Is A_{FB}^b trapped in a numerical bug?

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Abstract

The decay of Z^0 into a complete generation presents a numerical problem in the values of Weinberg angle usually related to A_{FB}^b

Consider the total square matrix element:

$$K_{\{f\}} = \sum_{u,d,e,\nu} C_f((T_f^3)^2 + (T_f^3 - 2Q_f\hat{s}^2)^2) \tag{1}$$

Lets trace his dependence $K_{\{f\}}(\hat{s}^2)$

$\hat{s}^2$	$\lvert \ln K_{\{f\}} - 1 \rvert$
0.2310	.001067
0.2311	.000954
0.2312	.000841
0.2313	.000729
0.2314	.000616
0.2315	.000503
0.2316	.000391
0.2317	.000279
0.2318	.000166
0.2319	.000054
0.2320	.000059
0.2321	.000171
0.2322	.000283
0.2323	.000395
0.2324	.000507
0.2325	.000619
0.2326	.000731
0.2327	.000842
0.2328	.000954
0.2329	.001065

An algorithm using a three-digits cutoff somewhere (say, in a conditional IF of the simulation code) would round the values between 0.2318 .. 0.2320 into the value 0.2319484

Compare e.g. with 0.23193 ± 0.00056 from ALEPH [2] hep-ex/0107033

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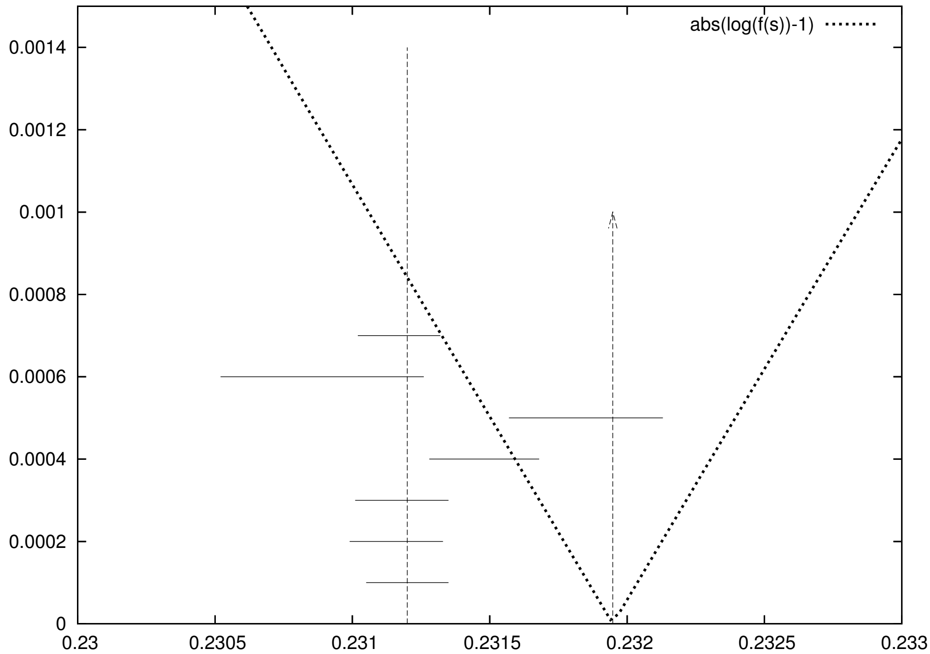

The figure shows $|1 - \ln K|$ as in the table, compared with the measured values of $\hat{s}^2$ from table 10.5 of [1]. Vertical arrows mark experimental central value, for all data, and the point 0.2319484 of singularity. It can be seen that the measurement from $A_{FB}^{b,c}$ is away from the rest of values but in agreement with the numerical singularity.

The precise apparition of the trascendent number e or its series should be taken with a bit of salt if thinking about applications in phenomenology. To give one example, almost the same numbers (0.2319478) are got if we "solve" e from its approximation

$$\sqrt{e - 5/2} \approx (1 + 3/8)\frac{e}{8}$$

I.e., if we ask the derivative of $\ln K$ to have the value

$$\left.\frac{d(\ln K(\hat{s}^2))}{d(\hat{s}^2)}\right|_{\hat{s}_Z^2} \approx -\sqrt{\frac{2}{3}}(1 + \frac{3}{8})$$

which give us a intrascendent (er, algebraic) value. And for sure other approximations are possible.

References

[1] S. Eidelman et al., Physics Letters B592, 1 (2004) and 2005 partial update for edition 2006

[2] A. Heister *et al.* [ALEPH Collaboration], "Measurement of A(FB)(b) using inclusive b-hadron decays," Eur. Phys. J. C **22** (2001) 201 [arXiv:hep-ex/0107033].