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Flexible Wing Pitch-up and Pitch-down in Free Steam Flows D. QI, Western Michigan University, G. HE, Institute of Mechanics Chinese Academy of Sciences, Y. LIU, Sichuan Universitry, China — The direct simulations of the pitch-up and pitch-down of flexible and rigid wings in a free stream are conducted at the Reynolds number of $Re = 100$ by using the lattice Boltzmann flexible particle method. The effect of bending flexibility in span-wise direction on unsteady aerodynamics are investigated. It is found that when the reduced frequency is large, the lift and drag forces increase nonlinearly upto a maximum as the flexibility increases, then falls down as the flexibility becomes excessively large. The maximum value in both lift and drag forces are significantly larger for a flexible wing than for a rigid wing. However, when the reduced frequency is small, no obvious lift maximum is observed. It seems that flexibility can be used to enhance the lift force at a high reduced frequency. The power efficiency, or lift force per input power, has a similar behavior to the lift, indicating the flexibility could benefit the power efficiency. Surprisingly flexibility improves lift only during pitch-down motion while the flexibility has a negative impact on lift during pitch-up motion, indicating that the pitch-down motion dominates the lift improvement due to flexibility. In a maneuver case a small and adequate deformation may largely enhances the wake capture, results in large LEV and TEV and reduces the flow separation. The wake capture is a main mechanism for a flexible wing to improve the lift.

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