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Mechanics of the Bounding Flight Revisited

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Biofluiddynamicists insist that the bounding flight is advantageous for high speed flight, because the former studies, based on arguments in terms of instantaneous dynamics, led to the lower speed bound suited for the bounding flight. Bounding flyers, however, make most of this technique in almost all the speed ranges. The present study relies on control theory and rigorous argument in terms of time averages. Two major conclusions are obtained by this novel analysis: the bounding flight is considered as the optimal bang-bang control for the unstable back-side flight; it is also revealed by the newly derived analytic solution for the time-averaged quantities that the bounding flight saves more energy than the continuous powered-flight in wide speed ranges, in particular at low speeds, and hence that the formerly known speed bound is found to be insufficient to account for the phenomenon. The present analysis supports the fixed-gear hypothesis proposed by biologists.

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