our model is just a model, and that we could start by assuming that the root probabilities are sufficiently asymmetric for the process to be non-stationary, and then that the process is sufficiently strand-symmetric for the model to be approximately correct. In either case assumption A of Corollary 3.1 could be an interesting tool for probing the limits of inference of this model.

In the spirit of Chang (1996) we have attempted to provide a constructive proof, and hope that the results here presented will enable the implementation of new phylogenetic methods. There are several options for such an implementation. Mossel and Roch (2006) provide an algorithm for directly applying the concepts in Chang (1996) to learn the full model parameters using spectral methods. It would be relatively straightforward to adapt that approach to the proof to Theorem 3.1. Alternatively, progress is being made towards fitting models that are *heterogeneous across lineages* (Jayaswal et al. 2011, 2014). These methods could be adapted to our setting. Also, the method of Yap and Speed (2005) where a homogeneous process is fitted to the whole tree would be trivial to implement for a strand symmetric process, but could be done with a solid theoretical basis and new insight into the limits of inference of such a model.

In addition to these immediate applications, this work provides a foundation for theoretical developments where a non-stationary model can be fully recovered for a two-taxon rooted topology. The ideas presented here could be extended to any such model, not just the strand-symmetric one on which we focus. Another possible direction for future theoretical development is a model that is rate-heterogeneous amongst alignment columns. We have ignored this possibility, both because it is possible to work around it with careful site classification, as in Yap and Speed (2005), and because recent results in non-stationary phylogenetic processes have shown that the general time-reversible model is less biased than the usual rate-heterogeneous general time-reversible model in comparison to a general non-stationary process in some circumstances (Kaehler et al. 2015). Another possible line of enquiry is to re-