Gravitational Perturbations as a Possible Cause for Instability in the Measurements of Positron Annihilation

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The annihilation of positrons is measured in a wide range of studies in the field of physical chemistry [1, 2]. One of the problems in these studies is the instability of the results of measurements [3–5]. As shown in our research, instability may result from the change of nonregistering gravitational effects related to alteration of the tidal forces upon the change of moon phases and the seasonal changes of the distance between the Earth and the Sun.

1 Materials and methods

A sample of ^{22}Na (5 mCu) was used as a source of positrons. The yield of positronium (I_2) and the parameters of its annihilation at the passage through organic liquids were measured by two techniques: either angular (parapositronium) or temporal (orthopositronium) correlations of annihilation quanta were registered. The yield of positronium was measured with a setup of "fast-slow coincidences". The setup was assembled according to a typical scheme, had the time resolution of 0.5 ns and was connected to a multichannel amplitude recorder [1, 2].

2 Results

In the experiments, I_2-parameter and spectra of triplet positronium were measured in the toluol samples purified from oxygen by the method of vacuum freezing-out and the samples under oxygen (0.6 atm). The measurements were conducted daily over a period of 3 months (November, 1981 — February, 1982).

Fig. 1 shows that in the oxygen-depleted samples, regular fluctuations in the positronium yield are observed, which correlate with the changes of the moon phase. The yield is maximal in the times close to the new moon and minimal in the times close to the full moon.

In the presence of oxygen, Fig. 2, no reliable effects were revealed. It can be explained by a specific influence of oxygen on the processes of formation and annihilation of positronium [1, 2]. However, these experiments indicate stability of the setup itself.

In addition to periodical fluctuations, one can see a trend in the series of measurements: the mean level of I_2 grows from November to February. This trend may be due to the seasonal change of the distance between the Earth and the Sun.

In more large scale the seasonal changes of positronium yield apparent from Fig. 3, which presents average results

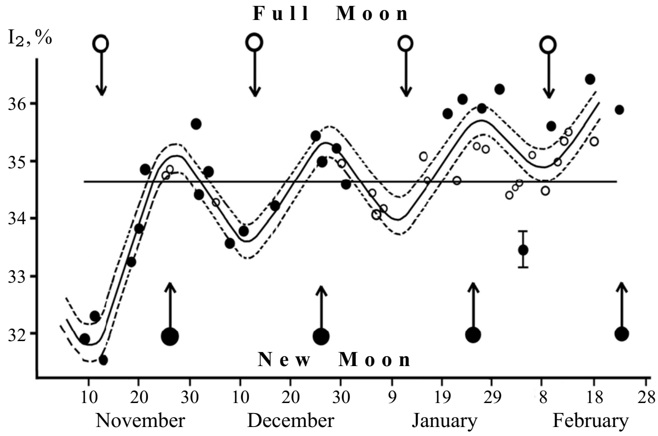

Fig. 1: Yield of positronium correlate with the changes of the Moon phases.

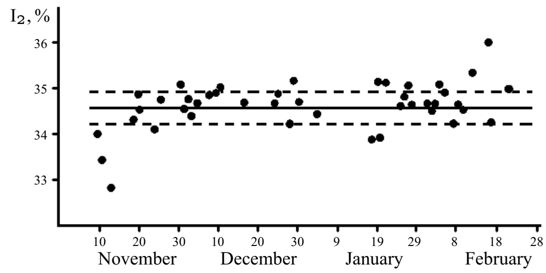

Fig. 2: Yield of positronium in the presence of oxygen.

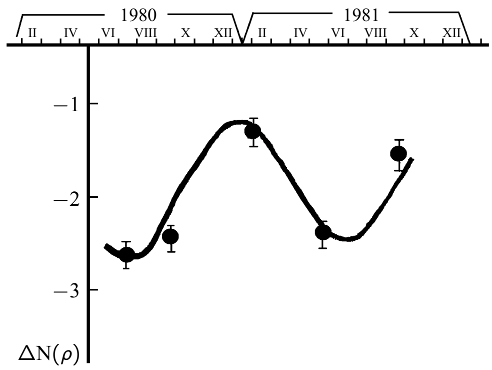

Fig. 3: Seasonal changes of positronium yield in 1980–1981.

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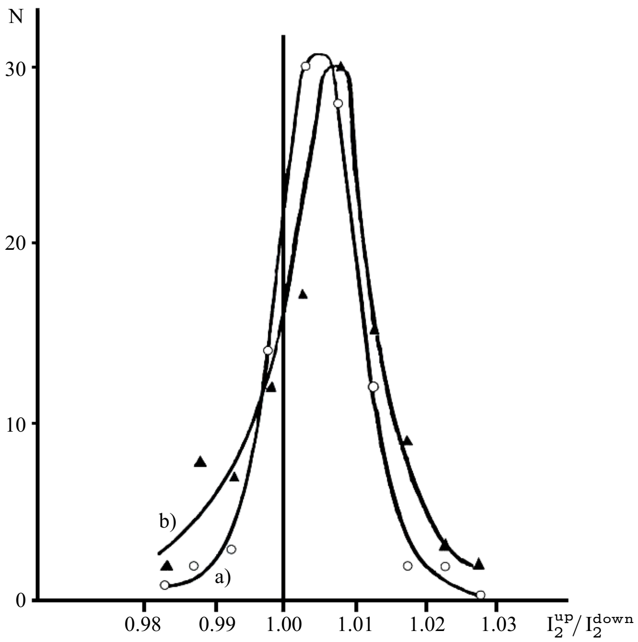

Fig. 4: Distribution of measuring results of positronium yield at the case of the experimental setup relocating up (triangles) and down (circles), with the height difference 1.5 m.

of large number of experiments provided in 1980–1981. It's possible to see that minimal yield is observable for summer solstice (June — July) and maximal yield for winter solstice (December — February).

The reliability of the conclusion that the yield of positronium depends on the tidal changes in gravity force was checked in the experiments of 1984–1985, in which the setup used for measuring I_2 was relocating up-and-down, with the height difference of 1.5 m. The measurements (1500 in total) were alternated (up/down) every 20 min. Finally, an I_2^{up}/I_2^{down} ratio was calculated. Fig. 4 shows a smoothed distribution of the results obtained. The mean of this ratio is 1.00447 for all the measurements. The root-mean-square error equals to $\pm\, 0.00064$. Thus, lifting the setup 1.5 m higher results in a reliable increase in the positronium yield (the difference amounts to 7σ).

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