We emphasize that the definition and results described in this section apply only to the case where the model of interest depends on a single parameter. A generalization to the multi-parameter case has been formulated and shown to have the properties listed at the beginning of Sec. II [12]. We shall not describe it here however, except for when evidence-based priors are specified for the additional parameters. This is a very common situation in high energy physics, and will be discussed next.

III. NUISANCE PARAMETERS

The reference prior algorithm described in Sec. II B pertains to models containing no nuisance parameters. In practice, however, every non-trivial problem must contend with such parameters and the reference prior algorithm must be generalized accordingly. In this paper we restrict our attention to nuisance parameters for which partial information is available, which is often the case in practice.

Depending on the type of partial information that is available, there are two plausible ways one might choose to incorporate nuisance parameters ϕ into the calculation of the reference priors for a parameter of interest θ [17]:

Method 1: Assume that we are given a marginal prior $\pi(\phi)$ for the nuisance parameters; compute the conditional reference prior $\pi_R(\theta \,|\, \phi)$ for the interest parameter given a fixed value of ϕ; the full prior is then $\pi(\theta, \phi) = \pi_R(\theta \,|\, \phi)\, \pi(\phi)$;

Method 2: Assume that we are given a conditional prior $\pi(\phi \,|\, \theta)$ for the nuisance parameter given the interest parameter; marginalize the probability model $p(x|\theta, \phi)$ with respect to ϕ in order to obtain $p(x|\theta) = \int p(x|\theta, \phi)\, \pi(\phi|\theta)\, d\phi$, and compute the reference prior $\pi_R(\theta)$ for the marginalized model; the full prior is then $\pi(\theta, \phi) = \pi(\phi \,|\, \theta)\, \pi_R(\theta)$.

In many high energy physics measurements there are often sound reasons for assuming that the nuisance parameter is independent of the parameter of interest. Information about a detector energy scale, for example, is typically determined separately from the measurement of interest, say of a particle mass, and is therefore considered to be independent *a priori* from one's information about the particle's mass. When an experimenter is willing to make this assumption, he or she can declare that $\pi(\phi \,|\, \theta) = \pi(\phi)$ and use Method 2. When this assumption does not seem fully justified, and it is too difficult to elicit the θ dependence