Machine Learning for the Classification of Low Frequency Extensions of Saturn Kilometric Radiation

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Saturn Kilometric Radiation is an auroral emission that occurs between a few kHz to 1.2MHz, and peaks in the frequency range 100-400 kHz. It was detected quasi-continuously by Cassini from its arrival at Saturn in 2004 until mission end in 2017 and its properties have been extensively studied. SKR bursts which are global intensifications of SKR as well as extensions of the main SKR band down to lower frequencies, known as Low Frequency Extensions (LFEs), result from internally-driven tail reconnection and from solar wind compressions of the magnetosphere, which also trigger tail reconnection. LFEs have been selected by eye and also using a numerical criterion based on an intensity threshold [1]. In our work we propose to develop a supervised machine learning algorithm to select SKR bursts with an associated LFE from the entire Cassini dataset. The algorithm will be built using data from the Cassini radio instrument (RPWS), with LFEs selected by eye using a polygon selector tool by Empey et al., 2021 [2] and will include examples of LFEs detected from a broad range of spacecraft locations. The criterion for LFE selection builds on that of Reed et al., 2018 [1], which selected LFEs in 2006, but will be tailored to account for the variation in radio signature observed across Cassini's trajectory. This is due to the fact that SKR visibility is highly dependent on observer location. We plan to explore different types of algorithms that may be based on images, or on time series data e.g RNN, CNN, U-Net, Transfer Learning.

1.Reed, J. J., Jackman, C. M., Lamy, L., Kurth, W. S., & Whiter, D. K. (2018). Low-frequency extensions of the Saturn Kilometric Radiation as a proxy for magnetospheric dynamics. *Journal of Geophysical Research: Space Physics*, 123, 443– 463. https://doi.org/10.1002/2017JA024499

2. Aaron Empey, Corentin K. Louis, & Caitriona M. Jackman. (2021). SPACE Labelling Tool (1.1.0). Zenodo. https://doi.org/10.5281/zenodo.5636922