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Using Machine/Deep Learning to Analyze Acoustic Data and Probe the Physical Development of Bubble Nucleation

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The PICO detector generates acoustic signals from the bubble nucleation caused by incident particles, such as alphas, neutrons, gammas, and potentially WIMPs. These signals contain properties that can be used to distinguish among different particles. The acoustic parameter (AP) is one such tool, it measures the magnitude of the acoustic signals at different frequencies, and can distinguish between nucleation sources at a precision up to 99%.

The purpose of our experiment is to better understand the impact a nucleation source (alphas, neutron particles, gammas, etc.) might have on the physical growth of a bubble. To accomplish this, we would first use neural networks and decision trees to identify key features of the acoustic signals formed by bubble nucleation. Then, we would use these features to distinguish between bubbles produced by one particle source to another. Finally, after categorizing these signal data signatures, we expect to be able to model the acoustic signal produced by different nucleating particles.

We will also be examining how bubbles produced in a superheated droplet detector (PICASSO) might grow in a different manner to bubbles produced in bubble chambers filled with superheated nucleation fluids (PICO).

We use a neural network to verify the fitting of the classification tree model. A neural network is a collection of computer "neurons"which mimic the behaviour of the human brain. These neurons, as they are trained with certain data, will activate in specific orders that are recognized by the module to help categorize the incoming data. In our experiment, we would train the data to distinguish between alpha and neutron induced bubble events using the whole acoustic signals. We expect to use this trained algorithm to confirm the accuracy of the classification tree module produced by Megan McArthur (also presenting a talk at CASST 2021). This classification tree module would then be used to highlight the bubble growth patterns of the trigger particles, which will allow us to explore the processes of bubble growth.

Author: Mr YEATES, Kyle (SNOLAB/Laurentian University)

Presenter: Mr YEATES, Kyle (SNOLAB/Laurentian University)

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