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Geometric invariance of compressible turbulent boundary layers WEI-TAO BI, BIN WU, ZHEN-SU SHE, Peking University, FAZLE HUSSAIN, Texas Tech University — A symmetry based approach is applied to analyze the mean velocity and temperature fields of compressible, flat plate turbulent boundary layers (CTBL). A Reynolds stress length scale and a turbulent heat flux length scale are identified to possess the same defect scaling law in the CTBL bulk, which is solely owing to the constraint of the wall to the geometry of the wall-attached eddies, but invariant to compressibility and wall heat transfer. This invariance is called the geometric invariance of CTBL eddies and is likely the origin of the Mach number invariance of Morkovin's hypothesis, as well as the similarity of energy and momentum transports. A closure for the turbulent transport by using the invariant lengths is attainted to predict the mean velocity and temperature profiles in the CTBL bulk- superior to the van Driest transformation and the Reynolds analogy based relations for its sound physics and higher accuracy. Additionally, our approach offers a new understanding of turbulent Prandtl number.

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