

## The Roles of Symmetries and Symmetry Breakings in Physics

Are there similarities in arts?

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In physics, a certain **symmetry** is understood as a physical or merely mathematical/abstract feature of an underlying system that is preserved or remains unchanged under some **transformation**. Examples of such symmetrical properties are a position in space, an incident of time, a momentum but also such quantities as spin, isospin, flavor, or color of particles etc. One discriminates between a variety of symmetry transformations, such as discrete or continuous, translations, rotations, reflections, inversions etc.

Without doubt the concept of symmetries is the **most powerful tool** of (theoretical) physics. Practically all perceived laws of nature originate in symmetries or their breakings.

I take the development and current understanding of the **Standard Model** of particle physics as an exemplification of the role of symmetries in physics. Thereby I demonstrate that all presently known **fundamental particles** (quarks and leptons, as ultimate constituents of matter) can be ordered according to their symmetry properties.

Up to now we know four **fundamental interactions** in the cosmos generating the electromagnetic, weak, strong, and gravitational forces. At least the first three of them are basically formulated as so-called gauge theories. Thereby the forces are induced by transformations breaking a (global) symmetry. Similarly the **generation of masses** can be explained by symmetry breaking.

As a result **symmetry transformations preserving** certain quantities serve as order principle, while **transformations breaking symmetries** generate dynamics. One may assume that these specific roles of symmetries and of symmetry breakings are prevailing in the same way or similarly in other areas of physics and other natural sciences.

Furthermore, there arise the questions of the roles of **symmetries and of symmetry breakings** in the arts, may they be governed by visual, audible or even intrinsic settings. I leave the answers to the pertinent experts and look forward to a profitable discussion. I imagine it will bring up many facets we combine with **symmetries in arts and science**.

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