

# FICTION + FACT = POSSIBILITY

## Part Three

### PROBLEMS OF COMMUNICATION WITH ALIEN INTELLIGENT BEINGS

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*This is the third of four papers delivered to the 1964 autumn meeting of the British Association for the Advancement of Science; you will remember that we have already reprinted in 'SF News' Professor W. T. Williams's paper on 'Problems of Alien Biology' and Mr A. R. Manser's on 'Alien Sociology'. Dr Mercer is a member of the staff of the Physics Department in the University of Southampton.*

#### Introduction

If we woke up one morning to find, hovering over our city, a space-ship from a distant galaxy, we would no doubt view it with very mixed feelings. But after the initial surprise had subsided, the very practical question would arise—how can we get in touch with its crew? If we did not, at best the ship might simply consider that there was nothing of interest in the vicinity and go away—and we would have lost an almost unique opportunity of immense potentiality. But at worst, the ship might have the means of destroying our whole planet. For a variety of reasons, we would find it imperative to *communicate* with the crew (or with the ship, if—as may well be the case—it is an unmanned robot).

But how should we start to communicate? Obviously there is no point in flashing English messages in the Morse code. What means should we use? Clearly this needs a good deal of thinking through, and it is this subject which I want to deal with—the basis of communication with alien intelligent beings (I use the word 'alien' in the science-fiction sense—the inhabitant of another part of the physical universe who may have no necessary common physical traits with us). All we know about these people is that they are intelligent—they must be so, or they could never have built a space-ship. Any communication must be on the basis of our common intelligence. This puts the problem in the best way—what is the basis, the lowest common multiple, if you like, of intelligence: something which is common no matter how much its physical vehicle changes. If we can understand this, we can understand how to communicate: in fact the two problems are bound up with each other.

To start with our case of the space-ship which has appeared in our vicinity, we assume that its builders are (1) intelligent; (2) at least as far advanced scientifically as we are—and probably much more so; (3) interested in finding other intelligences (this is probably a fair assumption, as they have apparently sent an exploring space-ship, although it is not impossible that races who are completely withdrawn and introverted exist); (4) ready to communicate and to receive signals, and to try to interpret them.

This last point is important, and it needs some discussing. The probe will obviously not expect communication in its own language. In fact, we must both seek a common language. . . .

#### Problems of sending signals

To follow this thought up, we should ask what signals would show that we are intelligent, and would be so understood by the probe. Any signals we send must look artificial—space is full of light and radio waves, and our signals must clearly look as if they have not arisen from a natural source.

I don't want to spend time discussing the mechanics of signalling, except to say that we are limited, over long distances, virtually to two means: short-wave radio, and 'laser' light beams. For most purposes it appears that radio is preferable. I might also remind you that such waves travel at the speed of light—so to communicate with a planet ten light-years away the round-trip signal would take twenty years! Clearly there is little scope for rapidly changing one's mind while conversing.

In many cases we are limited to sending a series of identical signals in time—i.e. a train of pulses of electromagnetic energy, either radio beams or light beams. One such series which has been suggested is a series of prime numbers (numbers which have no factors, but are divisible only by themselves and 1). If we send pulses in groups of 1, 2, 3, 5, 7, 11, 13, 17 . . . etc., they will clearly come from intelligent beings. No radio storms in the galaxy, or any other natural process, will produce prime numbers.

We might also try a series of squares, 1, 4, 9, 16 . . . etc., or the digits of  $\pi$ , the ratio of the circumference of a circle to its diameter, 3.141592 . . . This, being a ratio, is independent of the units of measurement. It does, however, raise the sort of point which we shall be considering again—can we assume that the circle is such a fundamental idea that any intelligent being, however alien, will know it? I think we can make this assumption—any being with any knowledge of working materials, such as constructing radio transmitters, must be familiar with the circle.

At this stage it might be pointed out that we could make pictures. It has been suggested in the past that we should build an enormous chain of beacons over a large land area, showing, for instance, Pythagoras' theorem. If a space-ship were hovering overhead this would certainly be possible; although we might well want to indicate that we had progressed further than the ancient Greeks, and some more sophisticated diagram, of the sort to be discussed later, might be more appropriate.

Such beacons, however, would be visible only to something close at hand—an alien space-ship orbiting the earth, as I mentioned earlier. What if we tried to send signals to a distant planet? Is there any way in which we can send pictures to them?

#### Some fundamentals of perception

Before discussing this, perhaps we should consider two further fundamental points. One is that we assume other alien races have eyes, or at any rate some corresponding sense organs.

The other is that they can understand pictures, which are two-dimensional representations of three-dimensional objects. Here again, we feel that a sense of vision must be essential to anyone with an advanced technology. Secondly, we feel that such an advanced technology must deal in pictures and diagrams. We may be wrong over this—there may be races dependent entirely on tactile senses dealing directly with three-dimensional objects. All we can say is that it seems unlikely: this is the sort of thinking we must, however, attend to if we are to establish a basis for a universal intelligence.

While on this point, we ought to consider a little further the modes which intelligence can take. There may be some intelligent races which are completely withdrawn and introspective, wishing to have no contact with anyone outside. There may be others who are uninterested: they may have solved all their political and economic problems, and spend their time watching television.

There are two other cases which may raise problems; one is the case of beings whose processes are very slow compared to ours. Although they may be intelligent, it would be virtually impossible to communicate with them. The other is the case of a civilization well versed in the abstract virtues of goodness, truth and beauty, but without any technology.

These would be difficult to communicate with—as a superior alien community would have found the classical Greeks—but I do not think there is an absolute bar. I don't consider that any entirely abstract philosophy can exist in isolation from the real world: even on this earth, our most idealist philosophers slip in ideas of material things—e.g. counting—which they could not do if in fact mind were the only thing which existed. (And it is worth noting that the ancient civilizations have led, in time, to our technological one.)

#### Sending pictures by trains of pulses

Returning to the problem of sending pictures, in fact it is not too difficult to do so by a series of pulses. What in fact should we send? I mentioned that we wanted something more advanced than Pythagoras' theorem. One subject we do know about is the way in which atomic nuclei can be split up in reactions taking place in stars. One such reaction, believed to be correct, is when lithium and hydrogen combine to form carbon and helium.

If we indicate this . . . it is probable that it will be recognized. The alien races will then know that we understand stellar reactions. We could send diagrams of the carbon cycle, indicating that we live on the basis of carbohydrate chemistry. We should perhaps send diagrams of our local constellation and solar system.

Apart from all this, once one can send pictures the problems become standard ones of education and logic. It is, however, a fascinating idea to compile an educational series on 'All about us and our world—for someone who has never seen any of it'. Think of putting together the whole sum of human experience and existence in a series of programmes. I would like to see some television series experts try it.

#### Listening to incoming signals

Quite apart from the problem of sending information, however, there is the problem of listening. Suppose other advanced galactic communities are trying to beam information at us? What should we be listening for?

Once again we are considering intelligent signals, differing from the natural signals in the universe . . . and the test to distinguish between natural and artificial is a *statistical* one, and can readily and quickly be applied, without studying each signal in detail.

I might point out that we could learn a good deal about the other planet just by the character of the radio signals, quite apart from their information content. If the signals appear at more or less fixed intervals, we might assume that this represents the length of their day. The basic frequency of their radio signal will slowly change, due to the transmitter moving towards and away from us, due to the rotation of the planet on its axis and about its star (this is the well-known Doppler effect). From a study of this frequency, we could deduce these quantities, and hence find something about their planet's behaviour. We might even, from this, be able to identify their star.

#### Population of intelligence in the universe

It is necessary to digress to consider just how many advanced communities there may be, as the type of signal received (or the type we send) does depend on it.

As far as we know, a small fraction of stars have planets. For any planet to be able to support life, it must be neither too hot nor too cold because life depends on chemical reactions, which will proceed too slowly at low temperatures, and will not proceed at high temperatures because substances decompose. (We know that the whole universe is made of the same materials we are familiar with, and the same general laws of chemistry apply.) Thus only a fraction of planets will be at the appropriate distance from their stars. Further, only certain types of star are suitable; they must give a constant energy output over the biological time-scale.

When all this has been worked out, the next problem is—how long may technologically advanced communities exist, compared with the whole time life has existed on their planet? This is a matter for speculation: perhaps by sociologists. In our own case, for instance, we have had radio for only some sixty years, while life has existed over the vastly longer biological life-time scale. If we can imagine advanced communities existing for much longer than our sixty years, we arrive at the quite speculative figure that there may be some hundred million advanced communities throughout our universe (taking the number of stars in the universe to be denoted by a 1 followed by 21 zeros, i.e. one thousand million million).

The general thinking in this section will be seen to stem from one aspect of the 'cosmological principle'—namely, that there is no reason to assume that we on this earth are unique, or specially privileged in any way.