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Boundary Layer Separation Control via Spanwise Lorentz Forces[1]

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The ability of a Lorentz force actuator to suppress boundary layer separation in a weakly conductive fluid was examined experimentally. The actuator comprising of an array of alternately arranged electrodes and magnets was flush mounted on the surface of a two dimensional hydrofoil model with a trailing flap inclined at 20° to the freestream flow in a water tunnel. The actuator was powered with a unipolar square wave at various frequencies and amplitudes in order to generate time-periodic, spanwise Lorentz forces. Velocity fields measured using PIV indicated complete flow reattachment on the inclined flap as a result of the application of Lorentz forces above a certain forcing amplitude. Performance of the actuator was weakly dependent on the forcing frequency, with improved performance found at a non-dimensional frequency of unity. The effectiveness of forcing varied with the Reynolds number, with better control achieved at higher Reynolds number for the same forcing amplitude and frequency. The ability of the actuator in suppressing separation appeared to be related to the appearance of distinct streamwise vortices as a result of Lorentz forcing.

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