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Confidence in the Neutrino Mass Hierarchy

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Analyses of neutrino mass hierarchy determinations at future experiments determine an expected Delta Chiˆ2. As the hierarchy is a discrete choice, and not a continuous degree of freedom, this Delta Chiˆ2 does not obey Wilks' theorem. As a consequence it does not follow a chiˆ2 distribution and its square root is not the number s of sigmas of confidence that can be expected. I will present a simple formula for s as a function of the expected value of Delta chiˆ2.

Summary

I will review Wilks' theorem, which is used to relate Delta Chiˆ2 to the confidence in a null hypothesis. I will then explain why Wilks' theorem does not apply to the neutrino mass hierarchy. I will show that Delta chiˆ2 obeys a Gaussian distribution even considering the effects of nuisance parameters. I will then use this distribution to answer 3 questions: (1) What is the probability that a fit of the data to the true hierarchy yields a lower chiˆ2 than a fit to the false hierarchy? (2) With what confidence does the median experiment determine the hierarchy? (3) What is the probability of determining the hierarchy with s sigmas of confidence?

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