

APPARENT MOTION

The expression 'apparent motion' is used often in physics conversation. Usage of the expression apparent motion is frequently criticized, for if it is meaningful to speak of 'apparent motion' then there must also be a 'true motion', and how is that a meaningful distinction?

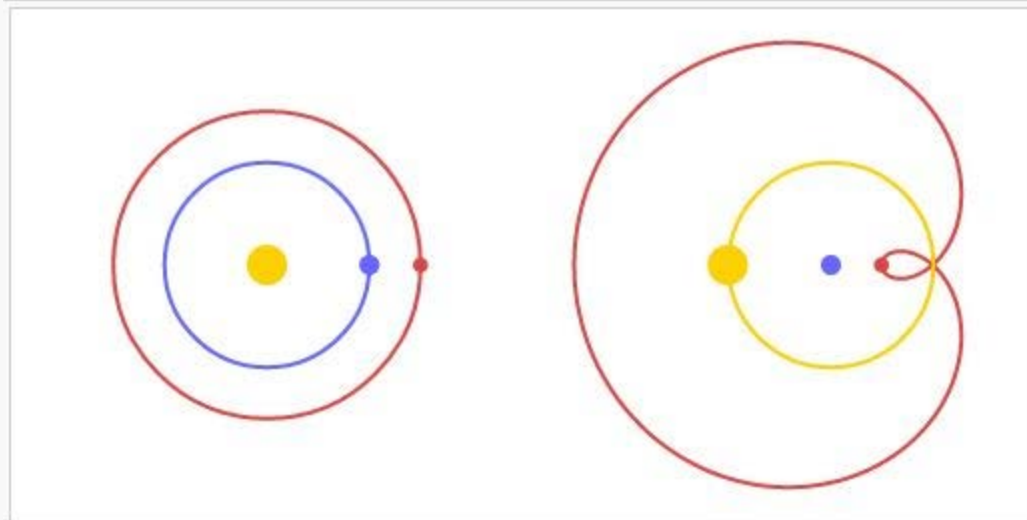
The expression 'apparent motion' can be given unambiguous meaning by relating it to the aim of physics to explain events taking place in terms of the action (or actions) of the fundamental interactions of nature.

The four fundamental interactions of nature are:

- Gravitational interaction
- Electromagnetic interaction
- Strong nuclear interaction.
- Weak nuclear interaction

In macroscopic physics it's the first two: gravitational interaction and electromagnetic interaction, that ultimately account for how events proceed. For example: the physics of an electric heating element bringing water to the boil: in the heating element electric energy is converted to heat. In a hydrodynamic energy plant gravitational potential energy is converted to electric energy.

Applying this in the context of celestial mechanics: if the orbits of the planets and all the other objects in the solar system are mapped in an inertial coordinate system that is co-moving with the center of mass of the solar system, then the orbits of all the celestial objects can be accounted for in terms of gravitational interaction. On the other hand, if the orbits of the planets are mapped in a coordinate system that is itself accelerating with respect to the center of mass of the solar system, then the motion with respect to that coordinate system is accounted for in terms of gravitational interaction, plus the coordinate acceleration that is involved. The coordinate acceleration is the acceleration of the non-inertial coordinate system with respect to the inertial coordinate system.



Apparent retrograde motion of Mars.

The yellow circle represents the Sun, the blue circle represents Earth, and the red circle represents Mars.

In the animation the representation on the right shows the motions of Sun, Mars and Earth with respect to a coordinate system that is co-moving with the Earth. As seen from the Earth Mars goes into retrograde motion from time to time. This retrogradation is an apparent retrogradation.

A general property of coordinate transformation is that under coordinate transformation from one euclidean coordinate system to another everything is preserved. All relative positions are preserved, all relative velocities are preserved, all relative accelerations are preserved.

In transforming laws of motion to a non-inertial coordinate system, the laws of motion are not changed. All that is changed in coordinate transformation is **notation** of the laws of motion. Transforming laws of motion to a non-inertial coordinate system is comparable to transforming notation of length from meters to centimeters. In either case, there is no physical content to it.

Definition of apparent motion

When a non-inertial coordinate system is used to map motion, then apparent motion is introduced. The apparent motion is the motion of the non-inertial coordinate system with respect to the inertial coordinate system.

How the equivalence class of inertial coordinate systems is distinguished from non-inertial coordinate system is discussed in the article [Inertial coordinate system](#).

Source : http://www.cleonis.nl/physics/phys256/apparent_motion.php