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Underlying principle of efficient propulsion in flexible plunging foil[1] XING ZHANG, XIAOJUE ZHU[2], GUOWEI HE, Institute of Mechanics, Chinese Academy of Sciences — Recently, it has been reported that passive flexibility in flapping foils can result in the enhancement of propulsive performance. In this study, we investigate the relations among propulsive efficiency, structural resonance and hydrodynamic wake resonance in a flexible plunging foil. We conduct fluid-structure-interaction simulations on flows over flexible plunging foils by using the immersed boundary method. The wake resonant frequency is computed by performing a linear stability analysis on the averaged velocity profile. The results indicates that: (i) optimal efficiency is not necessarily achieved at the structural resonance point; and (ii) optimal efficiency always occurs when the driving frequency matches the wake resonant frequency. By dissecting the wake structures, we found that whether the optimal efficiency is achieved at the structural resonance point depends on the strength of the leading edge vortex (LEV) relative to that of the trailing edge vortex (TEV). In addition, the validity of the aforesaid principle under the condition of free-swimming (self-propulsion) is also discussed.

[1]NSFC (11021262, 11023001, 11232011 and 11372331)
[2]Present address: Physics of Fluids Group, University of Twente, 7500 AE Enschede, The Netherlands

Xing Zhang
Institute of Mechanics, Chinese Academy of Sciences

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