

HOLISM

A Leading Paradigm Change in 21st Century Physics

Mendel Sachs

What will be the most significant paradigm change in 21st Century Physics? In my opinion it is the holistic model of matter, in its replacing the atomistic model.

The debate between the ontologies of holism versus atomism as underlying the fundamental nature of matter goes back to ancient Greece, in the Western Civilization and to the ancient teachings in Buddhism and Taoism in Asia. In ancient Greece the view of atomism was that of Democritus and his disciples and the holistic continuum view was that of Parmenides and his disciples. The atomistic model of Democritus has predominated to the present time until it was challenged, first by Michael Faraday and his field concept in the 19th century and then by Albert Einstein in his formulation of the theory of general relativity, based on the continuous field concept. The full implementation of the field concept, in turn, implies the holistic ontology as a fundamental basis for matter.

In the 20th century, the continuous field concept came into different branches of physics. Faraday's field concept was successfully applied to the laws of electricity and magnetism, as formulated by James Clerk Maxwell in the form of Maxwell's equations for electromagnetism. It was this continuum field that was to be the potential force exerted by charged matter on other charged matter.

The field concept then appeared in the expression of the quantum theory, in the form of a continuously distributed field of probability.

Thirdly, the geometrical field came into physics with the appearance of the theory of general relativity. Here, there is a continuously distributed field that is a measure of the metrical properties of spacetime. It is this field that predicted the gravitational manifestation of matter. This theory then superseded Newton's theory of universal gravitation. It replaced the discrete particularity of matter (atomism) with the continuous field of force. It replaced the concept of 'action at a distance' with the concept of propagating forces at a finite speed, between interacting fields of matter.

Newton's atomistic theory of matter was modified by a different particle theory of micromatter – the quantum theory. It is represented in terms of the matter fields that are probability distributions – described by the wave function ψ . In this view, the matter components of a system are still atomistic, and uncorrelated, unless an interaction between them might be 'turned on'.

The field theory of general relativity, that superseded Newton, is not atomistic. It is based on the interpretation of the matter fields as (Spinozist) modes of a single continuum. This is the entire universe. All of the (infinite number of) distinguishable modes are correlated fields, just as the multiple ripples of a pond, are in fact correlated modes of the single pond. Further, each of the multitude of matter fields, $\psi_1(x)$, $\psi_2(x)$, ... is mapped in the same four-dimensional spacetime x . This is a view of holism.

In the quantum mechanical particle view, each of the matter fields of the system is mapped in its own spacetime, $\psi_1(x_1)$, $\psi_2(x_2)$, ... Thus, for an N-particle system, one must deal with a $4N$ dimensional spacetime. Schrödinger referred to this N-particle system in quantum mechanics as "entanglement". It is because each of the N matter fields intertwines. In the holistic ontology there are N fields but only one spacetime, thus there is no entanglement!

Summarizing, the continuum, nonsingular field model of matter in general relativity is holistic and non-atomistic. What appear as separated things – electrons and protons, people, planets, stars, galaxies, etc. are really correlated modes of a single continuous entity – the universe. It is a model of the material universe that exorcises all remnants of atomism. All of these modes are dynamically coupled. This reflects the spirit of the Mach principle, originally applied only to the inertial mass of matter.

Quantum Mechanics is a contemporary theory in physics that also claims a holistic ontology, but in a different context than the holism of a continuous field theory. This is because of the Copenhagen School that insists that the measurement process by macro-observers of micro-matter is an integral part of the *definition* of elementary matter. That is, the 'observer' and the 'observed' are holistically a single entity.

But this is not really holism. The 'observer' in Quantum Mechanics obeys a different set of rules than the 'observed'. The former obeys the rules of classical physics while the latter obeys the rules of quantum physics. In this view, the only reality is the set of

responses of a classical ‘observer’ to the quantum mechanical ‘observed’. Indeed, this is a true approach of *positivism*. The philosophy of holism, on the other hand (in the sense of Spinoza) is an approach of *realism*.

Finally, let me comment on the extension of the holistic approach from physics to human relations. The following is taken from my article: “The Influence of the Physics and Philosophy of Einstein’s Relativity on my Attitude in Science: An Autobiography”, in M. Ram, editor, *Fragments of Science: Festschrift for Mendel Sachs* (World Scientific, 1999), p. 201:

The holistic view that is logically implied in our understanding of matter by Einstein’s theory of general relativity has interesting consequences when it is applied to the subject of human relations. The implication is that in reality there are no individual, separable things – protons, people, trees, planets, stars, galaxies, and so on. Instead these are the multitude of distinguishable manifestations of the whole, single, continuous entity that is the universe.

With this view, social relations must be viewed holistically. We are not separate egos, separate nations, and separate ethnic groups. We are all correlated in terms of the whole entity, a continuum of which we are only some of its infinitesimal manifestations. To understand this concept is to understand that in the long run we cannot gain for ourselves by being destructive to others or to our environments or to any aspect of all of nature. This is because we are all modes of a single holistic entity. By analogy, if a man has a sore toe, it would not be helpful to cut it off! To solve the problem must then require a cure for the toe as an integral part of the whole body. [This is the idea of holistic medicine, which has been practiced by many different groups of the human society for many centuries – in the Orient, by the Native Americans, by the aboriginal peoples throughout the world, and so on.]

With this view, the concept of war cannot be a resolution for any political problems between nations. Nor can ethnic or social prejudice be taken seriously as a reasonable conclusion – for the best interests of any individual or any societal group.

I believe that if the community of physicists eventually sees the truth in this holistic view, which has in large part been demonstrated in the physics of our time in the theory of general relativity and other aspects of modern physics, it could infuse into our culture

and affect our attitudes toward all of the social and environmental relations that we encounter. In my view, such a philosophical attitude would certainly be for the betterment of the human race.