Combustion, the process of transforming chemical energy into thermal energy (heat), is a vital part of our daily lives for both domestic and industrial use. Gas driven turbines produce electricity, gas fires heat buildings, and gas combustion powers cars, aircraft, ships and spacecraft.

The reliance on fossil fuels for combustion means that most of humanity is currently depending upon finite, non-renewable resources for heating and energy. Another important consideration is the production of pollutants as exhaust by-products. Some of these, such as carbon monoxide and soot, are harmful to humans. Others, including carbon dioxide and oxides of sulphur and nitrogen, are involved in complex chemical reactions in the atmosphere that influence global climate.

With global consumption of fossil fuels expected to rise in coming decades, it is imperative that industry does its utmost to increase combustion efficiency and reduce pollution. However, numerical software models designed to solve these problems are of limited usefulness, since experimental data obtained on the ground are influenced by both diffusion and convection driven effects, making optimal solutions difficult.

**Key Achievements:**
- Improved understanding of combustion processes.
- More efficient combustion on Earth.

Unfortunately, combustion processes on Earth are dominated by strong buoyancy forces and convection effects - a large temperature rise during combustion leads to dramatic local density changes in and around the flames. However, since there are no buoyancy effects in microgravity conditions, the measurements

"The understanding of particle formation in flames is a crucial prerequisite, both for the reduction of soot emission from technical combustors and for the synthesis of advanced nanoparticles. Experiments under microgravity help us to provide relevant data, since they offer a unique way to control boundary conditions of combustion processes."

PROF. S. WILL
UNIVERSITY OF BREMEN
BREMEN, GERMANY
made in orbit allow access to mathematical modelling. Furthermore, the large temperature and concentration gradients found during combustion on Earth lead to vigorous convection-driven flows, which are often turbulent and result in unstable burning. The microgravity environment enables the study of stable flames, which significantly helps to understand the fundamental physical and chemical processes involved in combustion. This, in turn, leads to an improvement of the mathematical models, which lead to an optimisation of combustion processes on Earth.

Past microgravity combustion experiments and modelling have led to a new understanding of basic combustion phenomena. The role of the different heat- and mass-transfer parameters in convection, diffusion and radiation is now much better understood.

Future experiments planned for the International Space Station will involve quantitative measurements of droplet and spray evaporation, auto-ignition conditions and soot formation in flames. In line with the political guidelines for the protection of the Earth's environment, the principal research objective is to improve combustion efficiency and to reduce pollution by power plants and engines.

Upon eliminating the influence of gravity, space research provides the path to bring new and vital knowledge about fire and fluids to humankind.