Modeling Gravitational Wave and Dark Matter Signals With Autoregressive Time Series and Fourier Analyses

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Dark matter is theorized to comprise a fundamental component of the universe, but it has not been detected or identified. Detecting dark matter would advance our knowledge of the universe and the principles of physics. To search for dark matter, models and simulated data are developed to statistically understand how the signal behaves. Then, the models are fit to real data to search for an actual signal. These models are created predominantly by using Fourier analyses; however, there are flaws to this method and it is more reliable to use multiple methods of modeling. In this study, I tested the novel use of autoregressive time series to determine if they can accurately model dark matter signals using simulated gravitational wave data. Autoregressive time series are a mode of modeling not frequently leveraged in astronomy. Then, I completed Fourier analyses to statistically analyze the autoregressive models with the traditional method. The methodology was conducted entirely in Python code through the server Jupyter Lab and simulated data sets were used. While the results showed that Fourier analyses created stronger models, they demonstrate that autoregressive time series can also accurately model dark matter signals. These results are significant because autoregressive time series have not previously been used to model dark matter, and this research showed that this method is viable. Importantly, this supports the use of more than one method of modeling in time domain astronomy, which provides more accurate and efficient results than seen before. This novel study concluded that autoregressive time series can accurately model dark matter, and astronomers do not have to rely exclusively on Fourier analyses for this research.

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