Oscillator dynamics in jet-edge interaction: classification of linear and non-linear frequency-selection mechanisms

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The use of high-bypass ratio engines in modern aircraft has positioned the jet exhaust closer to the wing. Interactions between the jet and flat plate (to represent the wing) are well-known to both increase broadband noise levels, and produce tones[1,2]. More recent works[3,4] also demonstrated that a spectral signature comprising a high-amplitude fundamental tone and subsequent harmonics may be found within the installed-jet parameter space.

This work considers a restricted parameter space across jet Mach number, M_j, and the radial displacement, R/D, of the plate (representing the wing), with a refined resolution of 0.01 such that M_j of $0.5:0.01:1$ and R/D of $0.5:0.01:0.7$ are considered. The axial displacement of the plate, and angle are kept constant at $2D$ and 45° respectively. Acoustic data were collected at each location in this parameter space. Power spectral density, bicoherence, wavelet transforms, and linear modelling are all employed to aid in distinguishing between the different spectral signatures found in the experimental data, and capture their transitions.

The dynamics at each point within the parameter space considered are classified as: broadband noise, tones arising through a linear (LFS) or non-linear (NLFS) frequency-selection mechanism, LFS with a singular harmonic or triadic interaction, and NLFS with other tones arising through triadic interactions. This result is presented in figure 1. The NLFS with triadic interactions (red) region is further subdivided based on the number of triadic interactions identified at each position.

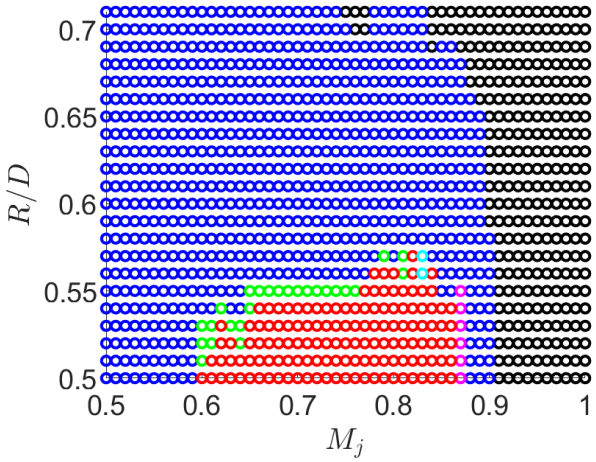

Figure 1: Installed jet dynamics present for the M_j, R/D parameter space considered. Broadband (black), LFS (blue), LFS with a singular harmonic (green), LFS with a singular triadic interaction (cyan), NLFS (magenta), and NLFS with triadic interactions (red).

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[1]Jordan et al., *Journal of Fluid Mechanics* **333**, 6516-6531 (2014)
[2]Cavalieri et al., *Journal of Sound and Vibration* **853**, 333-358 (2018)
[3]Amaral et al., *AIAA Aviation Forum*, 3830 (2023)
[4]Stavropoulos et al., *30th AIAA/CEAS Aeroacoustics Conference*, 3311 (2024)