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Inverse Magnus effect on a rotating sphere[1] JOOHA KIM, HYUNG-MIN PARK, HAECHEON CHOI, JUNG YUL YOO, Seoul National University — In this study, we investigate the flow characteristics of rotating spheres in the sub-critical Reynolds number (Re) regime by measuring the drag and lift forces on the sphere and the two-dimensional velocity in the wake. The experiment is conducted in a wind tunnel at $Re = 0.6 \times 10^5 - 2.6 \times 10^5$ and the spin ratio (ratio of surface velocity to the free-stream velocity) of 0 (no spin) - 0.5. The drag coefficient on a stationary sphere remains nearly constant at around 0.52. However, the magnitude of lift coefficient is nearly zero at $Re < 2.0 \times 10^5$, but rapidly increases to 0.3 and then remains constant with further increasing Reynolds number. On the other hand, with rotation, the lift coefficient shows negative values, called inverse Magnus effect, depending on the magnitudes of the Reynolds number and spin ratio. The velocity field measured from a particle image velocimetry (PIV) indicates that non-zero lift coefficient on a stationary sphere at $Re > 2.0 \times 10^5$ results from the asymmetry of separation line, whereas the inverse Magnus effect for the rotating sphere results from the differences in the boundary-layer growth and separation along the upper and lower sphere surfaces.

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