

## On the Relativity of Direction

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### Abstract

This paper is a call to realize and recognize the importance of directions in physics.

Relativity is a fundamental principle in physics. It means that nature must be describable equivalently for every observer.

In nature there are two fundamentally different ways for an object to change its position: 1) movement along a imaginary line, and 2) rotation around an imaginary axis.

Movement is change of position of an object in time. It is described by velocity. Velocity is a combination of speed and direction of movement. It is represented by a vector. The length of the vector corresponds to the speed of the velocity and the direction of the vector corresponds to the direction of the velocity.

Rotation is change of orientation of an object in time. It is described by spin. Spin is a combination of rotation speed and the direction of the axis. It (also) is represented by a vector. The length of the vector corresponds to the rotation speed and the direction of the vector corresponds to one of the directions of the axis. The direction of the vector is defined by the 'right hand rule': put your fingers of your right hand in the rotation direction around the spinning object and then the position of your thumb in respect of the hand, gives the direction of the vector.

The discovery that the speed of light is the same for every observer made us aware that the sum of velocities cannot just be obtained by adding their vectors. The speed of light has to be taken into account. This discovery led to the Special Relativity Theory and its famous result:  $E = mc^2$ .

The discovery that a reference frame is the same for every observer should make us aware that observations from an object by two observers from opposite directions, cannot just be compared as if they were observations by two observers from one direction. The rotations of the observers in respect of the object have to be taken into account. This leads us to the Principle of Perspective and its important achievements: an explanation for the correlation in Bell-test experiments and an explanation for the violation of Bell's inequalities.

The similarities concerning velocity and spin are unmistakable. As well in case of the Special Relativity Theory (movement along a line, translation) as in case of the Principle of Perspective (spin, rotation) something in relation to observers had to be discovered to understand things correctly. The Principle of Perspective is explained in [1].

For a change in position at least two objects are needed. One of them is supposed to be in a 'state of rest', whatever that may be, and the other changes its position in respect of the first one. For two objects the combination of movement along a line and rotation around an axis, is an orbital trajectory. This orbital trajectory of an object projected in a certain way, yields a wave description of the system. That makes the wave-particle duality comprehensible: the wave-particle duality is not a

particle showing wave properties as well as particle properties, but it is a notion that arises from the description of the system.

When the radius of the orbital trajectory approaches infinity, then the bending of the trajectory approaches zero and the circular trajectory transforms into a straight line. That is a scale effect. It shows the relation between movement along a line (velocity, translation) and a rotating movement (spin, rotation).

The Special Relativity Theory is hard to explain . So is the Principle of Perspective. Yet they both are ontologically true.

Reference:

G. van der Ham; The Principle of Perspective: <https://bell-game-challenge.vercel.app/>