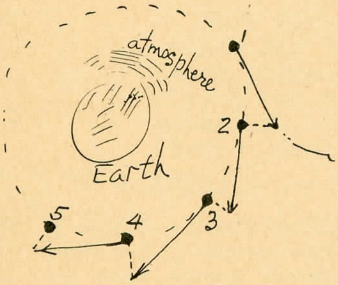


13. Why doesn't a space platform fall back to Earth? (Well, why doesn't our Moon fall to our Earth?)

Answer: Because it has a velocity, and the pull of the earth's gravity can only change the direction of flight along the circumference of a circle, as follows:



Satellite will keep retracing this path "forever," without burning any fuel; as Moon circles Earth.

Satellite wants to go along arrow, but Earth pulls it back; successive positions 1 2 3 4 5 ... form a circular path.

At a few thousand miles from Earth, there is certainly a vacuum (except for a wandering atom here and there), so no friction. Even at several hundred miles we are substantially in a vacuum.

14. Rockets have been fired several hundred miles into the air; speeds as high as 6,000 mi/hr. for the Piggy-Backs have been attained. A speed five times as great as this will take the Piggy away from us for keeps. New fuels, new designs, will yield these necessary speeds--but first come the claims of impending war--claims on scientific ingenuity for purposes other than space travel and scientific study.

15. A rocket to the Moon will probably be about 75 feet long and weigh 30 tons or so. A Space-Ship will be far far larger. Very great heat will have to be generated in the combustion chamber, because this will mean the gas will be at very high pressure and will escape through the hole at very great speed. And that's what we want: the more gas escapes at great speed, the more forward recoil momentum do we get, and consequently greater forward speed.

16. Here is a table containing some information about the planets of our Solar System, and their moons:

PLANET	DIST. FROM SUN. (MIL. OF MILES.)	LENGTH OF YEAR Relative to Earth	VEL. OF ESCAPE MI/SEC.
Mercury	36.0	88 days	2.2
Venus	67.2	224.7 days	6.3
Earth	93.0	365.25 days	7.0
Mars	141.5	1.886 yr.	3.1
Jupiter	483.3	11.86 yr.	37.0
Saturn	866.1	29.46 yr.	22.0
Uranus	1782.5	84.02 yr.	13.0
Neptune	2793.2	164.79 yrs.	14.0
Pluto	3675.0	248.44 yrs.	6.6

PLANET	RATE OF ROTATION Relative to Earth	MASS Relative to Earth	DENSITY grams cc	DIAMETER (Miles)
Mercury	88 days	.04	2.86	3,000
Venus	?	.80	4.86	7,700
Earth	1 day	1.00	5.52	7,900
Mars	24 hrs. 37 min.	.11	3.96	4,200
Jupiter	9 hrs. 55 min.	317.	1.34	86,700
Saturn	10 hrs. 14 min.	95.	.71	71,500
Uranus	10 hrs. 40 min.	14.7	1.27	32,000
Neptune	15 hrs. 40 min.	17.2	1.58	31,000
Pluto	?	.7	5.3	6,500?

PLANET	GRAVITY AT SURFACE	MOONS	DIAMETERS OF MOONS	DISTANCE TO MOONS (Miles)
Mercury	.27	---	-----	-----
Venus	.85	---	-----	-----
Earth	1.0	1 moon	2160.0	240,000
Mars	.38	2	10.5	5,800; 14,600
Jupiter	2.46	12	15 to 3,200	112,600 to 14,800,000
Saturn	1.17	10	300 to 3,550	115,000 to 8,034,000
Uranus	.92	5	150 to 1,000	80,000 to 334,000

Neptune	1.12	2	3000; 200	220,000 to 5,000,000
Pluto	.9	---	-----	-----

Item B. Atomic Energy

Particles of Nuclear Physics, and the Theory of the Bombs and Atomic Engines

Today we know of 98 different elements, like aluminum, gold, neon, uranium...Everything in the world is made up of some of these in various combinations, simple or complicated. Thus, water is made of hydrogen and oxygen, but bread requires many more than two.

The 98 different elements in turn, are actually constructed from a certain number of particles, in various combinations, as we will see below, after first listing these particles or "building blocks:"

1. – a small electrically-negative particle whose mass is about

$$\frac{9}{10,000,000,000,000,000,000,000,000,000}$$

of a gram. (One gram is the mass of about one cubic centimeter of water.)

This first particle is called the "electron." (When these particles come flying out of radioactive materials, they are called "beta" particles, or "beta rays.")

2. + a small electrically-positive particle, whose mass is the same as that given above.

This particle is called the "positron."

3. These are particles with more body than the ones above, and they occur in a number of sizes. One size, for example, is about 200 times the mass of the electron and positron.

These particles are called "mesons."

4. a neutral particle, that is, not electrical, perhaps of the same mass as the electron or positron. Actually, it has not yet been found, but there are reasons for believing that it ixists.

It is called the "neutrino."

5. a neutral particle, whose mass is about 1,836 times that of the electron or positron.

It is called the "neutron," and plays a vital role in bomb reactions.

6. an electrically-positive particle of almost identical mass with the neutron.

This one is called the "proton." It is the same as the core of an atom of hydrogen.

7. a burst of radiation, very penetrating, called a "gamma ray." The distance between two successive peaks, called "wave length," is very small for gamma rays, being about

$$\frac{1}{10,000,000,000,000}$$

of one centimeter. (The centimeter is this long: ———)

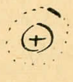
Often, some of these particles stick together, as follows:

8. A neutron, with a proton. This is called a "deuteron," or the core of a heavy hydrogen atom. (The proton alone is, as we indicated previously, the core of an ordinary hydrogen atom. The heavy hydrogen is called an "isotope," meaning "the same type"--that is, still hydrogen, though different in mass.)

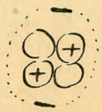
9. Two neutrons with a proton. This is called "tritium," or the core of a very heavy hydrogen atom. (Tritium, therefore is also an isotope of hydrogen.)

10. Two protons and two neutrons. This is called an "alpha particle," and is the same as the core or nucleus of a helium atom.

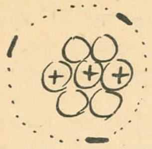
We have said that the 98 different elements are constructed out of combinations of these particles. Here are some examples:



Hydrogen atom, proton with electron.

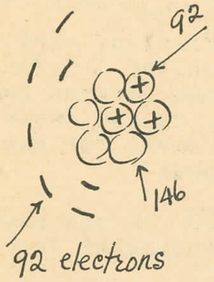


Helium atom, 2 protons, 2 neutrons, 2 electrons.



Lithium atom, 3 protons, 4 neutrons, 3 electrons.

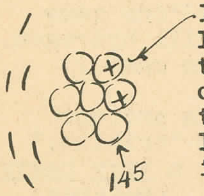
To take some heavier atoms:



If we have 92 protons and 146 neutrons (and 92 electrons,) then we have an atom of uranium. Thus, a uranium atom contains 92 and 146 or 238 of those round units in its core.

There is also a uranium atom with 92 protons, but only 143 neutrons, a total of 235. This then, is an isotope of uranium. (The number of external electrons is still 92.)

There are also other uranium atoms, that is, other isotopes, in every case with 92 plus charges in the nucleus, while the number of neutrons can be different.



If we have 94 protons and 145 neutrons (and 94 electrons) then we have an atom of plutonium. Thus, a plutonium atom contains 94 and 145 or 239 round units in its core.

We see, therefore, that atoms of different elements have different amounts of plus charges in their nuclei. The number of neutrons, on the other hand, does not determine the chemical character of an atom, but only determines whether they are light or heavy.

The number of plus charges in the nucleus is called "atomic number." The number of total round particles (neutrons and protons) is called "atomic weight."

It is often inconvenient to quote the weights of various atoms in tiny fractions of a gram, and so relative weights are used. The weight of an oxygen atom is taken as a base of comparison, and is said to be 16. The hydrogen atom is then 1.008 by comparison, helium is 4.003, lithium is 6.94, etc.

On this basis, the proton is 1.00758, and the neutron is 1.00894.

-II-

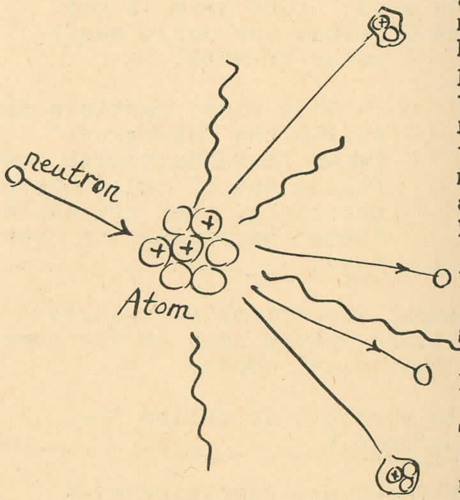
We may now consider the bomb process.

First of all, the uranium, plutonium, and hydrogen bombs should all be called A-Bombs or Atomic Bombs. The designations A-Bomb and H-Bomb are misleading. It would be correct to call the various A-Bombs:

1) U-Bomb (Uranium).
2) P-Bomb (Plutonium).
3) H-Bomb (Hydrogen).

Concerning the U-Bomb:

If a neutron strikes an atom of Uranium 235, the Uranium nucleus might split as follows:



This "fission" fragment may have 36 plusses (protons) and 47 neutrons--this would make it an atom of krypton.

This "fission" fragment may have 56 plusses and 81 neutrons--this would make it an atom of barium.

In 1905 Einstein gave the formula for mass to energy conversion, or vice versa: $E = MC^2$, where C is the velocity of light (30,000,000,000 centimeters per second).

To get E in calories liberated, we must write

$$E = \frac{MC^2}{42,000,000}$$

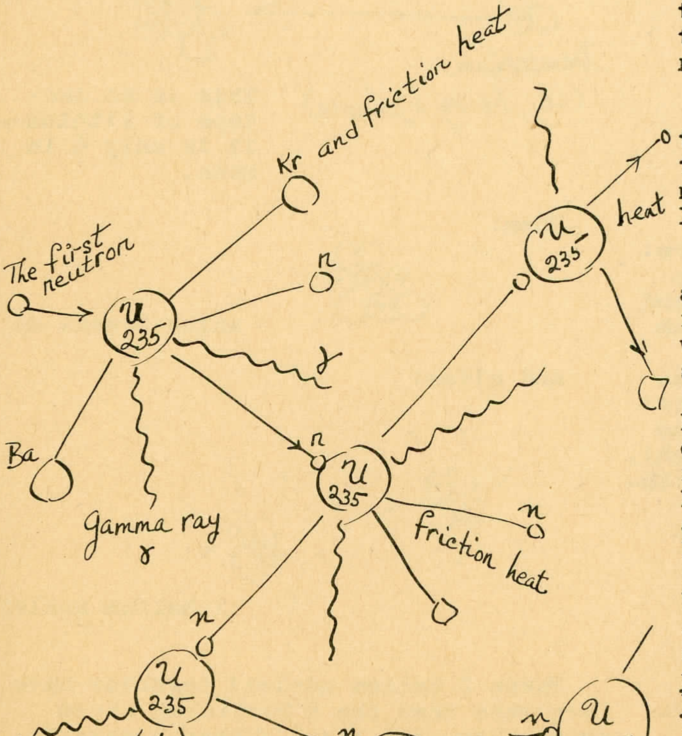
Thus, if after Uranium is split, a shortage of 100 grams is observed, we know that the following amount of heat was liberated:

$$E = \frac{100 \times (30,000,000,000)^2}{42,000,000}$$

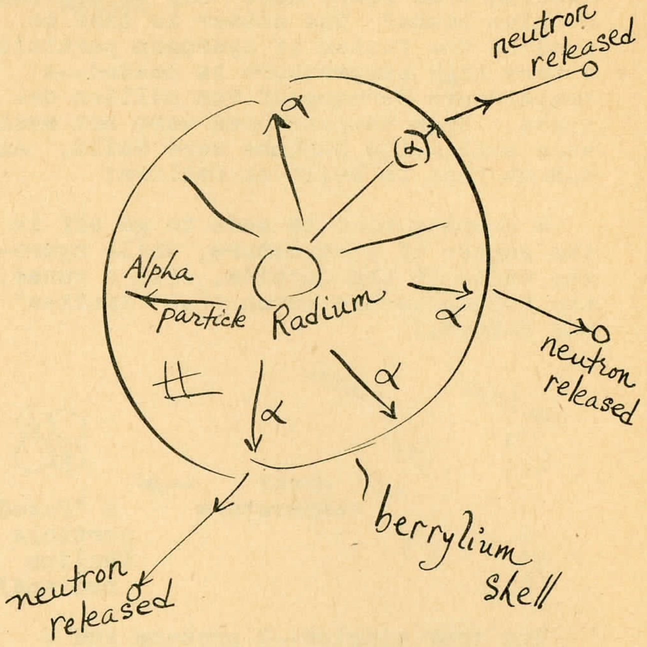
Or: $E = 2,150,000,000,000,000$ calories

We note that 36 protons and 56 protons add up to the original 92 protons of the Uranium atom. The total number of round particles is now 36, 56, 47, and 81; that is 220. But the original Uranium atom had a mass of 235. Therefore, we must account for about 15 units more (16 if we count the original bombarding neutron). In the sketch we have shown two neutrons flying away. There must be more. Actual experiment shows that less mass is found <u>all</u> <u>together</u> after the U-235 atom has been split than before; where is the missing little bit of mass? It has converted to energy in the form of gamma rays and friction heat that the flying neutrons and fission fragments give us as they tear through the air or through the cement casing of the bomb or through anything else in their way.

Returning now to the sketch of the splitting Uranium nucleus--what happens next? Obviously, the outward-flying neutrons will strike other Uranium nucleii, and in turn produce fission with a loss of some mass due to conversion to heat and gamma rays, and more neutrons, etc. This is the "chain reaction," which ends with a tremendous total liberation of heat and gamma rays (and flying fission fragments)--that is, the atomic bomb explosion:



The first neutrons which start all this may come from the following action, based on the fact that when particles which normally fly out of radium strike berrylium, neutrons fly out of the latter:



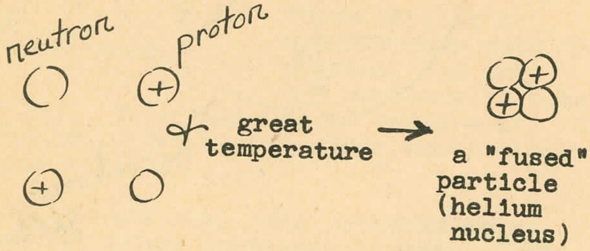
The problem of setting off the U-Bomb is therefore the problem of starting the chain by bringing, automatically, the uranium pieces and the initiating neutrons into proper positions.

The plutonium bomb, or P-Bomb, follows the same principle. However, the plutonium fission occurs with more loss of mass, and therefore we have more energy liberated as heat and gamma rays.

The hydrogen bomb, or H-Bomb, follows a sort of inverse process. Here we have, for example, four hydrogen particles which come together, fuse ("fusion" instead of "fission"), and become a helium nucleus. But this helium nucleus has less mass than the fusing four hydrogen particles. Where, then is the missing mass? It has converted into heat and gamma rays--a relatively large amount. In fact, one pound of fusing hydrogen yields seven times more energy than one pound of fissioning uranium. Why, then, do people speak of an H-Bomb as being 1,000 times more powerful than a U-Bomb? The answer is that <u>one can use a large amount of hydrogen in one bomb</u>. (A uranium bomb can only be one size--if there is little uranium present, the chain cannot become a runaway because of so much empty space, where neutrons miss; if there is a great deal of uranium, the chain runs away and gives an explosion without even using the extra pieces.) One can, therefore, use enough hydrogen to make a bomb perhaps 10,000 times stronger than a U-Bomb.

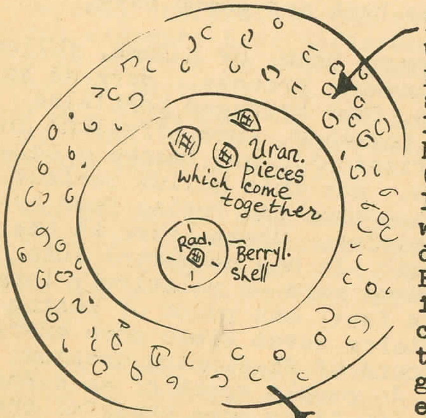
Why was the H-Bomb not seriously considered some years ago? Say <u>before</u> the uranium bombs? The answer is that to produce the fusion of hydrogen particles, a very high temperature is needed--a temperature perhaps of ten million degrees. Such temperatures were not available until--the U-Bombs were built. An H-Bomb then is built as follows:

A uranium bomb is made to go off in the center of a structure, while hydrogen waits on the outside. (In a sense, the U-Bomb is the match that "ignites" the H-Bomb.)



The four singles--2 protons and 2 neutrons--have a mass of about 4 x 1.008 or 4.032, but the produced helium nucleus has a mass of 4.003. Therefore 4.032 - 4.003 or .029 in mass has been lost. This has converted to heat and gamma rays. It is a relatively large amount (compared to U-fission mass conversion to energy).

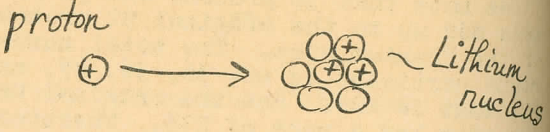
The H-Bomb:



Hydrogen waiting here: probably in some compound like lithium hydride. (Hydrogen alone as a gas would not be dense enough). Even the lithium itself can convert to helium, giving up energy.

One could also have here deuterium, i.e., very heavy hydrogen to convert to helium.

Here is one way that lithium converts to helium:



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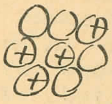
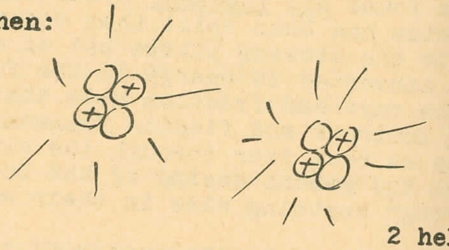


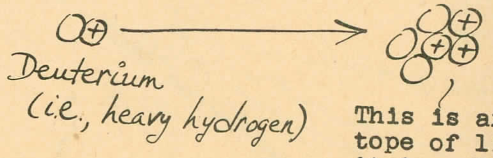
Then:



2 helium nucleii

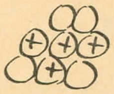
But these 2 helium nucleii add up in mass to less than the mass of the eight particles shown above them. The missing mass converts to radiant energy, gamma rays and friction heat.

Here is another lithium reaction which uses hydrogen, produces helium, and yields energy:



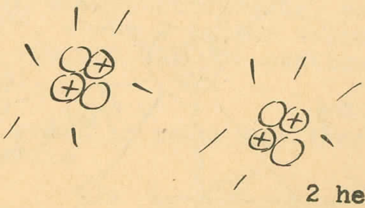
This is an isotope of lithium--it is only 6 in mass.

Then:



which breaks up

And gives:

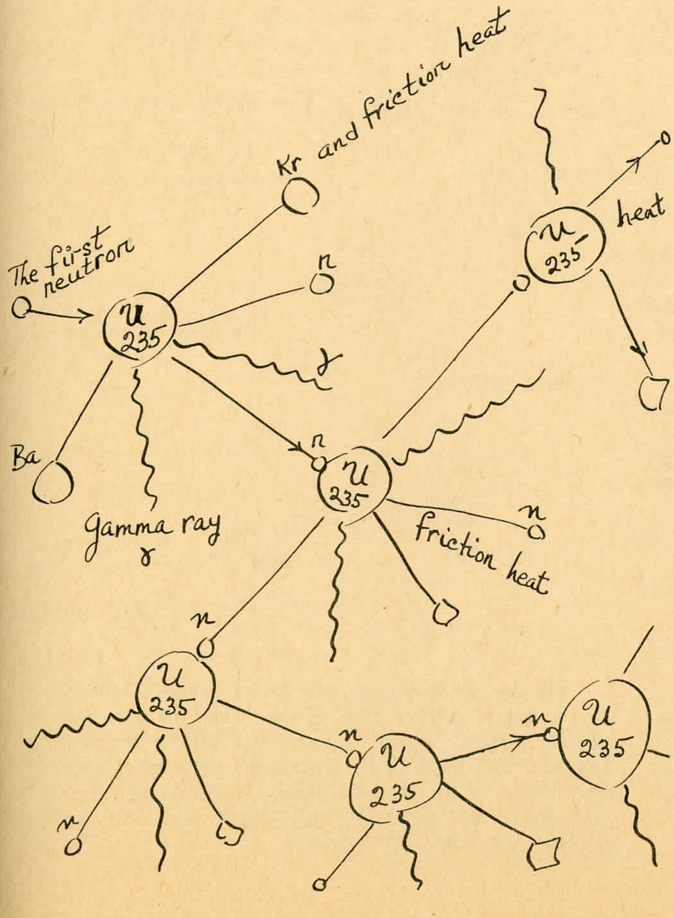


2 helium nucleii

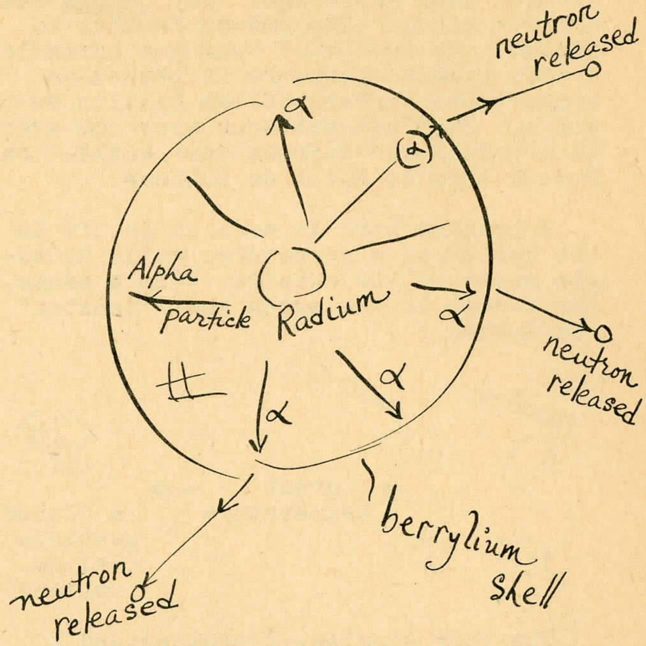
These 2 helium nucleii together have less mass than the 8 particles shown above them, and the difference reveals itself as radiant energy, gamma rays, and friction heat--from the flying of the helium nucleii through air or through anything around them.

We note that 36 protons and 56 protons add up to the original 92 protons of the Uranium atom. The total number of round particles is now 36, 56, 47, and 81; that is 220. But the original Uranium atom had a mass of 235. Therefore, we must account for about 15 units more (16 if we count the original bombarding neutron). In the sketch we have shown two neutrons flying away. There must be more. Actual experiment shows that less mass is found all together after the U-235 atom has been split than before; where is the missing little bit of mass? It has converted to energy in the form of gamma rays and friction heat that the flying neutrons and fission fragments give us as they tear through the air or through the cement casing of the bomb or through anything else in their way.

Returning now to the sketch of the splitting Uranium nucleus--what happens next? Obviously, the outward-flying neutrons will strike other Uranium nucleii, and in turn produce fission with a loss of some mass due to conversion to heat and gamma rays, and more neutrons, etc. This is the "chain reaction," which ends with a tremendous total liberation of heat and gamma rays (and flying fission fragments)--that is, the atomic bomb explosion:



The first neutrons which start all this may come from the following action, based on the fact that when particles which normally fly out of radium strike berrylium, neutrons fly out of the latter:



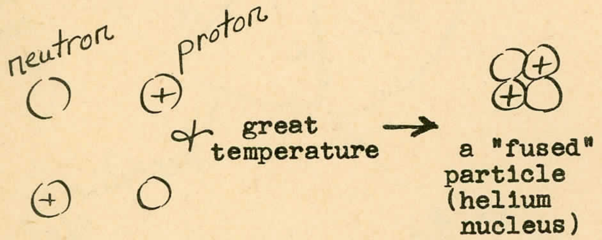
The problem of setting off the U-Bomb is therefore the problem of starting the chain by bringing, automatically, the uranium pieces and the initiating neutrons into proper positions.

The plutonium bomb, or P-Bomb, follows the same principle. However, the plutonium fission occurs with more loss of mass, and therefore we have more energy liberated as heat and gamma rays.

The hydrogen bomb, or H-Bomb, follows a sort of inverse process. Here we have, for example, four hydrogen particles which come together, fuse ("fusion" instead of "fission"), and become a helium nucleus. But this helium nucleus has less mass than the fusing four hydrogen particles. Where, then is the missing mass? It has converted into heat and gamma rays--a relatively large amount. In fact, one pound of fusing hydrogen yields seven times more energy than one pound of fissioning uranium. Why, then, do people speak of an H-Bomb as being 1,000 times more powerful than a U-Bomb? The answer is that one can use a large amount of hydrogen in one bomb. (A uranium bomb can only be one size--if there is little uranium present, the chain cannot become a runaway because of so much empty space, where neutrons miss; if there is a great deal of uranium, the chain runs away and gives an explosion without even using the extra pieces.) One can, therefore, use enough hydrogen to make a bomb perhaps 10,000 times stronger than a U-Bomb.

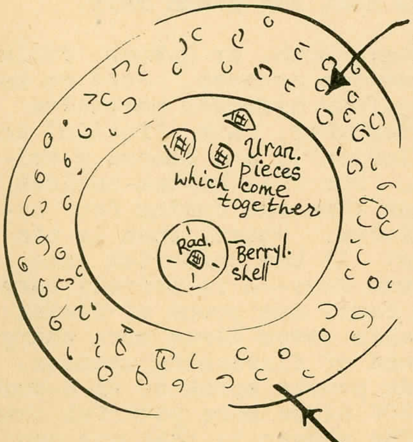
Why was the H-Bomb not seriously considered some years ago? Say before the uranium bombs? The answer is that to produce the fusion of hydrogen particles, a very high temperature is needed--a temperature perhaps of ten million degrees. Such temperatures were not available until--the U-Bombs were built. An H-Bomb then is built as follows:

A uranium bomb is made to go off in the center of a structure, while hydrogen waits on the outside. (In a sense, the U-Bomb is the match that "ignites" the H-Bomb.)



The four singles--2 protons and 2 neutrons--have a mass of about 4 x 1.008 or 4.032, but the produced helium nucleus has a mass of 4.003. Therefore 4.032 - 4.003 or .029 in mass has been lost. This has converted to heat and gamma rays. It is a relatively large amount (compared to U-fission mass conversion to energy).

The H-Bomb:



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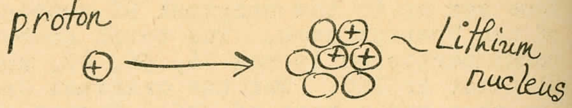

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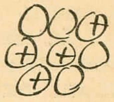
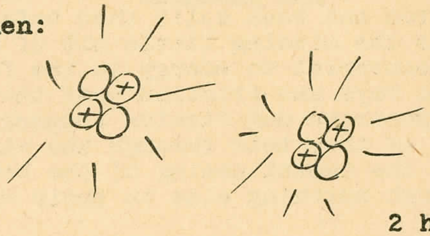


Then:



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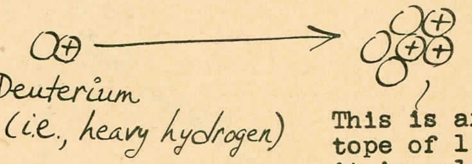

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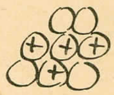
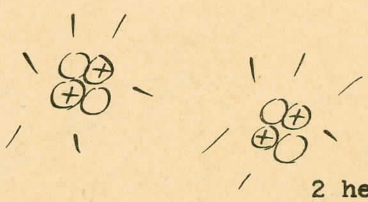


which breaks up

And gives:



These 2 helium nucleii together have less mass than the 8 particles shown above them, and the difference reveals itself as radiant energy, gamma rays, and friction heat--from the flying of the helium nucleii through air or through anything around them.

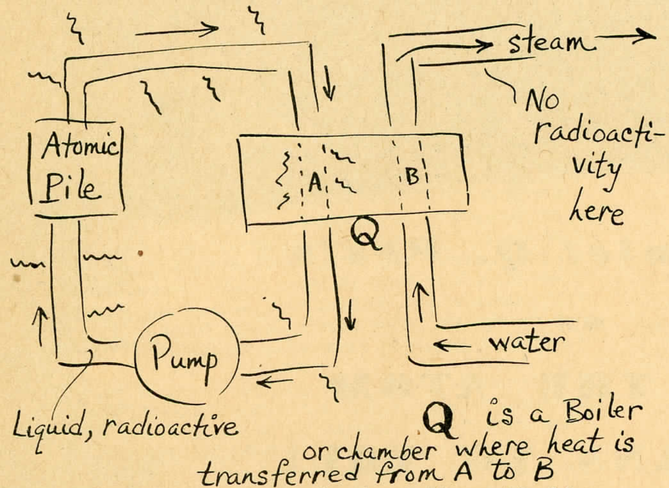
Finally, here is a very heavy hydrogen reaction:

The helium nucleus has a mass which is less than the proton and tritium taken together, and the missing amount appears as energy.

In general, then the heavier elements like uranium give energy when they are made to split or fission, and the lighter elements like hydrogen, give energy when they are made to come together or suffer fusion.

Elements in-between would give less and less in their respective reactions, with some critical element--at transition region--giving nothing either way.

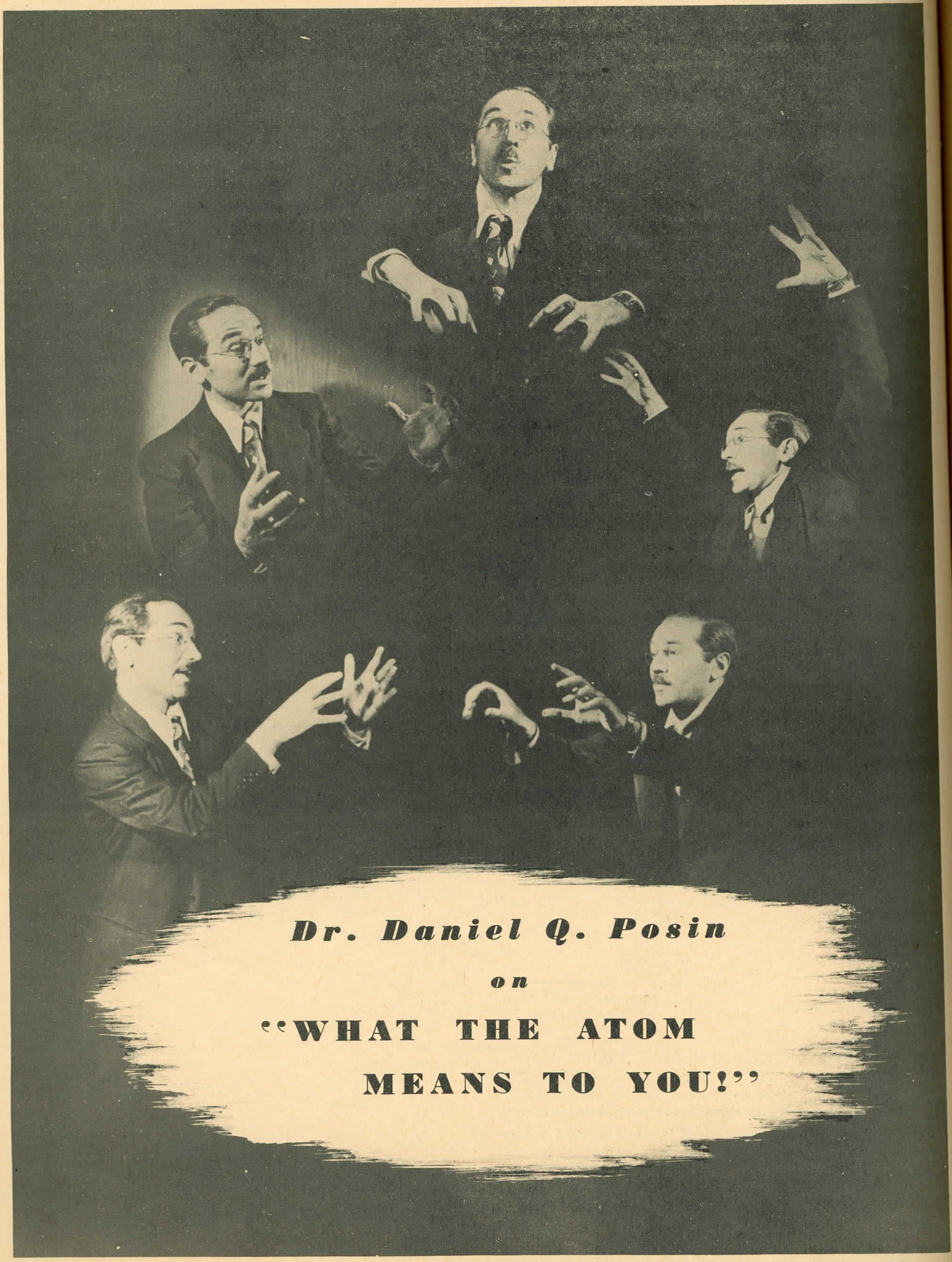
With regard to peaceful applications of atomic energy for power uses, one can say that uranium and plutonium can be so used. (Perhaps other materials are also used --- secret ones.) One must arrange the uranium or plutonium pieces in a different manner--for one thing, further apart. This arrangement is called an atomic pile. Then the chain does not run away, but becomes steady trrrrr, giving up heat which might be used to boil steam, and the steam would turn turbines and generate electricity.



One must guard against radioactivity, but it can be done as shown in the diagram.

Atomic piles or power plants cannot at present be used to drive an automobile. The piles are very large in size, and besides, the neutrons and gamma rays would irradiate the people and produce radiation sickness. Heavy shielding with lead to guard against radiation would tend to make the automobile a giant structure. But atomic engines could work for ships and even for airplanes--for the very large ones.

The hydrogen fusion reaction, however, can never be slowed down to give a controlled moderate liberation of heat. The hydrogen work therefore can be applied only to the needs of a world engaged in large-scale mass destruction.



Photos and montage by Ed Hirschoff of Minneapolis

The following speech was delivered on 500 occasions in the U.S., England, and Canada, starting in 1946...

THE SPEECH

"The name of this talk is, as you know, 'Atomic Energy' and the first thing I'd like to say is this — atomic energy does not mean necessarily the atomic bomb. I mean people sometimes use these phrases almost interchangeably. But the point is that you can use atomic energy for peaceful purposes; that's one thing. Or, you can use it for unpeaceful purposes — that is you can make atomic bombs out of it. It's like with water. You can drink it, or you might drown yourself in it. It all depends on how you feel and your point of view.

"Now the next thing that I would like to say is this: atomic energy — and I'll explain in a minute what it is — is not a recent discovery. Most people think that we invented it or discovered it say in 1945, just before we dropped the atomic bombs on the Japanese. That isn't right at all. Atomic energy is very old. It's as old as the hills. I mean it literally — it is as old as the hills. But of course something was achieved only recently — we learned how to make bombs out of atomic energy. That's new. Well now, to show you how it all started, I'll have to speak about a substance called uranium. Because atomic bombs have been made of uranium, as you have heard many times.

"Now the first interesting thing about uranium is this; In about 1870 a Russian scientist named Mendeleyev told about his studies with the chemical elements — you know, gold, silver, tin, zinc, nitrogen, oxygen, uranium, and so on. There were about 60 of these elements known at that time and Mendeleyev announced a discovery. He said,

" 'I have found a certain system — a certain plan of unity among the elements. And I have made a chart listing them all, and we can see relations among the elements, by use of the chart. Now here is an interesting thing,' he said. 'This plan that I have found shows me that the element called uranium has not been well understood. The weight of this substance has been incorrectly determined. The chemists think that it is 120 times heavier than the lightest element — hydrogen. But I am firmly convinced, from the plan of unity — the periodic system — that it does not belong in the 120 place. It must weigh about 240. That would make it the heaviest of all known elements so far. I am sure that it is the heaviest and I have placed it at the end of all the elements.'

"Well, it turned out that he was right. Now, there is another thing that he said about uranium. He wrote in one of his books, 'There is something deeply hidden about uranium. And I recommend to young men seeking problems of interest in science, to take up the study of this intriguing element.'

"There was another great scientist, this one in France, a professor by the name of Becquerel, who made an astounding discovery with uranium, in the year 1896. Now, this is what Becquerel found: He found that uranium could make spots on a photographic negative even when the uranium was at some distance from the negative. It seemed as though something came out of the uranium, traveled through space and made marks on a photographic negative. This was the first time in history that it had been found that a substance could emit some energy from itself, an element, like uranium, emit something from itself which would travel through space, through air and, perhaps, even wood, and make spots on a photographic negative.

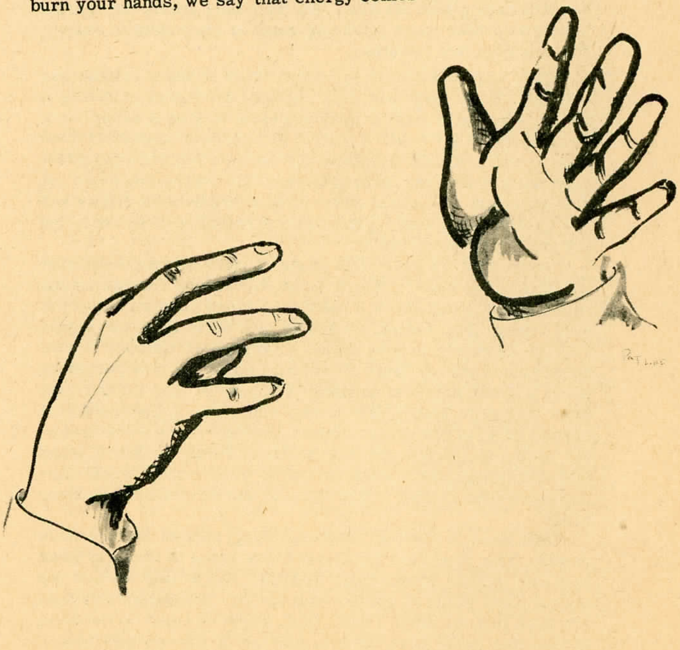
"Well, Becquerel was very excited and communicated his discovery to some friends of his. In fact, I am thinking now of Marie Curie. Marie Curie had married a French Professor of Physics and Chemistry named Pierre Curie, but she had originally been a Polish girl, and here already in this study of uranium we have dealt with a Russian and a Frenchman and a girl from Poland, and we will see presently that scientists in many parts of the world, were at one time or another involved in the production of uranium and substances like uranium. And they learned how to use them for peaceful purposes in atomic energy, and unfortunately for the not-so-peaceful purposes, too.

"Then Marie Curie went to work on this uranium because it was so strange and could emit something from itself which could penetrate even wood, and she in turn found another substance that behaved like that, and this she named 'radium'. Radium too emitted something. And not only that, but there was another substance she found and she called it 'polonium,' and it too emits....

"Now I would like to skip a few years and take advantage of the invention of a certain instrument called the Geiger counter. Geiger was the man who invented the instrument, and 'counter' means, of course, that the thing counts, and here is how we will think of uranium and radium from now on. If I have a Geiger counter here in front of me — I am pretending my left hand is the Geiger counter — and I have a sample of radium near it, and I am flexing the fingers of my right hand as you see — as though something flies out of the radium — then the Geiger counter begins to click, click, click, and as I bring the radium closer, like this, click, click, click, click, click, and take it away further, like this, click, click, and the same can be done with uranium click, click, click. Uranium clicks and radium clicks, and it was found that a substance named thorium clicks and polonium clicks and there are several others, perhaps eight in all, found in nature which click, click, click, click, click, click. But gold doesn't and tin doesn't and copper doesn't...

"Now, we call this clicking an 'energy,' because it can make the clicky sound and can affect a photographic negative or some of this can warm up a little bit of water even from a distance; held at a distance, a piece of radium can warm up a little bit of water in a cup. So, an energy is pouring out, though slow to be sure; but the clicking goes on and on and on, and radium will click now, click, click, click, and it clicks next year and the year after, and the year after that, and in a hundred million years and more, it will continue to click, although, of course, it will get less clicky — click, click, click, click. The same is true with uranium.

"All the elements have their times of clickiness and their times of decay, you might say, but they certainly last for ages. And this energy from uranium, for example, where does it come from, exactly? It comes from the very tiny particles of which uranium is composed. From the tiny atoms of uranium. You see every substance in the universe is composed of its atoms, the tiny particles. Copper, for instance, consists of copper atoms, gold of gold atoms, tiny particles of gold. Well uranium consists of uranium atoms and since something comes from the uranium, something which can warm the water or burn your hands, we say that energy comes from the uranium,



"Now I pretend that my left hand is a Geiger counter, and in my right hand I have some uranium, and I bring it up to the counter. Click click click click click . . . and my flexing fingers imitate a radiation pouring out from the uranium. Energy from its atoms . . ."

or energy comes from the uranium atoms. Energy from the atoms. Atomic energy. This is the thing that makes the clicks, or spots on a photographic negative, or warms up water. Atomic energy. Slowly, dribbling, out and out, almost endlessly. But no one could make this energy pour out at once and be done with. They tried, but they could not do it. It is as though one has a dam with a little hole in it and the water dribbles and dribbles out for ages. And the people try to knock the wall of the dam down and get all the water at once. But they cannot do it. The energy from the radioactive atoms just dribbled and dribbled, at its convenience. And by the way, you can see it. With water vapor in a box, this energy, as it comes out of uranium, leaves white streaks. And if you have a zinc sulphide screen near a piece of radium, these 'rays,' the energy from the radium, or these click particles from the radium, fly out, strike the screen, and make it flash. Like stars flashing in the sky of night. Energy from the atoms.

"Now we will come to a man named — well, he is a man in the news still today, a man named Einstein, who, in the year 1905, had something to say on this problem. This something came from his Theory of Relativity; but for us, we will take only the single result which we need for energy from tiny particles, energy from atoms. That is what we are discussing. And Einstein said that his theory shows that some day, perhaps, mass or substance, you know like glass, or water, or iron, or copper, might be convertible into energy, into heat. And here I pretend I have in front of me a piece of copper, and perhaps somehow some day the atom particles which make up this piece of copper may be unlocked and out will come pouring a BURST of heat and the copper is gone. Mass has converted to energy. And Einstein said, in fact — if you think about the clicky uranium, click, click, or the radium, click, click, click, click, they are already producing a little bit of energy from their atoms. Atomic energy is pouring out and the mass is disappearing, the radium is getting lighter and the uranium is getting lighter, and not so much substance is left. It weighs less and less and some day all the uranium will be gone and you will have gotten the heat. You will have gotten the energy. That is what they mean by saying mass is equivalent to energy. The one goes into the other.

"Well, you know, some scientists tried to make radium and uranium give up their energy all at once instead of dribbling it out little by little over a million years, to give it all at once, because then they could create a tremendous amount of heat pouring out WHOOSH! available for you, and boiling away great amounts of water and boiling the air. Of course you could put it to good use. You could attach it to a boiler of an engine and run a train if you could get it all or plenty of it at once, but you can't do it on a dribble.

"I think that the year 1919 might at least be mentioned next and this is the year in which Lord Rutherford did something about getting clicks out of a substance which normally does not emit clicks. But, really, we should now move on to the period 1930 to 1938, and in this period a very great advance in our knowledge of energy from atoms was made. In this period we made a great advance: unclicky substances like tin and zinc were forced to emit a few clicks, and, in fact, the most important thing to say is that Irene Curie in France — the daughter of Marie Curie — and her husband, Frederic Joliot, found that substances after being forced to emit clicks, would furthermore even remain clicky for long periods of time, in many cases.

"And here is a rather striking thing, though merely incidental. This discovery by Irene Curie came in the very year that her mother Marie died. In 1934. Marie had worked for almost forty years on radium and she had introduced it to hospitals so that the click, click, click, might be tried on cancers. Maybe they could burn out a cancer and it proved successful. But she had handled radium so much that it had burned her arms and her body and in 1934 she died from radium burns. She had found an instrument of mercy for the people and it had cost her her life. She had used energy from atoms to save lives instead of taking lives, as was done at Hiroshima. She had used atomic energy for peace and not for massacre. And as I say, in the year of Marie's death her daughter Irene made a great discovery — perhaps a discovery that could lead to substitutes for radium, to save lives, for there is little radium in the world. And I would guess that more than one person here before me is alive because of having had radium treatment — remember Marie Curie and energy from atoms for a peaceful purpose. And before I forget — uranium cannot be used as a substitute for radium, because its clicks are not strong enough. And the same is true of polonium and thorium.

"Now you will remember that only uranium was clicky, and radium and thorium, and a few more like that, but copper was all right, stable, so-called, stable, dependable, but now they found a way of making copper clicky, and the way they did it was like this:

"You take a piece of copper and you let some particles, like particles from radium, bombard it, or fall on it. The clicks from radium fall on the copper and the copper begins to emit and becomes clicky, click, click, click, click. Aluminum also can now be made clicky by being annoyed or bombarded, and all the substances of the world, all the quiet ones, gold and silver and tin, and even the gases, nitrogen, hydrogen, and so on, can be made clicky if we work on them, using various bombarding devices, machines such as the cyclotron. The cyclotron. The cyclotron was invented in Berkeley, California in the period of about 1930 and thereabouts. I happened to be a student there at the time. The cyclotron produces a terrific stream of fast-flying particles and if you let them come out of the machine and tear through the air you'll see an exciting glow, a red-purple glow. But ordinarily you have these fast-flying particles fall upon a piece of aluminum, for example; say that aluminum is the target, then, and the flying particles are the bombarding bullets. Well, that sort of treatment makes the target clicky. Click, click, click on a Geiger counter; click, click, click, out comes the energy, pouring slowly. And so, all the substances of the world can be made clicky; and some are clicky to begin with.

"Now why should you make substances clicky? The answer is, in fact, perhaps twofold. First scientific curiosity — we wonder why radium is clicky and zinc is not; and so we wonder about atoms and how they are built, and we try to make zinc clicky and little by little we learn things about nature. And another reason for trying to make unclicky substances clicky is this — as I have indicated. We would like to find a substitute for radium. After all, the energy from the atoms of radium click, click, click, click, click, can burn off a tumor or a cancer if properly used; and now, there is not very much radium in the world, but if we go to work we might be able to find a substitute for radium. Now, let us try a substance at random; take copper and bombard it in the cyclotron. Here comes a stream of particles falling on the copper and pretty soon the copper is clicky, click, click, click. Now, is the clicky copper a good substitute for radium? Well, actually not. So we try others and one is very good and that one is cobalt. You put cobalt up as a target and bombard it with the particles from the cyclotron and here they come flying and impinge upon the cobalt and the cobalt becomes clicky, click, click, click, and it promises to be a good substitute for radium. And that would be wonderful, a peaceful use for a substance which has been made clicky or radioactive, a peaceful use like the kind to which radium is put. Peaceful use of slowly-pouring atomic energy.

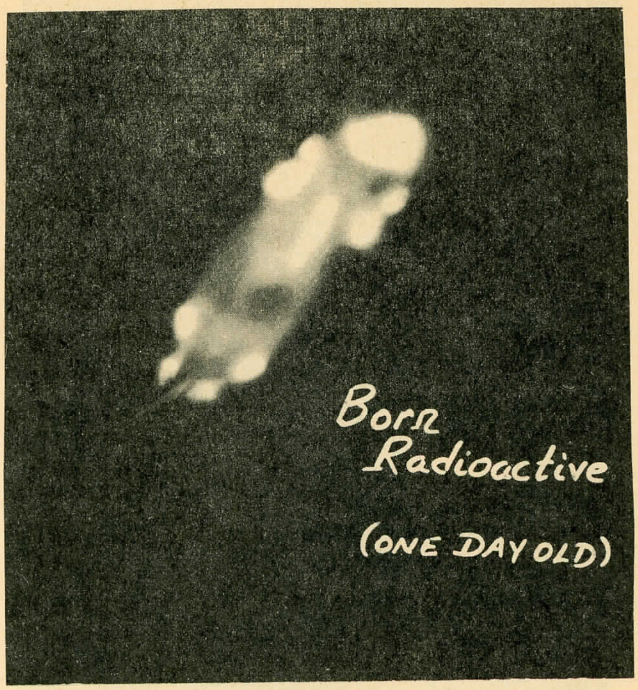
"And there is a substance named phosphorus which you put up as a target in the cyclotron or another machine and which then becomes clicky, too, by being bombarded in this way; and the phosphorus can be taken internally by a man who is sick, perhaps suffering with a disease called multiple myeloma, but just barely starting to suffer from it, and then his body begins to click inside from the clicky phosphorus, and there is some evidence that there is progress in the treatment of this disease by the artificially-radioactive phosphorus.

"So you see, peaceful uses for energy from atoms, many peaceful uses, and I haven't time to mention how many there really are. But I'll finish about that disease — multiple myeloma. What happens is this. Something goes wrong with the bone marrow. Now in the bone marrow the blood is manufactured, and this I did not know until I myself became interested in some work that I'll mention in a minute. Well, of course, the blood is created by the marrow and we live on, but sometimes something goes wrong inside the bone marrow and the blood is destroyed as soon as it is made. This is perhaps multiple myeloma. And of course the patient becomes anemic and cannot live without good blood and has to have blood transfusions, and if the disease is allowed to run too long — well, there is not a very hopeful outcome in prospect.

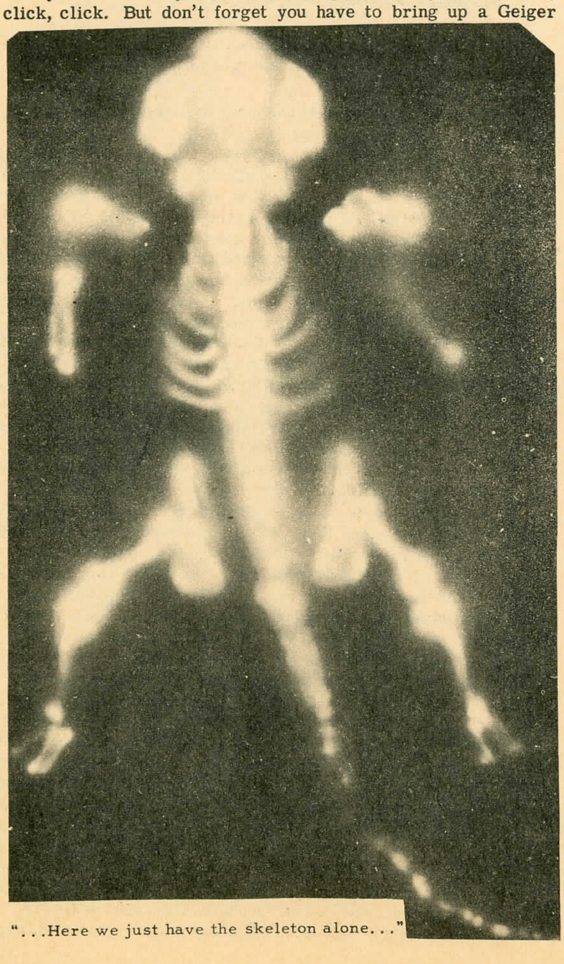
"But as I was about to say, they have found recently that if the patient takes an injection of clicky phosphorus, or drinks it, then the phosphorus goes to the bone marrow, — oh to the bones and flesh too, but we're interested in the bone marrow,— and there click click click, it seems to kill off the infection or whatever it is. And the patient shows improvement. But I must hurry to say that the treatment is promising only for very early cases of these diseases and the thing to do is simply to have regular, complete health examinations, say every six months, and to have a blood test, by all means. And so here we have energy from atoms tending to save life again, just as radium's energy does through the radiations that pour out and burn off a cancer. By the way, you can't take radium internally, you know, you can't drink it, because it is poisonous and besides it clicks too long — maybe long after you've stopped clicking. But phosphorus is all right for the human body and besides, the phosphorus stops clicking after a while, before healthy tissue is damaged.

"Now I have some pictures to show you — of some work I did. From Berkeley came some artificially-radioactive phosphorus in liquid form in a little bottle. Then I had one of those white laboratory rats injected with some of the clicky solution. About a day later the rat was killed with ether, and placed on top of a black envelope. Inside the envelope was a photographic negative and the rat was left lying that way for four days. The clicks came out of its body, the energy from the atoms poured out and made spots on the negative. Then the negative was developed and a picture was obtained. Next the rat was boiled and the skeleton was removed and assembled on top of another negative and after three days — look. You see the flesh was removed and therefore the large amount of clicky radiation in the bones could reach the photographic negative without interference by the flesh. Now you can understand why clicky phosphorus is useful in bone marrow diseases. Because, as you see, it so readily goes to the bones.

"Let's look at another picture now. I had another one of those white rats — a pregnant one — injected with some clicky phosphorus, in the back of the neck. Four days later the rat produced a litter of ten ratlings — or whatever you call them. Of course it was going to produce them anyway. What I want to say is this — every new-born ratling was clicky. Click, click, click, click. But don't forget you have to bring up a Geiger



"All ten were born clicky. Click click click. . . . And I put one on the photographic negative, the first day. And the clicks came out and he took his own picture. . ."



". . .Here we just have the skeleton alone. . ."

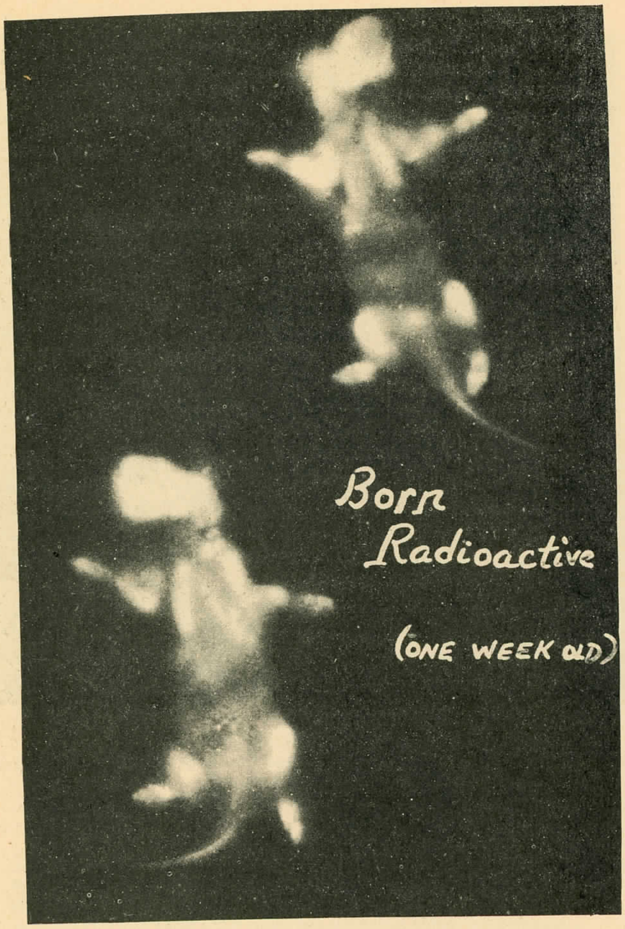
counter in order to hear the clicks. Otherwise you just have silent clicks. Well, one of the ratlings was taken now and placed on a photographic negative and four days later the picture was developed. See, born that way. Energy from the atoms — for a peaceful purpose — to study the processes of a body.

"A week later I put on two of the ratling's brothers on a negative, or sisters, I don't know. And here is their picture. Self-portrait. With no camera, no X-rays, no lenses — just clicks pouring out. These pictures are called 'radio-autographs,' though one might call them 'self-rays.'

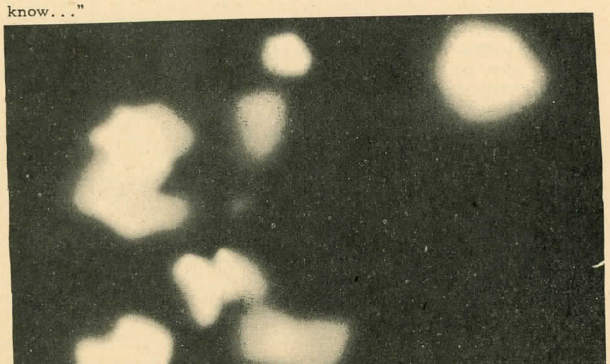
"Next I borrowed a hen and she, too, got an injection of clicky phosphorus, in the back of the neck. The next day she laid a radioactive egg. Oh yes, click click click all over the place. I almost said cluck cluck cluck. I hard-boiled the egg, separated the shell, the white and the yolk and tested each with the Geiger counter. Practically all the clicks were coming from the shell. Remember this was phosphorus. Well, I broke up the shell and dropped it on a photographic negative. Three days later this picture was produced. The hen continued to lay clicky eggs for three weeks, then apparently got tired of it all — no, actually, all the clicky material in her body had been used up. So she was given an injection of clicky iron. Again the eggs were clicky, but nearly all the clicks were coming from the yolk.

"Finally, a different experiment. A bacteria called E. coli was allowed to feed itself on radioactive phosphorus. Then the bacteria was separated from the unabsorbed clicky material, by washing, centrifuging, and testing the wash-water until it no longer clicked — that is, all the extra click material had been washed away. The solid mass of bacteria clicked like anything. The test-tube with it was placed on a photographic negative. Look. So you see, you can make bacteria clicky, then inject it into an animal and by tracing the clicks find out where the bacteria goes. They call these 'tracer experiments'. I had help from a Panamanian girl named Teresina Patiño. She had come to study at Montana State University where I was teaching. And I had help from a freshman named Charles Yost. I wonder what happened to him.

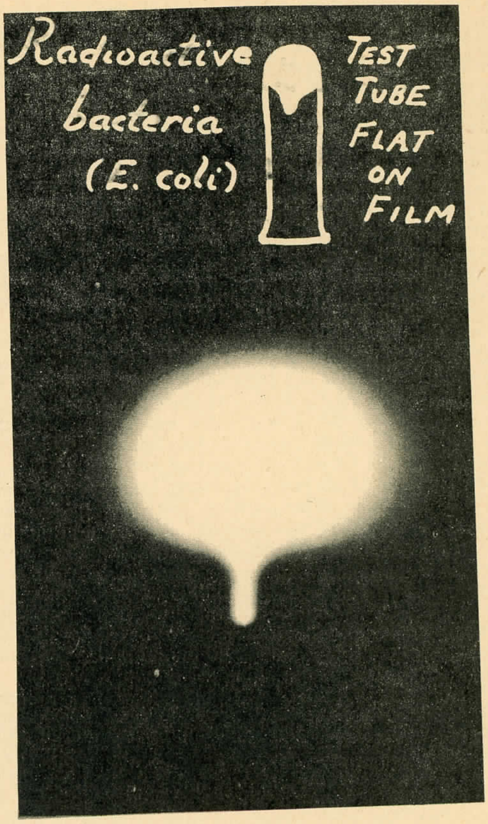
"Well, I wish I could do that kind of work now. But I've got to spend my time telling about the abuse of this gift to man —



"Next week I put two of his brothers on. Or sisters — I don't know..."



"...And the egg was born electrical. It was clicky, and I hard-boiled it, then dropped the shells on a photographic negative..."



"...So we let the bacteria feed on clicky phosphorus. On radioactive phosphorus. And the germs became clicky..."

I've got to tell about the unpeaceful uses of the clicks, the murderous uses of energy from atoms.

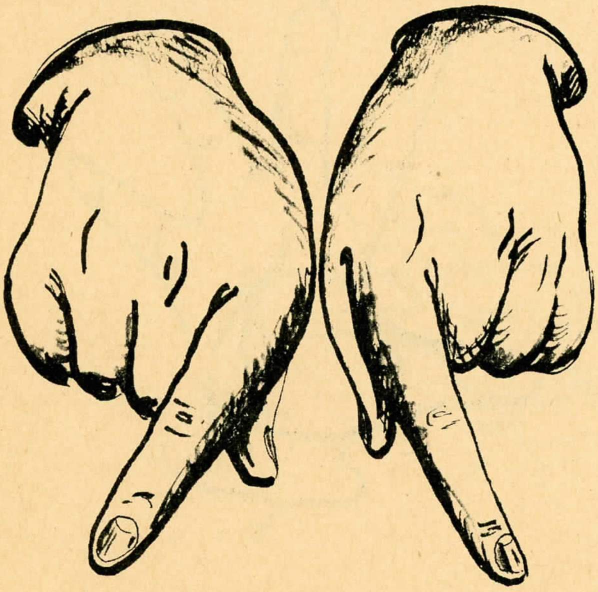
"Well, then, we come to the year 1938 and 1939, and the not-so-peaceful uses begin. The German scientist Hahn was experimenting with uranium. Now whether he planned it or not, he was approaching the possibility of getting all the clicks from uranium at once, all the energy out of the atoms of uranium at once, all the heat immediately. Now what might then happen? Here I pretend I have uranium; and I know that its clicks last for millions of years, a hundred million years, although diminishing in amount; but now suppose we get all this out at once, by agitating the uranium which is clicky anyway, but too slowly. Suppose we bombard it, until suddenly it will click all at once, a great big clicking, but instead of clicks we can think of whooshing heat. After all, you hear clicks only when you have a Geiger counter nearby. Otherwise it is better to think of a little energy turning into heat. I will pretend that heat is pouring out of the substance of uranium instead of the clicks. And if you have water in front of you, if this had happened to Hahn with water in front of him all the water would boil away, and even Hahn might boil away. But of course, he would not unlock all the uranium at once. He would be careful and unlock it a little bit, like this — whoosh! — and then a little more and then he would say, 'Oh, now, let's call a halt to this. It is working all right. The clicky uranium spills itself and gives everything out, but I don't want it to happen here to me.' I do not mean all this is being planned by him, but he was experimenting with uranium and I am looking at the possibilities.

"So what might he do? He might be thinking of making a bomb. This would be a bomb made from the energy coming from the atoms, an atomic energy bomb; the atomic bomb would come that way. The uranium would give its all out for him, maybe. Well, actually what Hahn discovered is the first step. Though he didn't realize it. What actually might a man do? He might see that it was working; whooshing heat pouring out of uranium, then he would halt the mechanism. He would put a clockwork on it tick, tick, tick, and then this piece of uranium is dropped over New York City, let us say, and the clockwork goes tick, tick, and the uranium is unlocked WHOOSH! Heat pouring out of the substance of uranium, and perhaps this might be a million degrees of heat; a sun created for an instant. A sun dropped over New York City. Well, but Hahn didn't get that far, and actually I believe he was working as a peaceful scientist.

"Now we'll do it, deliberately, like this. I'll pretend that my left hand is uranium and that it is clicking; I'll flex my fingers, like this; but the clicking is slow, and that's the trouble and now I bring up another material that sends out particles — neutrons — here, my right hand. And now I bring the two clickers closer together, hoping that a flying neutron might make a dead-center hit on one of the emitting atoms of uranium and upset that atom so that it will give everything; you know, the neutron will say, in effect, 'Come on, give all, what are you waiting for? You don't want to dribble for a hundred million years. Give the works now.' And if it does give the works — this is only one nucleus I am speaking about — then there will be a heat track or two coming out into space — pht. You see? Pieces of the nucleus might be flying apart with such speed that as they tear through the air they will cause a great amount of heat by friction — I mean a great amount for pieces for just one nucleus.

"Now that would not be enough to be of any consequence, two or three tracks from a single nucleus which is bursting asunder is not enough to bother a flea; but if all the atoms in the uranium can be made to do this at once, to give their all, or plenty, instead of conserving it for our descendants, then you'll have pht, pht, pht all over the place happening all at once, and this will be such a frictionful effect, sending so much heat through the air, through cement or through human bodies, so much friction from the bursting uranium atoms, which are flying at terrific speeds — I mean the fragments flying at terrific speeds — that you will have a boiling effect; you will have the sudden creation of the sun that I mentioned, above the buildings, the people, and of course this would destroy everything with the burning and the heat waves that come out. It might be million degree heat — and remember that the temperature of the sun is only 6000 degrees on the surface and that the sun is 93,000,000 miles away. But here you'd have million degrees bursting immediately over your head.

"Well, Hahn was bombarding uranium with neutrons and he had this sort of success with a single uranium nucleus at a



"And there's the hit! And the uranium nucleus splits — it fissions — two big pieces split out along a spreading V and as they tear through the air, the friction is very great and there is heat — pht!"

time. Just one. I mean a neutron came flying and hit a uranium atom dead center — right on the nucleus — hit a nucleus which was giving off only a little energy gradually and forced it to give out plenty at once. But as I say he accomplished this with only a single nucleus at a time and not with many of them simultaneously, you see.

"The one that split went like this. Here comes a neutron from the right, say my index finger and it hits a uranium nucleus on the left — say the other index finger — so there's the hit! And now the uranium nucleus splits like this, pht, forks out into a spreading V. That's two pieces, of course, the V, but besides that there is another little particle flying away from the wreckage, or sometimes two little particles — they are new neutrons. In addition there are some wiggles coming out of the explosion, wiggles, called gamma rays. I'll tell about them later.

"Well, this large bursting of the nucleus is called 'fission', nuclear fission — meaning a break, like the fission in a part of the earth due to an earthquake. So I'll summarize. A neutron hits a uranium nucleus, fission occurs — two large hunks fly away, and one or two, or three, perhaps, neutrons, besides. And some wiggles. And the heat, pht, that you get comes from the flying pieces as they 'frictionize' through the air. See?

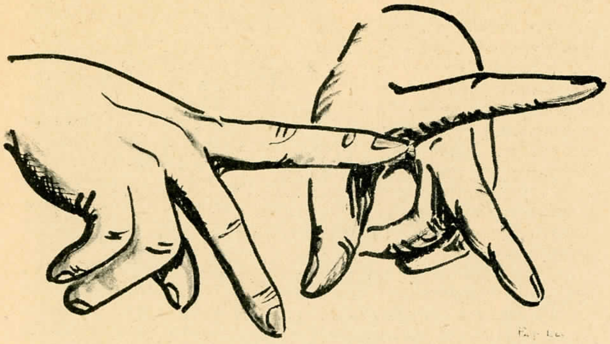
"Actually, Hahn apparently did not realize what he had achieved.

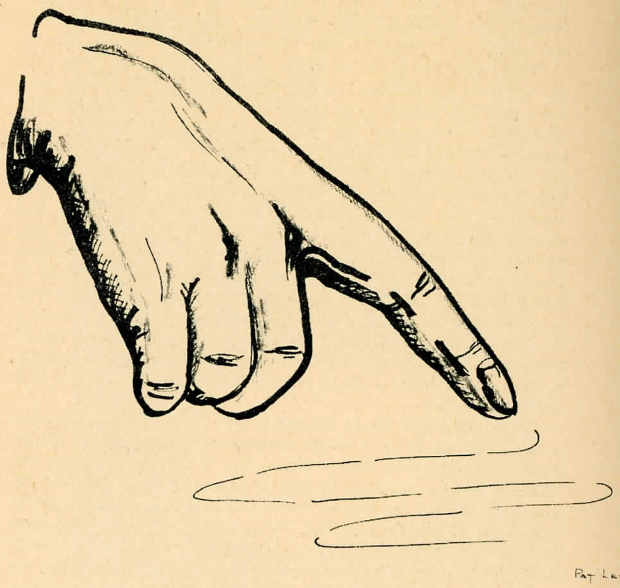
"But there was a woman scientist associated with Hahn, Lise Meitner, Jewish, who had to leave Germany to save her life. By the way, I heard her give a talk at Harvard in 1946. She was for a while a professor at the Catholic University in Washington, but now she is in Sweden. Well, she went from Germany to Denmark and there she proved by calculations that Hahn had achieved the kind of thing I've told you — nuclear fission with plenty of friction heat. So Lise Meitner told the great Danish scientist Niels Bohr about it — a very nice guy — I met him once at the University of California. Well, Bohr escaped from Denmark — you know, the Nazis had it under control already and he came to the United States, and then the critical times begin.

"Now we have the American scientists with their refugee friends and others who had come from Europe, gathering with Einstein as the guiding spirit. They are all gathered and they are worrying; they are worrying about Hahn and the Nazis. Are the enemy scientists going to get all the energy, and the heat, or plenty of it, pouring out of uranium and are they going to achieve a new super-bomb and drop it over American cities? Will the Nazis be successful? The scientists in America are worried, desperate. Einstein then writes a letter to President Roosevelt, warning him about the Nazi investigations and suggesting that scientists in the United States be put on the uranium problem. Roosevelt agrees at once.

"Now, the Americans and the refugee scientists Fermi, Szilard, and some others are thinking hard. They realize that they'll have to try the following: Uranium is up before them and it is clicking and they bombard it with the particles, the neutrons, and there is a hit, a neutron hits a particle of uranium which is clicking and now this particle of uranium splits into two pieces and heat comes from the flying pieces as they tear through the air. And there are also some neutrons flying out. There are a few neutrons and each neutron will then hit another uranium nucleus, and this nucleus will split, and then they must have some more targets of uranium and other neutrons will hit these. But remember, we have many neutrons now released and each one of them will be hitting a target of uranium — pht! And so we have splits and splits, and four targets and each is hit, two neutrons, and more, and eight targets and sixteen targets and thirty-two targets, a chain reaction going, and all splitting and all contributing heat and all of this happening in a millionth of a second, pouring out, million-degree heat boiling over a city.

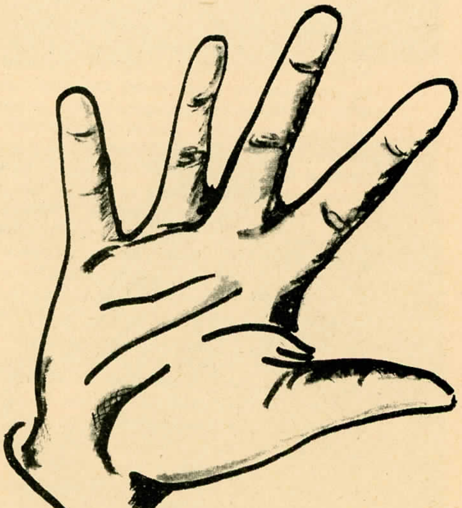
"But how do you keep this from happening while you are stacking the pieces of uranium? You don't want this to happen to you in a laboratory. Well, you must do this — withhold one piece, at least. Take one out of the way. Here we go. I am going to make clicks and it will go like this pht, pht, pht, pht, — or else I will make a noise of this type — trrrrrr — and this means that I am hitting successively with more neutrons, more neutrons, splitting, splitting more uranium, heat piling up, piling up, splits piling up, two times two, times two, times two, times two. Here we go: trrrrrr... Well, you had better not have any more; pull one out of the way. It will go like this

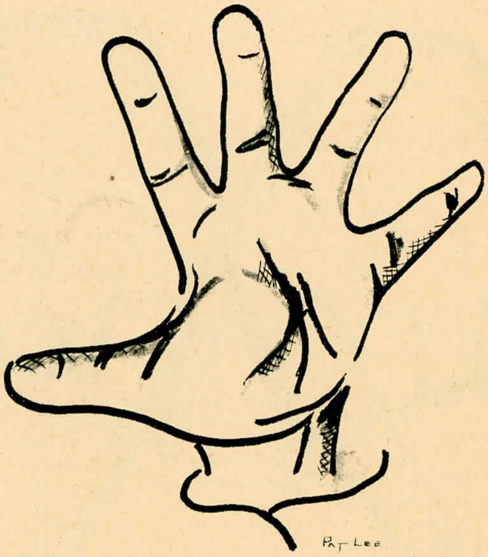




"Each neutron perhaps heads for another uranium nucleus and splits it — there's the fission and heat — pht! and more neutrons, more splits, more heat . . . pht! pht! pht! pht! pht!. . ."

"And there goes the chain — as I trace it through space here! TrrrrrrrrrrrrrrrRRRRRRR! PhttttttttttttttttTTTTTTT! WhooooooooooshhhhhHHH!"





"WHOOOOSHHHH! . . .
Boiling over the top. Million degree heat.
Million degree heat struck the people . . ."

trrrr — misses — trrr — misses — a neutron goes through an empty place: there is no uranium there. You took one piece out of the way — remember?

"I was not on the bomb project. I used to work on the peaceful uses of atomic energy. But I am guessing that it is something like this: So you pull one piece out of the way, pay someone a quarter to hold that piece back, on a spring. Now you stack all the other pieces. Here we go. It will work like this — trrrr — misses — trrr — still misses — trrr — misses. Well, now you are ready and you take this in a bomber and it is ready, and this is how it goes, and one piece is on a clockwork, you might say, with a spring, on a radio work, maybe, it doesn't make any difference. One piece, let me say, is in the wrong place and all is dropped over Hiroshima and it falls, click, click — misses — and then tick-tock, tick-tock, goes your clock and the piece flies into place and they are all in place and now you have trrrrrrrrrRRRR — WHOOSHHHHH over the top, boiling over the top, and the heat is red heat, million-degree heat, pouring out in a millionth of a second, spreading over the city, boiling red heat, boiling the people, vaporizing them, killing the Japanese people, dead, vaporized into space, gone, completely gone, and the heat pours on, on, over the city it comes, and the walls melt and crumble and the earth crumbles and melts away, and the heat pours on. And the heat — has struck the people. And now it is less, it is less, it is less, but it is very high temperature still, but less, and the people drop dead from boiling, not enough to vaporize, just dead from boiling alive like rats, like lobsters. They drop to the ground and the heat spreads and goes on and on, still less, and it scorches the people, scorches, and they develop scar burns, body burns.

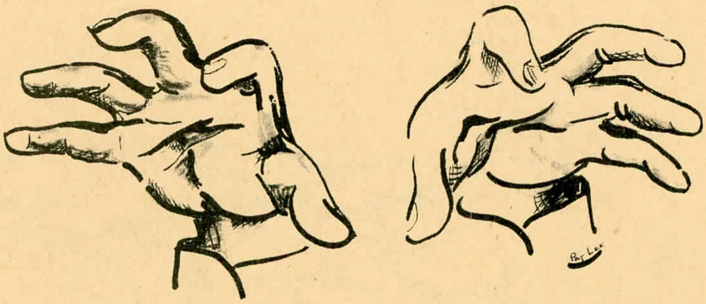
"But there is more killing; there is more killing that comes out of the bomb, not only the blast, the heat, the boiling effect; and I am thinking now that out of the center of the bomb when the reaction took place, when that took place, out came wiggles from the center of the bomb, like my hands are wiggling here, into every direction. Remember I mentioned the wiggles that come out at every fission. The wiggles come out and these are death rays, really; essentially they are death rays. These wiggles, remember, are called 'gamma rays.' The gamma rays come out and they travel through space and they can go through cement, solid cement walls, and they penetrate the walls and they reach the people and the people die, eventually, from what is called radiation sickness. They die, it may take a week; it may take more than that. Bloody diarrhea. Acute leukemia. The people might fight back with blood transfusions and good food and rest, and many Japanese won this fight against radiation sickness. And many did not win. The gamma rays damage the bone marrow, the marrow of your bones, and this is serious because in the bone marrow the blood is manufactured, remember? And when you cannot replenish your blood supply you must have transfusions, and more transfusions and more, and yes, you might win. The bone marrow might pick up and recover if you have not had much gamma raying, but it may not.

"All together, by these various mechanisms, 80,000 Japanese people lost their lives at Hiroshima from one bomb and some will continue to lose their lives from the radiation sickness which goes on and lingers. And in addition, for miles around, those Japanese women who were pregnant had miscarriages. Horror compounded on horror.

"Now there is another thing which bothers some of us. A man named Muller, Professor Muller at the University of Indiana, knows about things of this sort. He is a great scientist, a geneticist, who studies genes. Genes are the tiny things that transmit heredity characteristics. If you are a man, your child will be of manlike form and the child will have manlike eyes and hair and the manlike nose, and he will be a human being. But there is some fear that the gamma rays damage the genes and heredity characteristics, so that the man of you is destroyed or the woman of you is destroyed in future generations; perhaps the Japanese will produce children who are not quite human in every respect, somewhat of a monster birth, perhaps.

"These gamma rays, then, they not only murder us immediately but they may murder our offspring for years, for centuries to come, Muller thinks. This may happen. You might read his letter to 'Life Magazine' in the issue of April 7, 1947.

"And now with the new bombs, with the stronger bombs which make the bomb of Hiroshima like an obsolete thing, like a Model T, you might say, of atomic bombs, with the new bombs, which might be a thousand times stronger, what will happen then? Already Admiral Zacharias has admitted that we have



"Then the wiggles come out. The wiggles, like my hands are wiggling — the gamma rays — and they penetrate great walls, and they penetrate human bodies, damaging the marrow of our bones. . ."

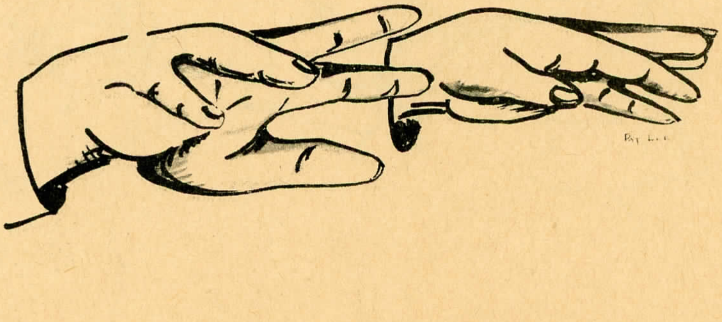
an atomic bomb fifty times stronger than the previous one. How many people will die?

"In addition to this blast and the gamma ray killing and the burning and the boiling, the new bombs will be accompanied by something which we call 'loading'. We put a load on the bomb, an extra load, l-o-a-d. This means a block of copper goes for a free ride or a block of iron or maybe a block of uranium, for a free ride, and then what happens? Well, the piece on the spring, remember? flies into place, the little piece that I was holding out slides into place and here goes the bomb again — trrrrrrrrRRR — WHOOSHHHH — spreading, spreading, but in addition, this block, this load, now vaporizes, the load becomes a vapor, a copper dust, if you want, and this copper dust becomes clicky click, click, click, click, click, click, and the wind takes it and the copper dust floats. The wind takes it and the dust settles all over. It may settle over one state, two states, three states, over half a country, perhaps, if there is enough of this clicky substance that has become the dust, the atomic cloud, they call it, the death dust it has been called. This dust will float and it will settle and the people will breathe and they will die because the lungs click and the body is poisoned; the clicks go on and the body is poisoned and cannot live, and the clicky dust will settle to the ground too and the earth will imbibe it and the atoms, the clicky atoms, the energy from the clicky atoms goes on and clicks, click click click click and the clicky particles settle into the soil and they penetrate deep within and the plants that come up and the corn that comes up and the flowers that come up, are all clicky, and when the apple tree grows the apple tree is clicky, and when the apple is born on the tree it is clicky click, click, click, and we eat that apple, you eat that apple, and you will die.

"This may be our future: this horrible thing, when it need not be, may be before us. But you will say, 'Oh, but we have the secret. Thank goodness we have the secret of the bomb.' I will tell you this: To make the bomb you have to know where to put the pieces so that the chain will begin to work. Where do you put the pieces, here, there, some over here, two pieces of uranium here, two over there, six over here? Where do you put them? Well, is that a secret? Do you wish to sleep peacefully now, thinking that is a secret? It took us two years; the American scientists took two years, with their friends, to find where to put the pieces. How long do you think a so-called enemy would take, might take? Well, take the Russians. I imagine you have them on your mind. How long will they take? Do you wish to say twenty years, that the Russians are incapable of thinking scientifically along these lines? That is not true. Or the French or the Spanish with the Fascist Franco, or in Argentina, where they have found uranium. How long to find where to put the pieces? It may not be very long. I will say three years, I will say five years, if that will make you happy. But it is no secret. It is merely a temporary advantage that we have. And remember that they started working in 1945, after atomic bombs exploded over Japan.

"Then of course, it is not that easy; I admit that. The pieces must be pure uranium, a type called uranium 235 — for one type of bomb. Well, we built the entire city called 'Oak Ridge' just to purify uranium. It was hard to do. It took us almost a year to build this city. All right, can the Russians build a city? They might call it 'Oakski Ridgeski', if you want. I think they can build cities and they will purify uranium, and they will find where to put the pieces. There is no lasting secret. Do not let anyone tell you there is one.

" 'Well then', you say, 'the war starts. At least, let us defend ourselves. We will defend ourselves.' I can tell you about this, for I have worked where the defense against rockets was being made — at the Massachusetts Institute of Technology where we worked on radar. By radar control, by sending electricity signals into space, it was possible to locate V-1's, where the V-1's were, and shells could be fired, the shells from the guns to explode in the vicinity of the rocket and in this way the rockets were brought down, but only 70 per cent of them and then the Germans changed to a V-2 rocket which travels faster and I haven't time to tell you, but I will only say this, that radar with guns, cannot follow in space accurately the V-2. The V-2 travels too fast, almost 4,000 miles per hour. Radar cannot 'track it', the scientific men call it; it cannot by radar-control track the V-2, for firing a gun accurately. We do not know where to point the guns and it cannot be done automatically. There is no defense. The bombs that will come in the rockets will get through.



"And the clicky dust. Death dust . . . the radioactive cloud . . . click click click click . . . the wind takes it . . ."

"There is no way to stop them, and you say 'weapon, counter-weapon', but that is a thing of the past; that is a thing of the past. Bow and arrow, yes, and a shield will stop the arrow; and a bullet is stopped by a stone wall, yes; but you can't hide behind stone walls when atomic bombs begin to fall. There is no defense.

"There will never be any adequate defense except a moral one, a will of the people to establish a world community secure in peace. This is our goal — to support all peaceful movements. This is what we must do.

"We are no longer in an age where we can take our chances with a war every other decade. We can no longer survive in such an age. Americans, and Russians and Frenchmen and Englishmen with their private interests — that is all of an obsolete age, a Model T Age; for when atomic bombs begin to fall they won't ask your nationality.

"We are in a new age in the Atomic Age — The Age of Universality and as Einstein says, 'In the shadow of the atomic bomb all men are brothers.'

"There is only one defense against atomic bombs — and it is the unbreakable will to outlaw all war, completely. This alone will stop the bombs. We must talk peace, talk hope, we must indicate that we are human beings worthy of the name, human beings, evolved to a wondrous species that can prevent itself from destroying itself. We must talk hope — we must not listen to those who would scuttle us, who tell us that war is surely coming, that there is no hope. Do not listen to these men of little faith, who say that the 3rd World War has begun. The 3rd World War has not begun and it need not ever begin if we work for peace, completely, unsparingly.

"I know, I know you say, 'Tell it to the Russians' yes, I want to tell it to the Russians, I want to tell it to the French and to the British. I want to tell it to the Americans. I want to tell it to all men — that they have one world and that they must cherish it. Or it may not survive the times that have come — the age that is upon us.

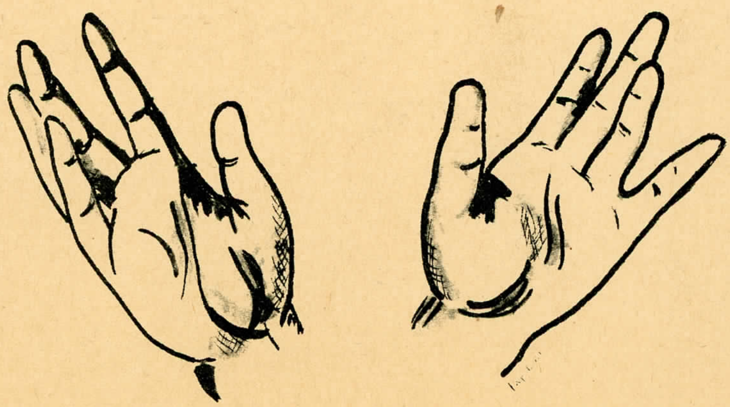
"It is the age when the peoples of the world must become one.

"Support the United Nations, support World Government, support any peace movement and put aside the thoughts and words of childishness — 'loss of sovereignty'. For these are the times of men.

"When the colonies in America joined to form the great United States did they give up some sacred sovereignty? Was that a step of foolishness? Do we regret? There is no loss awaiting us — there is only a gain. There is a universal sovereignty awaiting us, the sovereignty of the Brotherhood of Man. It has been done between States in the United States — it can be done between nations. But in this great Brotherhood we must go all the way, to take evil and prejudice from our hearts — and the Jew is as good as the Catholic, and the Greek is as good as the Frenchman, and the Russian is as good as the American.

"But make it anything you please. World Government, World Federation, genuine United Nations — so long as our real objective is the peace of the world.

"Somewhere, we have read, 'I call heaven and earth to record this day against you, that I have set before you life and death, blessing and cursing: therefore choose life, that both thou and thy seed may live..."



"There is only a moral defense. A defense in spirit..."