

# CP violation and the 2008 Nobel Prize in Physics

The 2008 Nobel Prize in physics was awarded to Prof. Nambu “for the discovery of the mechanism of spontaneous symmetry in subatomic physics” and to Profs. Kobayashi and Maskawa for their predictions of the existence of the fifth and the sixth quarks. In this article, I will explain what Profs. Kobayashi and Maskawa received the Nobel Prize for. You need to read my article “The symmetry of physical laws: the *CPT* theorem for laymen” to understand this article.

As I explained earlier in that article, the fact that the weak force is not invariant under parity inversion was discovered through experiments proposed by two Chinese theoretical particle physicists in 1950s.

It was also experimentally discovered that our universe is not *CP* invariant either. In other words, it is *CP* violating. In 1972, Kobayashi and Maskawa showed that, if at least six different species (called “flavors”) of quarks exist, then that our universe is not *CP* invariant can be explained (at the time, only three different species of quarks had been observed). As the fourth quark was discovered in 1974, the fifth in 1977, and the sixth in 1995, the prediction of Profs. Kobayashi and Maskawa was verified.

*CP* violation has a deep connection with cosmology. The universe in which we live is mostly made out of matter, and it is hard to find any substantial quantities of naturally-occurring anti-matter. This implies that symmetry between matter and anti-matter is not respected. Physicists think that this asymmetry is connected to *CP* violation. However, physicists still can’t explain quantitatively why there is so much more matter than anti-matter in our universe.

It is known that the strong force respects *CP* symmetry. The problem of why the strong force respects *CP* symmetry is called the “Strong CP problem.”

We will talk about the experiment that first confirmed *CP* violation in our article “The neutral kaon system.” James Cronin and Val Fitch won the 1980 Nobel Prize for this experiment.

## Summary

- Our universe is not *CP* invariant, as there are at least six different flavors of quarks.