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Application of a hierarchical MCMC follow-up to Advanced LIGO continuous gravitational-wave candidates

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We present the first application of a hierarchical Markov Chain Monte Carlo (MCMC) follow-up on continuous gravitational-wave candidates from real-data searches. The follow-up uses an MCMC sampler to draw parameter-space points following the F-statistic. As outliers are narrowed down, coherence time increases, imposing more restrictive phase-evolution templates. We introduce a novel Bayes factor to compare results from different stages: The signal hypothesis is derived from first principles, while the noise hypothesis uses extreme value theory to derive a background model. The effectiveness of our proposal is evaluated on fake Gaussian data and applied to a set of 30 outliers produced by different continuous wave searches on O2 Advanced LIGO data. The results of our analysis suggest all but three outliers are inconsistent with an astrophysical origin under the standard continuous wave signal model. We successfully ascribe two of the surviving outliers to an instrumental artifact and a strong hardware injection present in the data. The behavior of the third outlier suggests an instrumental origin as well, but we could not relate it to any known instrumental cause.

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