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Investigating the Van der Pol analogy in vortex shedding using Pade approximants and compact finite differences DANIEL JOHNSTON, MOHAMMED AFSAR, ADRIAN SESCU, IOANNIS KOKKINAKIS, University of Strathclyde — The Van der Pol (VDP) oscillator serves as an analogy for vortex shedding in the near-wake region of doubly infinite (i.e. spanwise homogeneous) slender bluff bodies. In this work, approximate solutions to the VDP equation are investigated using Pade approximants and compact finite difference schemes. The Pade approximant formulae are found using expansions of the well-known asymptotic solution. We compare this to the corresponding Taylor series and the classical 4th order Runge-Kutta solution. The Pade approximant solutions consistently show closer agreement to the numerical solution over their corresponding Taylor series, especially at $O(1)$ values of the small parameter in the VDP equation, for a longer interval in time. We then asses the accuracy of the numerical solution using compact difference schemes. We find that the spectral-like schemes introduced by Lele (J. Comp. Phys. 103, p.16, 1992) show closer agreement with the VDP analogy, when compared with conventional schemes, as the initial rate of growth of the oscillations in the near-wake is increased. Finally, we consider this analogy as a model of the Von-Karman vortex street in the wake behind a cylinder, validate the results using CFD simulations, and discuss conditions for which its applicability may break down.

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