"SOUNDS OF NUCLEAR RADIATION"
- IDENTIFYING FUNDAMENTAL NUCLEAR PARTICLE INTERACTED ACOUSTIC SHOCK SPECTRA VIA TMFD COUPLED-MACHINE LEARNING

Presenter

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Neutron and alpha nuclear particle detection and characterization is of fundamental importance to science and engineering – impacting fields as varied from astrophysics to nuclear energy/security, radiation dosimetry and nuclear medicine. Distinguishing one particle from the other has to date required specialized detectors and complex electronic trains. The Metastable Fluid Advanced Research Laboratory (MFARL) at Purdue University has developed the novel tensioned metastable fluid detector (TMFD) sensor technology, which can spectroscopically detect alpha and neutron radiation while being entirely blind to common background (beta and gamma) radiation. Alpha and neutron radiation interacting with the tensioned metastable state fluid atoms of the TMFD at the nanoscale can lead to acoustic shock signals – via audible and visible fast growing bubbles on the microsecond time scale.

For this study, the acoustic shock waves were led through a wave guide and interact with tiny piezoelectric transducers leading to electric pulse shock spectra - and used to generate particle specific spectrograms which describe how the acoustic power is uniquely distributed across both frequency and time. We attempted to discriminate between these spectra by training a neural network to analyze the spectrograms of the acoustic signatures generated from neutron and alpha particle interactions. Rn-222 isotope dissolved in the TMFD sensing fluid provided alpha particles, whereas, an external Pu-Be/Am-Be source provided neutrons.

Over 2,367 particle interaction event shock spectra were recorded. The spectrograms from these events were then used to train a Keras classifier and then used to train a convolutional neural network (CNN) algorithm. After a 5-fold cross-validation, the CNN algorithm was able to accurately identify the incident particle as being either α or n, with a success rate of $89.39\% \pm 9.6\%$.