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Cubature Rules for Off-Lattice Boltzmann Methods in Two and Three Dimensions[1] DOMINIK WILDE, University of Siegen, ANDREAS KRAEMER, Freie Universitaet Berlin, MARIO BEDRUNKA, University of Siegen, DIRK REITH, Bonn-Rhein-Sieg University of Applied Sciences, HOLGER FOYSI, University of Siegen — The discretization of the velocity space of on-lattice Boltzmann methods is primarily designed with focus on the regular lattice. However, the mostly used D2Q9, D3Q19, and D3Q27 low-degree cubature rules of the regular lattice Boltzmann method evoke errors in the stress tensor, which is one of the method's major drawbacks. We show that high-degree cubature rules cancel these errors, provided they integrate $e^{-\mathbf{x}^2}$. Also we demonstrate that cubature rules significantly reduce the number of required abscissae in comparison to the obvious product rules of the one-dimensional Hermite quadrature. As an example, we were able to replace the degree-nine product rule D3Q125 by a D3Q45 velocity set. The properties of the introduced cubature rules are shown by using the semi-Lagrangian lattice Boltzmann method for test cases such as the two-dimensional shock-vortex interaction and the three-dimensional compressible Taylor-Green vortex.

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