International Astronomical Union agrees on a new reference frame for directions in space

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In the future, when spacecrafts are sent to other planets or when the rotation of planet Earth is studied, a new reference frame will be used. On 30 August, at the General Meeting of the International Astronomical Union (IAU) in Vienna, the new international celestial reference frame ICRF3 was adopted, allowing for more precise directional specifications in space. It is based on the accurate measurement of over 4000 extragalactic radio sources. TU Wien (Vienna) played an important role in the international consortium, which was in charge of providing the new realization.

A coordinate system for the universe

In the same way that a reference system is required to measure mountain peaks (measuring the longitude and latitude of the Earth and the height above sea level, for example), it is essential to agree on a reliable reference system for specifying directions in space. "Using the fixed stars we see in the night sky is not a good idea," explains Professor Johannes Böhm of the Department of Geodesy and Geoinformation at TU Wien. "Over time, they shift a little, relative to one another. This means it would be necessary to define a new reference system every few years in order to maintain the required level of accuracy."

Extragalactic radio sources, on the other hand, are another matter entirely. "Nowadays, we know hundreds of thousands of objects in space that emit extremely intensive, long-wave radiation," says Böhm. "These are supermassive black holes at the centre of faraway galaxies, also known as quasars, which are sometimes located billions of light years away from us."

These radiation sources look practically like dots from Earth and their huge distance makes them ideal for establishing a worldwide reference system. Relatively small shifts between the quasars do not play a role here.

Comparing different radio telescopes

However, achieving the highest possible level of precision requires some effort: it is not sufficient to simply take a picture with a radio telescope and read the direction of the radio source from that. Instead, the data from different radio telescopes is compared. "Each radio source delivers a signal with a certain noise," explains David Mayer, an assistant in Johannes Böhm's team. "When you measure this noise at two different radio telescopes at the same time – ideally located thousands of kilometres apart – you can very accurately determine the time difference between the arrival of the signal at the first and second radio telescope. From this, one can calculate the direction the signal is coming from with extreme precision." These calculations require very powerful computers such as the Vienna Scientific Cluster VSC-3. Alongside TU Wien, research groups from all over the world have provided solutions for the reference frame ICRF3 such as the NASA Goddard Space Flight Center and the Observatoire de Paris.

With this method, the position of the radio sources in the starry sky can be indicated with a precision of around 30 micro-arc seconds. That roughly corresponds to the diameter of a tennis ball on the moon, as viewed from Earth.

At the General Meeting of the International Astronomical Union (IAU) in Vienna, the decision has been made to use this high precision radio source map as the international reference frame.

It will for example be used for specifying the position of astronomical

objects or spacecrafts. Also, the reference system is essential for monitoring our own planet, such as the precession of the Earth's rotation axis or the movement of the poles.

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