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It exists after all

Why was the existence of carbonic acid unfairly doubted for so long?

The carbonation leading to the lovely bubbles in our champagne and soda water is usually attributed to carbonic acid. However, this is not entirely accurate. It is actually carbon dioxide (CO_2) that was formed during fermentation or forced into the beverage. A mere 0.003% of the dissolved gas is present in the form of carbonic acid (H_2CO_3).

According to the textbooks, pure carbonic acid does not exist because it is extremely unstable. This has since been revealed to be a mistake. In recent years, various research groups have been able to isolate and characterize carbonic acid as a pure compound. Its stability has been proven in both the solid and gas phases, a result that could not be properly explained for a long time. What causes the discrepancy with earlier observations?

Innsbruck researchers working with Klaus R. Liedl, Erwin Mayer and Andreas Hallbrucker have now revealed the secret. By performing some theoretical calculations, they found out, under which conditions carbonic acid is stable, and why this stability went unrecognized for so long.

The result obtained by Liedl and his colleagues is both amazing and simple: water plays the crucial role! Absolutely water-free carbonic acid is very stable. Liedl calculated a half-life of 180,000 years for it. “However, carbonic acid decomposes immediately if it comes in contact with water. A single water molecule is enough to speed up the decomposition of a molecule of carbonic acid a billion times.”

Why is carbonic acid a subject of research at all? Some interested parties are scientists who are trying to determine whether carbonic acid is present in the universe. For this they need the spectra of pure, gaseous H_2CO_3 from the laboratory for comparison.

However, carbonic acid is also vital for us: it is an essential intermediate in the transfer of CO_2 between tissue and blood, in particular, between the lungs and blood. The transformation of carbon dioxide into carbonic acid is accelerated by an enzyme, carboanhydrase. In solution, thus also in blood, carbonic acid itself mostly dissociates into a bicarbonate anion (HCO_3^-) and a proton (H^+). This equilibrium is necessary to maintain a constant pH level in blood.