



Photo: MPI for Nuclear Physics/Christian Föhr

## On the Racetrack

Most of the vast expanse of space is extremely cold and empty. Nevertheless, chemical reactions take place there, too. These result in the formation of ions (electrically charged particles), small and large molecules, and interstellar dust. The dust clouds, in turn, give rise to stars and planets. The chemistry of interstellar space is therefore one of the most active research fields in astronomy.

With the new Cryogenic Storage Ring (CSR), scientists at the Max Planck Institute for Nuclear Physics are bringing space into their lab. However, the level of technical complexity it requires is almost as extreme as the conditions in space: the temperature in the inner vacuum system of the CSR is just a few degrees above absolute zero, or minus 273 degrees Celsius; the pressure of less than  $10^{-14}$  millibar is one hundred trillion times lower than normal air pressure. It is thus possible to keep even highly reactive, multiply charged molecular ions on the 35-meter circuit of the storage ring for several minutes – or sometimes even hours. As they circle at high speed, covering distances that correspond to many times the distance between the Earth and the moon, the ions cool down to temperatures that resemble those in interstellar clouds.

The ion beams are steered and focused by electric fields. The scientists can use these fields to bring about a reaction between the stored ions and electrons or neutral atoms, or to investigate them with laser beams. In this way, low-energy collisions, which are typical for the conditions in interstellar space, can be examined under controlled conditions in the laboratory.

Similar to a person who wears several layers of clothing to protect themselves against the cold, the cryogenic region of the storage ring has a number of shielding layers to insulate it against the ambient heat. Cooling down the apparatus takes more than three weeks – as does heating it up again after several months in measurement mode. The photo shows the storage ring when it was still open four months before it was cooled down for the first time.