Minimal Number of Discrete Velocities for a Flow Description

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It seems intuitively correct to describe fluid flows by using fictitious particles hopping on homogeneously separated nodes with a given finite set of discrete velocities, however, it is not clear how many discrete velocities are needed for the motion of the fictitious particles to satisfy a certain level of accuracy with acceptable stability. This question is clarified by the discrete Boltzmann equation, which is originally developed from the cellular automata to fluid flows. Here we show that we can describe a compressible thermal flow of the level of accuracy of the Navier-Stokes equation by only 33 discrete velocities for two-dimensional space comprised of a square lattice. As a result, we have broken the previously known minimal number by sparsely and widely distributing the discrete velocities.

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