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Flow mechanism analysis of the Magnus effect for spinning finned projectile

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The study of the side force and the yawing moment of the spinning finned projectile usually focuses on the time-averaged value, because the engineer demands the time-averaged value to design the trajectory and analyze the stability of the projectile. However, for the flow mechanism study of the side force and the yawing moment, the analysis of the transient flow field is necessary. The previous studies always treat the transient aerodynamic coefficient directly. In this paper, the transient aerodynamic coefficient is divided into two parts. The static coefficient is decided by the roll angle ψ and the unsteady coefficient related to the spin rate . This paper presents the numerical simulation of a spinning projectile with four fins at angles of attack 15° and 25° with several spin rates. According to the research, dividing the transient aerodynamic coefficient into the static coefficient and the unsteady coefficient contributes to the Magnus mechanism study. The results showed that the unsteady coefficient have linear correlation with the spin rate in the present conditions. Besides a few cases at small Mach number and large angle of attack, the transient aerodynamic coefficient makes positive contribution to the time-averaged side force and moment. Furthermore, in supersonic conditions, the shock wave caused by the fins significantly influences the side force and moment, in other words, the shape of fin obviously affects the side force and yaw moment. At high Mach number, the leeward flow induced by the fore-body dominates the Magnus effect.

Biography

Jiawei Zhang is pursuing his Doctor's degree at Beijing Institute of Technology. His main area of research is the aerodynamic characteristics of spinning projectile.

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