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A Machine Learning Approach for Dark Matter Search Analysis: From Savitzky-Golay to Autoencoder

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In the quest to improve the analysis procedure for dark matter (DM) axion searches in haloscope experiments, we propose integrating deep learning (DL) techniques into the current methodology. Specifically, as a first step towards full DL integration in the procedure, we aim to show the well-known Savitzky-Golay filter used for spectral shape removal can be replaced by a deep convolutional autoencoder filter. This transition seeks to address three key challenges: better preservation of grand spectrum noise distribution, reduced axion signal attenuation, and lower spectral pollution around EMI/EMC parasites. We will present the first results of this new analysis path enriched by the innovative approach that enhances accuracy and reliability in identifying potential axion signals. If successfully applied, this method can also be adopted by other DM searches both narrow-band and wide-band, including the axion anti quark nuggets proposed by A. Zhitnitsky, which are also a source of transient DM axions.

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