The Properties of Scalar Motion

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A typical description of the "expanding universe" of modem astronomy reads as follows:

> The common analogy likens the galaxies to spots on the surface of a balloon that is being inflated. As the rubber stretches, all the spots move away from each other.

But this description is immediately followed with an explanation of the origin of the motion, the so-called "Big Bang," that is totally incompatible with the motion as described. According to the Big Bang hypothesis, the galaxies are moving outward from a common point of origin, and the apparent recession in all directions when viewed from a particular location is due to velocity differentials. But the spots on the surface of an expanding balloon are, in actual fact, moving outward from each other, not from a common point. Thus, if the motions of the galaxies originated from a Big Bang they are not similar to the motions of spots on an expanding balloon, whereas if the galactic motions do have this character they could not have originated from a Big Bang. At the moment there may not be any available means of deciding between these alternatives, but the fact that the analogy is so widely used without recognition of the inconsistency that is involved shows that there is a definite need for a better understanding of the nature of the type of motion that takes place when a balloon expands.

The distinctive feature of this type of motion is that it is *scalar*; it has magnitude but no inherent direction. This lack of a direction of its own distinguishes it from the more familiar *vectorial* motion, which has both magnitude and direction. To illustrate the difference between the two, let us first consider the motion of an insect traveling along a compass needle. This motion has a magnitude (a speed) and also a direction, toward magnetic north (or directly opposite). In this case the direction is an inherent property of the motion. It is totally independent of where the compass is placed in a room (the reference system), or how it is placed—right side up, upside down, or otherwise. Then, for comparison, let us consider the motion of a spot Y relative to another spot X on the surface of an expanding balloon. This motion, too, has a magnitude. But it has no inherent direction. It acquires a direction when placed in a reference system, but this direction is *not* independent of where and how the balloon is placed in the room. On the contrary, it is totally dependent on that placement. In order to give the motion XY a direction, the balloon must be arbitrarily correlated with the reference system, as, for instance, by placing it on the floor with point X in coincidence with point A of the floor, and point Y in coincidence with some point B in the reference system. If the correlation takes place in some other way—that is, if some point B on the balloon surface is placed in coincidence with A, or if point Y is placed to coincide with point C—then all directions of motion on the balloon, including the direction of the motion XY, are altered.

As this illustration shows, a motion on the balloon surface has no property corresponding to the magnetic north direction of the vectorial motion along the compass needle. It does have what we may call a scalar direction; that is, its magnitude is positive, and it therefore causes the distance between X and Y to increase. In the context of a spatial reference system it is an *outward* motion. But outward motion cannot be represented as such in the reference system. The representation must have a specific vectorial direction, and in order to acquire such a direction the scalar motion must be correlated with the reference system by some process independent of the motion itself. In the balloon illustration it was assumed that the expanding balloon was deliberately placed in a specific position on the floor, but this position could have been the result of inanimate physical factors, such as air currents, or it could have been purely a matter of chance.

Representation in the reference system requires an actual physical correlation, even if accomplished by chance, and the direction thus represented therefore does have a physical significance. For instance, if the direction XY of the balloon motion coincides with direction AB in the reference system, then the motion XY terminates if there is an obstacle at B. But the line AB is only one of the possible ways in which the motion XY could have appeared in the reference system as the result of an appropriate correlation. From a given initial point, a vectorial motion can be represented in only one way, because both its magnitude and its direction are fixed. On the other hand, a scalar motion can be represented by a line of the correct magnitude in any direction.

Furthermore, once it is realized that the direction of a scalar motion, as represented in the reference system, is not a property of the motion itself, but the result of chance or other external influences, it also becomes apparent that this representation is not limited to a *fixed* direction. To illustrate this point, let us place the expanding balloon in the position previously mentioned in which point X rests on point A of the floor, and point Y coincides with point B in the reference system. Then let us turn the balloon around point X (and A). Instead of taking the constant direction AB, the line XY representing the scalar magnitude now takes successive directions AC, AD, AE, etc., where C, D, and E are points on the circumference of a circle centered at A. The total magnitude of the motion, the distance moved by point Y outward from X in a given time interval, remains the same, but it has been distributed over all directions in the reference system, instead of being confined to the one direction AB. The *motion* still has magnitude only, but the *representation* of that motion in the reference system, which necessarily has a direction, has been rotated.

In the absence of physical obstacles, this rotation of the representation can continue indefinitely. It follows that where such rotations exist, the scalar motions with continually changing directions are quasi-permanent features of the physical universe. Discontinuous or non-uniform motions are not permanent because they require repeated application of external forces to interrupt the continuity or uniformity. But it is not essential that the motion be unidirectional. A continuous and uniform change of direction from positive to negative and back again, a simple harmonic motion, meets the requirements for permanence. Simple harmonic motion is ordinarily visualized as translational, but it can equally well be rotational. Thus we arrive at the conclusion that four general types of representation of scalar motion in a fixed spatial reference system are possible: (i) translation, (2) linear vibration, (3) rotation, (4) rotational vibration.

As matters now stand, there are no physical phenomena that present-day science recognizes as scalar motion of any of these types, except to the extent that it is realized that the motion of spots on an expanding balloon, and similar motions in three dimensions, have characteristics differing from those of ordinary vectorial motion. But long experience has indicated that whatever is physically possible actually does exist somewhere in the universe. Indeed, this is so commonly accepted as true that it is often stated as a general principle of nature in some such positive form as “What *can* exist *does* exist.” On this basis we are justified in concluding, independently of any physical theory to which we may subscribe, that it is at least probable, if not certain, that scalar motion does play a significant part somewhere in physical activity. Inasmuch as there is no significant role for scalar motion, as such, in currently accepted theory, it follows that the physical effects of that motion are currently being attributed to something else. Once this is recognized it is practically obvious that some basic *forces* of unknown origin are actually manifestations of these various types of scalar motion.

Force is defined, in physics, as an aspect of motion. It is motion (measured as energy) per unit distance, and expresses the rate at which motion can be transferred. For example, a confined gas exerts a pressure (a force per unit area) against the walls of its container. If a portion of the container wall is free to move, as in a gun, the magnitude of the force determines the rate at which the motion of the gas molecules is transferred to the projectile. Most mechanical forces—those of the push-pull type—can easily be visualized in motion terms.

In these applications, and in the definitions on which they are based, force is a *relation*, not a physical entity in itself. It has the same physical standing as acceleration, which is the increase in motion (measured as speed). In fact, force *becomes* acceleration if it is unopposed. But there are also forces in nature that do not lend themselves so readily to identification with vectorial motions, and whose origin is obscure. Consequently, a different concept of "force" has emerged in physical thought, one in which force is viewed as an independent basic entity, rather than in the normal way as a derivative of motion. These presumably independent forces are exerted over many, or all, directions, and therefore do not conform to the standard definition of force, which identifies it as a vector quantity. But the scientific community has been able to accommodate itself to this contradictory situation by treating such forces as composites in which the various components are vectorial forces arranged in certain patterns to form "fields." The inability to account for the origin of these forces is handled by asserting that no explanation is possible; that they must be taken as "given" features of the universe.

The finding that these forces of a basic nature are simply the force aspects of scalar motions now opens the door to a better understanding of those forces, without doing any violence to the advances in knowledge that have been made in the past. There is no conflict, for instance, between Einstein's conclusion that gravitation is *equivalent to* a motion and the present finding that it is a motion. But the realization that it is a motion, and that it is a *scalar* motion, goes a long way toward placing gravitation in its proper place in the physical picture. Thus, in this and other similar situations, clarification of the nature and properties of scalar motion makes a significant contribution to physical understanding, irrespective of the physical theory or theories in whose light the new findings are viewed.