Precise activity measurements on ^{36}Cl samples refute a dependence of the decay rate on the distance between the Earth and the Sun

At PTB, the activity of chlorine-36 was measured by means of the TDCR method over a period of more than 3 years in order to find out whether variations occur which depend on the season. The results have shown clearly that the distance between the Earth and the Sun has no significant influence on the decay rate. This refutes the assumptions made by other authors in publications where such a dependence was asserted.

A group of US American scientists had recently published measurement data concerning the radioactive isotope chlorine-36 [1]. The measurement values showed fluctuations according to the seasons, which the researchers explained by corresponding changes in the decay rate of the nuclide. They attributed these fluctuations in the decay rates of chlorine-36 – as well as of other isotopes – to the changes in the distance between the Earth and the Sun. With this distance, also the flux of solar neutrinos at the surface of the Earth changes, which – according to these scientists – allegedly influences the decay rates.

Previously, this research group had used data from long-term measurements of other radionuclides – which originated, among others, from PTB – in order to back up this controversial theory. Measurements of the decay rates of long-lived radionuclides are often carried out over several years. The resulting data, for example, are used to determine the half-life of the respective radionuclides, or to test the stability of the detector system used. Long-lived reference sources are even used to compensate for changes in the efficiency of detectors. In the long-term measurements, considerable fluctuations occur, depending on the type of detector used. In some cases, these fluctuations seem to be correlated with the respective season. A group of scientists headed by Ephraim Fischbach and Jere Jenkins interprete this correlation as being proof of a dependence of the decay rates on the distance between the Earth and the Sun. They attribute the fact that the extremes of the fluctuations – temporally – do not correspond to the perihelion and the aphelion, to effects occurring inside the Sun itself, which also cause changes in the neutrino flux. What the publications by Fischbach, Jenkins et al. have in common is that the theory is based on experimental data which were obtained by means of detector types that are known to be particularly sensitive to environmental parameters. For instance, the measurements performed on silicon-32, chlorine-36 and radium-226 are based on gas detectors.

The results obtained by these authors are therefore extremely controversial. Some researchers investigated other isotopes and found no seasonal dependence. This does not prevent the American researchers from sticking to their theory – in their opinion, the dependence of the decay rates on the season is given for certain isotopes only.

In a recently published article, the American scientists have now used measurements with chlorine-36, which were obtained with a Geiger counter at the *Ohio State University Research Reactor* (OSURR). These, too, show clear fluctuations that the authors again interpret as another proof of their theory.

Chlorine-36 has also been investigated at PTB [2]. The measurements started in 2009; after some time, it was determined that further repeat measurements should be carried out in order to investigate a possible dependence on the season. The detector used at PTB, however, was a liquid scintillation counter. For this purpose, a small amount of the radioactive material is put directly in the organic liquid scintillator, which rules out any potential problems with the self-absorption of the radiation originating from the radioactive decay inside the source itself. Also, the TDCR procedure was used; it allows the detection probability to be determined without an additional reference source [3]. This compensates to a large extent for fluctuations of the detection probability due to changes in the properties of the source or of the detector and due to environmental influences. In this way, the TDCR liquid scintillation measurements exhibit a clear advantage compared to simple counting rate determinations with gas detectors.

PTB's results are shown in Figure 1, where they are compared with the results from [1]. Hereby, it becomes obvious that the TDCR/LSC results fluctuate far less. Nothing suggests a dependence on the season. If ever there is an influence of solar neutrinos on the decay rate, the measurements carried out by PTB should be able to detect it. Since this is not the case, it is proven that the fluctuations observed in [1] must have another origin. What would be plausible would be influences that parameters such as, e.g., temperature, humidity and pressure may have on the sensitive detector/source system. What is worth pointing out is that the measurements carried out at OSURR and those performed within the scope of PTB's latest experiment both dealt with the same isotope, and that the periods at which they were carried out by the two institutes partly overlapped.

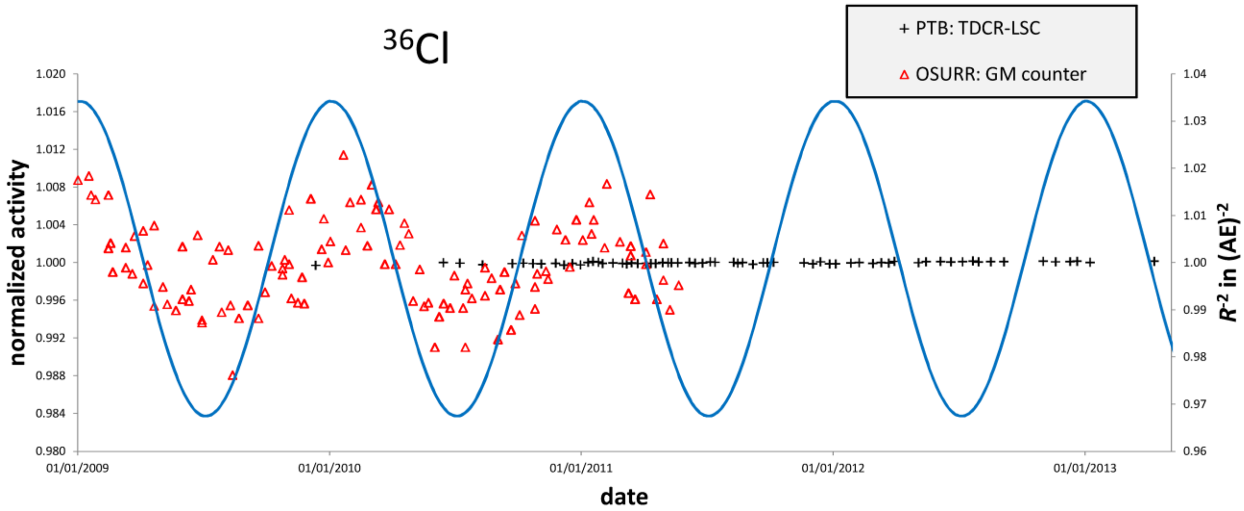

Fig. 1: The normalized activity as a function of time shows no dependence on the season in PTB's data, contrary to the data obtained at the Ohio State University Research Reactor (OSURR). The blue line represents the reciprocal square of the distance between the Sun and the Earth, expressed in the astronomic unit (AE).

An influence of solar neutrinos on the decay rates cannot be fully ruled out by PTB's measurements. If such an effect really exists, it is, however, smaller by more than one order of magnitude than that asserted by the authors in [1].

Since April 2013, additional long-term measurements have been carried out at PTB with strontium-90/yttrium-90. After more than half a year, also these data show no dependence on the season and, thus, refute the results published in [4] and [5] which are, again, based on measurements with a gas detector.

Literature

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