

# Nature alive: microphysical objects as proto-organisms

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An attempt is made to interpret nonrelativistic quantum physics in terms of rudimentary psychophysical systems, i.e. proto-organisms, possessing rudimentary psychic as well as physical aspects. The relevance of this interpretation to psychical research, and the possible contribution of psychical research to the development of the interpretation, are indicated.

## 1. INTRODUCTION

The objects of our everyday experience can be divided into two broad classes — living organisms and material objects. Classical physics, i.e. physics from the time of Galileo and Newton until around 1900, modelled all physical objects as inert, material objects. The constituent particles of both living organisms and material objects were considered to be material objects.

Several prominent philosophers and scientists of this century have held the view that the smallest natural objects, from which ultimately all other natural entities have evolved, are simple living organisms, possessing a rudimentary psychic aspect as well as a physical aspect (see, for example, Whitehead (1938), from which the title of the present essay is taken and Teilhard de Chardin (1959), Burgers (1965), Agar (1951)). In a recent essay (Villars (1982)), the present author restated the evolutionary argument in favour of this point of view (see, also, Lawden (1964)) and suggested that modern quantum physics could be interpreted as already, tacitly, describing features of the psychic aspect of microphysical objects. The purpose of the present essay is to elaborate this suggestion by attempting to identify the defining characteristics of living organisms and showing to what extent they are applicable to microphysical objects.

Modern physics has failed to provide a unitary conception of microphysical objects in terms of classical physical concepts. This may be due to the fact that they share more of the characteristics of living organisms than of the material

objects with which physics has traditionally been concerned. Perhaps we may eventually obtain a unitary conception of microphysical objects if we try to picture them as very rudimentary living organisms – proto-organisms – instead of as some kind of material object.

## 2. DEFINITION OF A LIVING ORGANISM

The following properties are characteristic of most things that would normally be called living organisms:

(i) Activity. A living organism which becomes completely inactive, both inwardly and outwardly, is considered to be dead.

(ii) Spontaneity. Not all the actions of a living organism are completely determined by external causes. Whereas a stone lying on the ground will remain unmoving until kicked or moved by some other external influence, a sitting animal may spontaneously get up and move away. Living organisms are capable of acting spontaneously in partial independence of external influences.

(iii) Wholeness. A machine, for example a robot, is capable of acting spontaneously. The spontaneity of a living organism is supplemented by its wholeness. Living organisms are not merely the sum of their parts, but are capable of acting as a whole in ways not completely determined by the nature and arrangement of their parts. (The respective roles of wholeness and mechanistic determination in the behaviour of living organisms are discussed in detail in Agar (1948).)

(iv) Perception. All living organisms perceive, or are sensitive to, their environment.

(v) Purposiveness. By virtue of their spontaneity and wholeness, living organisms are partially autonomous entities, possessing a limited power of self-determination. The autonomous actions of a living organism, though not determined by either internal or external causes, are not random, but rather are determined by subjective aims, or purposes, which generally subserve wider purposes useful to the organism. (A detailed discussion of the concept of purpose in biology is given in Agar (1938).)

(vi) Self-reproduction.

(vii) Nutrition.

(viii) Respiration.

Microphysical objects, i.e. individual molecules, atoms and atomic particles, do not share the last three characteristics listed above. However, the following Sections will attempt to show that they do share the others. To do this, each characteristic will be considered in turn.

### 3. ACTIVITY

Heisenberg's Principle of Indeterminacy states that the spread in the range of possible values of a microphysical object's position ( $\Delta q$ ) and the spread in the range of possible values of its momentum ( $\Delta p$ ) are related by the formula,

$$\Delta q \cdot \Delta p \geq h/2\pi \quad (1)$$

where  $h$  is Planck's constant. A microphysical object has a precise position if and only if  $\Delta q = 0$ , and a precise momentum if and only if  $\Delta p = 0$ . It follows from equation (1) that  $\Delta q$  and  $\Delta p$  cannot simultaneously equal zero. Hence, microphysical objects cannot simultaneously have a precise position and a precise momentum. It follows that they can never be at rest in the classical sense, for they cannot simultaneously be at a precise position with a momentum of precisely zero. This alone is sufficient to establish their essential activeness. However, the fact can be further seen in the contrast between classical and quantum physical observables.

Physical observables are the quantities that can be directly measured, such as position, momentum, angular momentum, energy, etc.. In classical physics, these were interpreted as properties possessed by the observed object in itself, independently of the process of observation. This was an idealisation of the actual situation. In fact, all physical observations involved an interaction with the observed object. However, classical theory allowed in principle that this interaction could be made indefinitely small, or, if this were impractical in any particular case, compensated for by further observations of unlimited precision. Consequently, it was possible to idealise and regard the results of observation as representing properties of the observed object alone.

By contrast, in quantum physics, due to the quantisation of action and the very small masses of the objects observed, the interaction of observed object and observing apparatus cannot in general be made negligibly small or compensated for by further observations. The observed object and observing apparatus are involved in an irreducible and unanalysable interaction. Consequently, we cannot idealise and regard the results of observation as properties of the observed object alone.

As Bohr, in particular, has emphasised (see e.g. Bohr (1963)), in quantum physics the interaction between the observed object and the observing apparatus forms an inseparable part of what is observed. The results of observation derive from this interaction and must be taken to represent properties of the interaction as a whole, not properties of the observed object alone. Thus, quantum observables are properties of the interaction between the observed object and the observing apparatus. Quantum position, momentum, energy, etc., are each properties of a different mode of interaction with observing apparatus. This

further emphasises the essential activeness of microphysical objects; what we observe of them are not passive intrinsic properties, but rather interactions with observing apparatus, i.e. modes of behaviour.

#### 4. SPONTANEITY

Consider the behaviour of microphysical objects, e.g. electrons, in the apparatus shown in Figure 1. A beam of electrons, all emitted with the same initial energy by the electron-gun apparatus, is diffracted by the narrow slit and recorded by the photographic plate. The experiment can be performed with a very low intensity beam so that only one electron at a time passes through the apparatus. After being diffracted by the slit, each electron interacts with the photoemulsion to produce a mark at some point between A and B. If the experiment is repeated, the electrons will in general produce marks at different points, such as X, Y, Z, in the emulsion. This result is characteristic of the behaviour of microphysical

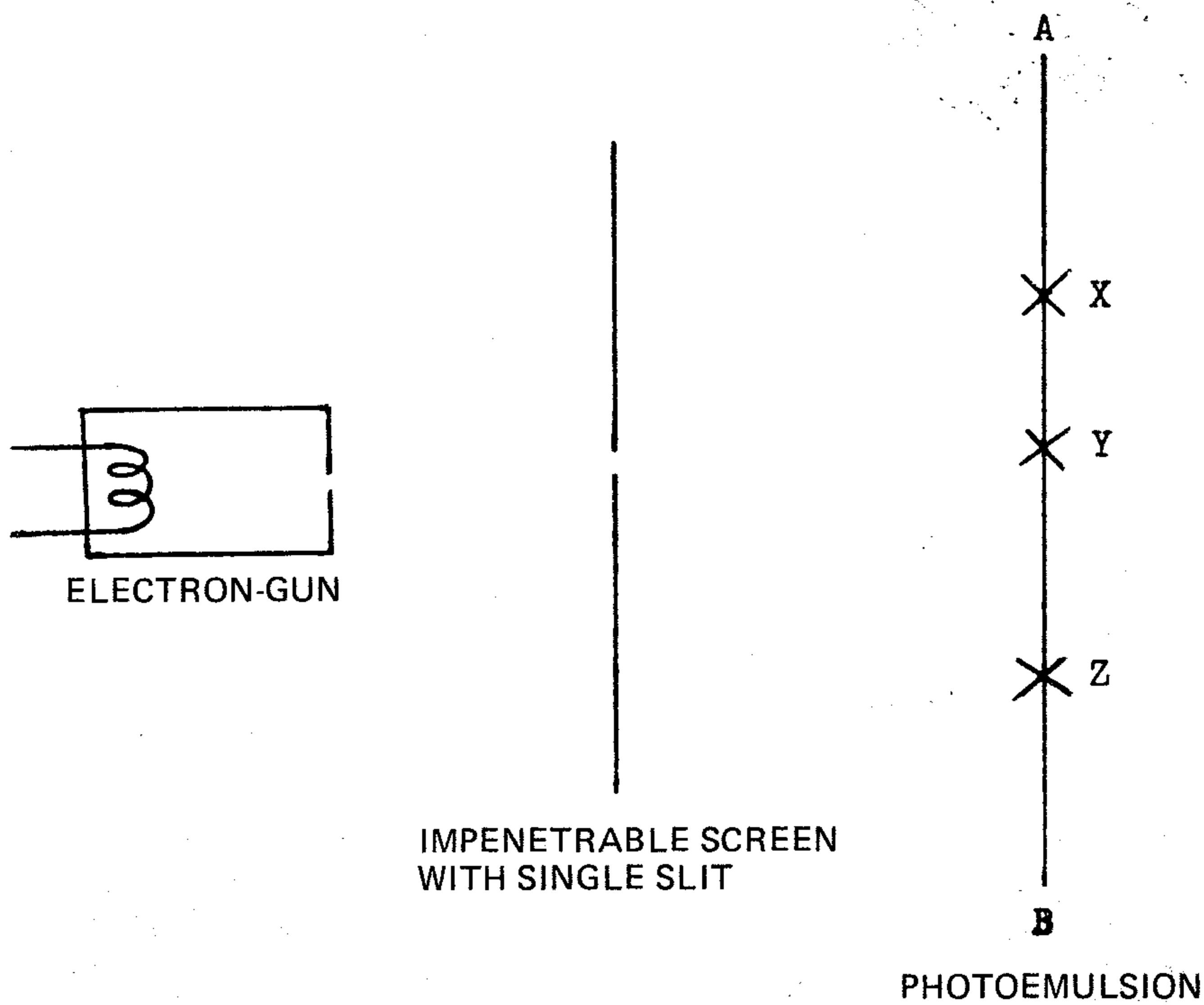


FIGURE 1 Single slit electron diffraction experiment

objects. In general, if the same experiment is repeated with the same initial conditions, different individual results are recorded.

Clearly, the value of the electron's initial energy does not completely determine its interaction with the photographic plate, but rather a wide range of possible interactions is left open to it. This freedom from complete determination by external causes is what is here called spontaneity. Within the limits imposed by the initial conditions of the experiment, each electron spontaneously realises one of its possible interactions with the plate.

This spontaneity is also revealed in many other phenomena, for example the spontaneous decay of radioactive nuclei and the spontaneous emission of light radiation by molecules in high energy states. In these cases, the precise moment of decay, or emission, is not predetermined. Just as the sitting animal may spontaneously get up and move away, so too the radioactive nucleus or excited molecule may spontaneously decay or emit light.

## 5. WHOLENESS

A machine is the sum of its parts. Given the nature and arrangement of the parts, we can calculate the behaviour of the whole simply by considering the parts in interaction. Thus, the behaviour of the whole is completely determined by the nature and arrangement of its parts. Classical physics was a mechanistic theory in this sense. In classical physics, the state of a compound system could always be obtained by combining the separate states of its parts. The state of each part could be specified independently and the whole regarded as a combination, or sum, of the parts.

By contrast, in quantum physics, a compound system is capable of occupying states which cannot be obtained by combining separate states of its parts. In such a state, it is impossible to specify the state of each part separately. Consider, for example, a molecule whose total spin is zero consisting of two atoms, A and B, each of spin  $\frac{1}{2}$ . (This example is taken from Bohm and Aharonov (1957)). The state function describing the molecule as a whole has the form,

$$\psi = \frac{1}{\sqrt{2}} (\psi_1^A \psi_2^B - \psi_2^A \psi_1^B), \quad (2)$$

where the  $\psi_i^A$  and  $\psi_i^B$  are functions which describe A and B independently. It is impossible to specify the state of atom A in this molecule exclusively in terms of the functions which describe it alone, i.e. the  $\psi_i^A$ , and likewise for B. The states of A and B are immediately interdependent and cannot be specified separately. Consequently, the state of the whole cannot be regarded as a combination of separate states of the parts.

Such a system is capable of acting as a whole in ways not determined by the

nature and arrangement of its parts. For example, the interactions of the whole system with observing apparatus, leading to particular results, cannot be understood as any kind of combination of interactions of its constituent parts with the apparatus. (The whole may be in a particular eigenstate of an observable, whilst the parts are not in eigenstates of the observable at all). Clearly, a compound system in quantum physics is *more than* the sum of its parts. Microphysical objects share the property of wholeness characteristic of living organisms. (A more formal discussion of the wholeness of microphysical objects is given in Weyl (1949).)

## 6. PERCEPTION

As shown in the previous Section, the states of the parts of a compound system in quantum physics may be immediately interdependent. This kind of immediate, or instantaneous, interdependence is in fact a very general characteristic of microphysical objects (see Schrödinger (1935), Bohm and Hiley (1975), d'Espagnat (1976) and (1979), Hiley (1980)). In general, if two microphysical objects interact, their states after the interaction will be instantaneously interconnected even though they may have separated by macroscopic orders of distance since the interaction. In nature, microphysical objects will generally have a long history of interactions with one another and consequently, a widely extended range of immediate connections. Furthermore, we know from the Pauli Exclusion Principle that the states of microphysical objects may have this kind of immediate interdependence even when there has been no previous interaction between them.

How are these immediate interconnections between states possible? Clearly, microphysical objects are not completely localised entities, instantaneously isolated from one another. The present author has suggested an interpretation of microphysical objects as centres of perception, each centred in a particular spatial region but having immediate, instantaneous perceptions of other objects centred in distant regions (Villars (1981)). Such objects can be pictured schematically as in Figure 2; each object is centred in one particular region, such as A, but also has immediate perceptions of other objects centred in distant regions, such as B and C. It is by virtue of their immediate perceptions of one another that the instantaneous coupling of separated microphysical objects, revealed by quantum physics, is possible.

The term 'perception' is used here in preference to a more neutral term such as, for example, 'connection', in order to emphasise that, according to the present interpretation, these forms of relationship are a feature of the inward, subjective aspect of microphysical objects. The term 'perception' immediately suggests a form of internal relationship, not merely external objective relations

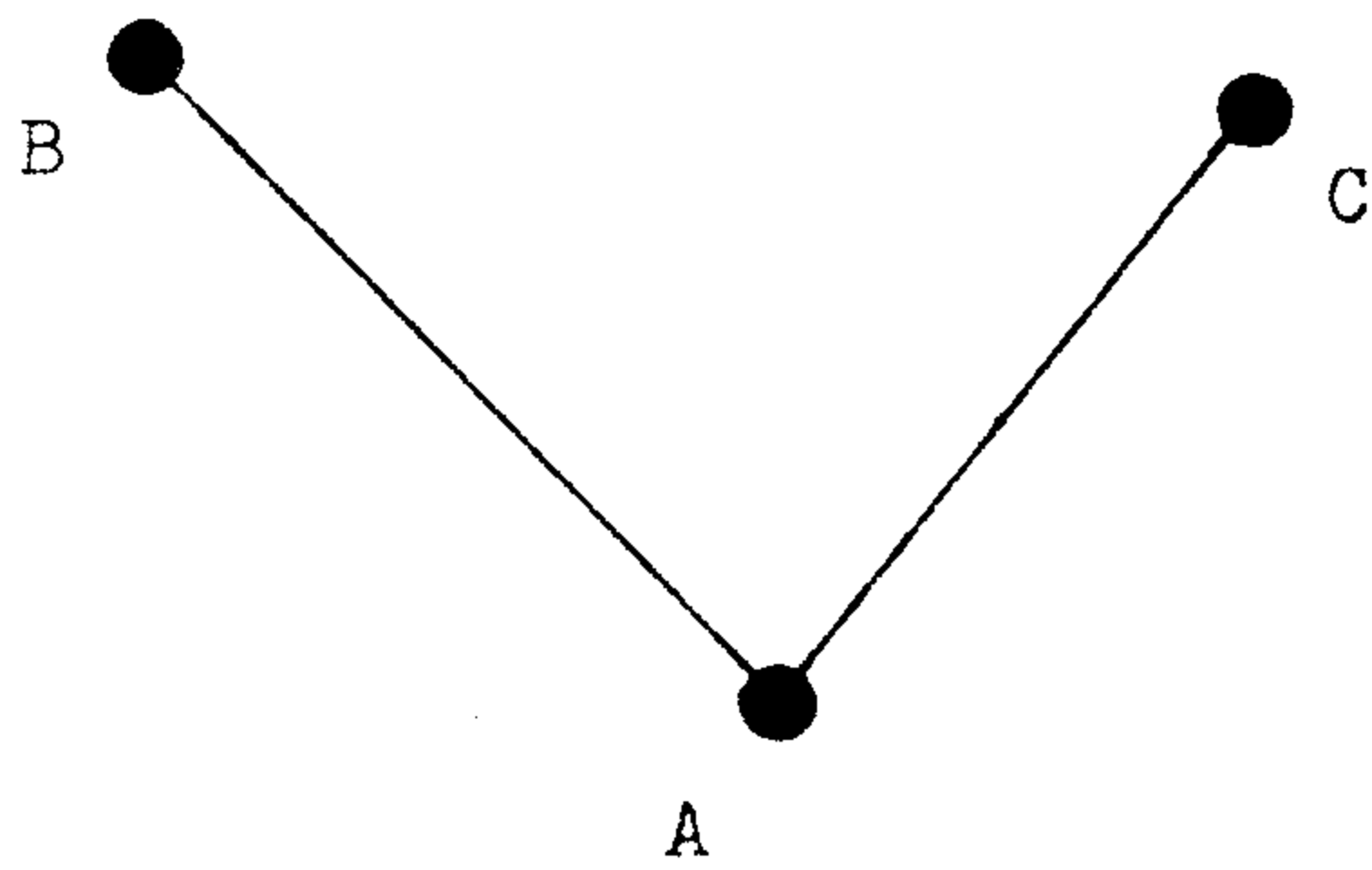


FIGURE 2 Schematic representation of a microphysical object conceived as a centre of perception

as suggested by the term 'connection'. It is suggested that the immediate perceptions of microphysical objects are an aspect of their rudimentary subjectivity from which our own, vastly more complex, subjectivity has evolved.

If we accept this interpretation of microphysical objects as centres of perception, it is clear that they share the property of perception, or sensitivity to environment, characteristic of living organisms.

## 7. PURPOSIVENESS

Consider again the single slit electron diffraction experiment described in Section 4 above. If this experiment is repeated many times, with each electron having the same initial energy, the marks produced on the photoemulsion eventually form a pattern similar to that shown in Figure 3. This pattern is completely determined by the initial conditions of the experiment. Thus, though each individual electron may spontaneously actualise any possible interaction between the limits A and B, it is clear that this spontaneity is not unrestricted randomness. The pattern in the marks produced by a large number of electrons represents a pattern of tendencies affecting the behaviour of each individual electron. In general, these tendencies vary widely; microphysical objects show marked preferences for some possibilities rather than others.

Given the Hamiltonian, or total energy, operator of a quantum system and the state  $\psi_0$  of the system at time  $t_0$ , the Schrödinger equation can be used to calculate the state  $\psi$  of the system at any later time. The magnitude of a microphysical object's tendency towards any particular interaction can then be calculated from  $\psi$ . However, why a microphysical object's state conforms to the Schrödinger equation and why it evolves in accordance with that equation is not

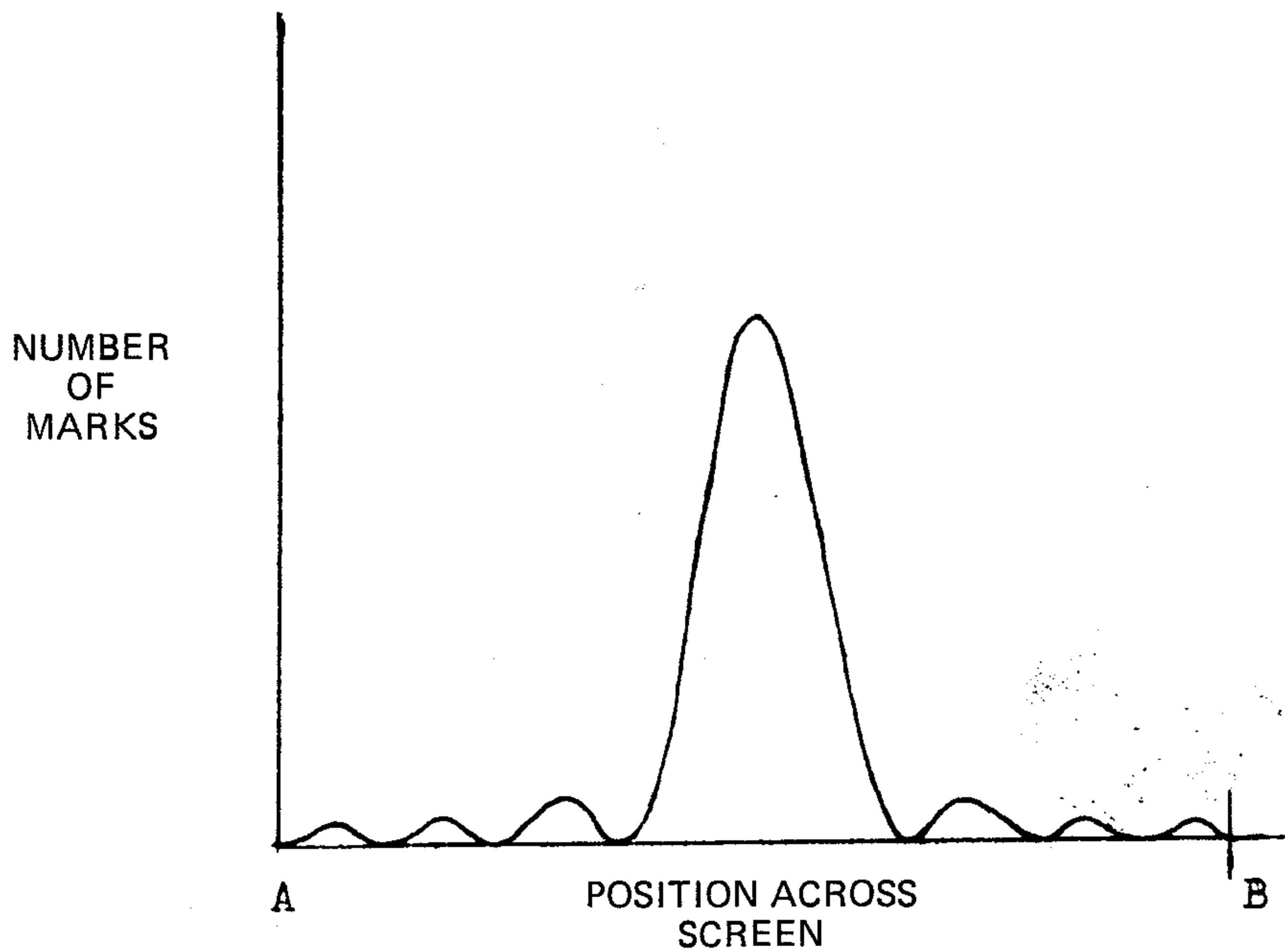


FIGURE 3 Pattern of results in single slit electron diffraction experiment when a large number of electrons are used.

explained by quantum theory. This equation is simply postulated as an axiom of the theory. Thus, if we ask "Why is a microphysical object's tendency towards possibility X greater than its tendency towards possibility Y?", quantum theory can only answer "Because this follows from the Schrödinger equation given the initial conditions of the experiment". Compare, in this respect, an electron 'wave' evolving in accordance with the Schrödinger equation and a water wave spreading on the surface of a pond. The water wave also obeys a wave equation. However, in this case, the form of the equation can be explained in terms of the forces acting between the molecules in the water surface. By contrast, in quantum theory, once the Hamiltonian operator of the system has been derived, no further explanation of the Schrödinger equation is possible. As yet, we know of no sub-quantum level of reality in terms of which the form of the Schrödinger equation can be explained. Thus, whilst quantum theory explains the preferential tendencies of microphysical objects in the sense of determining them, it offers no explanation of their origin.



It is possible that a future physical theory will explain the preferential tendencies of microphysical objects in terms of some, as yet unknown, mechanical causes. For example, D. Bohm's 'hidden variables' interpretation of quantum theory (Bohm (1952)) proposes an explanation in terms of a new kind of physical force, which he calls the "quantum force". However, this theory is only speculative and a mechanical explanation may prove impossible. In that case, it is possible that the tendencies of microphysical objects, inexplicable in terms of causal mechanisms, are determined teleologically by aims or purposes. Thus, the pattern of tendencies in the behaviour of microphysical objects can be interpreted as the resultant of two factors, chance and unconscious subjective aims. Chance introduces the spread in the range of possible interactions open to the object, while its subjective aims determine its preference for one interaction rather than another. According to this mode of explanation, the preferential tendency of a microphysical object to actualise one possibility rather than another is due to the fact that the preferred possibility more fully realises one of the subjective aims of the object.

Current formulations of quantum theory are not ideally suited to emphasise the possible teleological aspect of quantum phenomena suggested here. A reformulation in terms of common characteristics which distinguish the more probable possibilities generically from the less probable possibilities would be more appropriate. This would enable us to identify the subjective aims which influence the behaviour of microphysical objects. For example, if quantum theory could be reformulated in terms of some kind of minimum principles, like the principles of least action or least time in classical physics, then the minimum conditions of this reformulation could be interpreted as the subjective aims of the object. It seems likely that the minimum conditions of such a reformulation would prove to be more complicated than the simple least action, or least time, of classical physics. The subjective aims of the object, coupled with its perception of the experimental arrangement and the randomisation introduced by the irreducible element of chance in quantum processes, ought to enable the relative probabilities of the various possible results of an observation to be calculated.

## 8. CONCLUSION

The above discussion shows that microphysical objects can be interpreted as sharing the properties of activeness, spontaneity, wholeness, sensitivity and purposiveness characteristic of living organisms. Hence, it seems reasonable to regard them as being very rudimentary living organisms. That they do not share the properties of self-reproduction, nutrition and respiration shows that they have only a very rudimentary degree of organisation. They are proto-organisms, much simpler than even the most primitive unicellular organisms, but from

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which, ultimately, all other organisms have evolved.

A microphysical object's immediate perceptions affect its behaviour. The interdependence of quantum states after interaction and the Pauli Exclusion Principle show some of the ways in which this is so. However, if we accept the centres of perception idea as an underlying model, it is clear that the potential for long range correlations of events based on a microphysical object's immediate perceptions is far from being exhausted by these rather limited phenomena. Thus, if microphysical objects *are* centres of perception, we may expect more patterns of immediate interdependence of spatially separated events to become apparent as our understanding progresses.

These revelations need not necessarily come from advances in fundamental physics. The existence of a wide variety of ESP and PK phenomena is by now well-established by psychical research. We may speculate that their explanation lies in the 'unconscious knowledge' of the surrounding universe implicit in the immediate perceptions of the microphysical objects which make up the human brain and nervous system. It is possible that these immediate perceptions affect the behaviour of microphysical objects in the brain and that these modifications of their behaviour cause patterns of neural stimulation which eventually give rise to extra-sensory perceptions.

These hypothetical correlations between the behaviour of microphysical objects in the brain and distant microphysical objects in the environment, may be explainable in terms of the specific forms of long range correlation already known to physics. However, it is also possible that they may be of a kind unknown to contemporary physics. Thus, the physical foundation of paranormal phenomena may not necessarily come from the application of known physical laws. It is possible that the facts established by psychical research will necessitate a broadening of our basic physical concepts, perhaps along the lines of the generalised centres of perception idea suggested in Section 6 above.

Thus, as has recently been suggested in another context (Lawden (1982)), psychical research has the potential to broaden our scientific worldview, so that we come to recognise a psychic aspect of all natural entities, from the simplest microphysical objects to the most complex mammals. If all natural entities are psychophysical systems, with psychic as well as physical aspects, the prospect for a scientific understanding of the human psyche as an effective phenomenon within nature would seem to be greatly increased.

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