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Transitional Wake Dynamics of a Low-Aspect-Ratio Finite-Span Flapping wing SUNETRA SARKAR[1], Indian Institute of Technology Madras, India, CHANDAN BOSE[2], University of Lige, Belgium, SAYAN GUPTA[3], Indian Institute of Technology Madras, India — This study investigates the three-dimensional flow dynamics of a low-aspect-ratio flapping wing at a Reynolds number of 250. A discrete immersed boundary method is employed to solve the three-dimensional Navier-Stokes equation. Kinematic parameters, particularly the amplitude and frequency of the flapping motion, are found to have significant effects on the flow-field transition. Even though the three-dimensional wake is seen to be more stable as compared to the two-dimensional cases, an aperiodic transition is observed beyond a considerably high value of dynamic plunge velocity (kh). The periodic bifurcated wake is seen to transition to a very complex aperiodic wake as kh is increased to a significantly high value, marking that the aperiodic transition in the wake of a flapping wing is indeed a physical phenomenon. The critical value of kh beyond which the aperiodic transition takes place is seen to be much higher than the 2D case. The qualitative nature of the dynamical transitions is seen to be very similar in 2D and 3D with different bifurcation boundaries. The underlying complex interactions among leading-edge, trailing-edge and tip vortices generated in each flapping cycle and their role behind the loss of periodicity are investigated in detail.

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