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Fast test to assess the impact of marginalization in Monte Carlo analyses and its application to cosmology

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Monte Carlo (MC) algorithms are commonly employed to explore high-dimensional parameter spaces constrained by data. All the statistical information obtained in the output of these analyses is contained in the Markov chains, which one needs to process and interpret. The marginaliza- tion technique allows us to digest these chains and compute the posterior distributions for the parameter subsets of interest. In particular, it lets us draw confidence regions in two-dimensional planes, and get the constraints for the individual parameters. It is very well known, though, that the marginalized results can suffer from volume effects, which can introduce a non-negligible bias into our conclusions. The impact of these effects are barely studied in the literature. In this talk I first illustrate the problem through a very clear and simple example in two dimensions, and suggest the use of the profile distributions (PDs) as a complementary tool to detect marginalization biases directly from the MC chains. I apply this method to four cosmological models: the standard ΛCDM, early dark energy, coupled dark energy and the Brans-Dicke model with a cosmological constant. I discuss the impact of the volume effects on each model and the cosmological tensions, using the full Planck 2018 likelihood, the Pantheon compilation of supernovae of type Ia and data on baryon acoustic oscillations. This test is very efficient and can be easily applied to any MC study. It allows us to estimate the PDs at a derisory computational cost not only for the main cosmological parameters, but also for the nuisance and derived ones, and to assess the need to perform a more in-depth analysis with the exact computation of the PDs. This talk is based on Phys.Rev.D 106 (2022) 6, 063506 [arXiv:2203.16285].

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