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DSMC simulations of leading edge flat-plate boundary layer flows at high Mach number DR. SAHADEV PRADHAN, Department of Chemical Engineering, Indian Institute of Science, Bangalore- 560 012, India — The flow over a 2D leading-edge flat plate is studied at Mach number $Ma = (U_{inf}/\backslash sqrt\{k_B T_{inf}/m\})$ in the range $<Ma<10$, and at Reynolds number number $Re = (L_T U_{inf}\ rho_{inf})/\ mu_{inf}$ equal to 10 using two-dimensional (2D) direct simulation Monte Carlo (DSMC) simulations to understand the flow phenomena of the leading-edge flat plate boundary layer at high Mach number. Here, $L_T$is the characteristic dimension, $U_{inf}$and $T_{inf}$are the free stream velocity and temperature, rho_{inf} is the free stream density, $m$is the molecular mass, mu_{inf} is the molecular viscosity based on the free stream temperature T_{inf},and $k_B$is the Boltzmann constant. The variation of streamwise velocity, temperature, number-density, and mean free path along the wall normal direction away from the plate surface is studied. The qualitative nature of the streamwise velocity at high Mach number is similar to those in the incompressible limit (parabolic profile). However, there are important differences. The amplitudes of the streamwise velocity increase as the Mach number increases and turned into a more flatter profile near the wall. There is significant velocity and temperature slip ((Pradhan and Kumaran, J. Fluid Mech-2011); (Kumaran and Pradhan, J. Fluid Mech-2014)) at the surface of the plate, and the slip increases as the Mach number is increased. It is interesting to note that for the highest Mach numbers considered here, the streamwise velocity at the wall exceeds the sound speed, and the flow is supersonic throughout the flow domain.

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