An introduction to BGK models

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In the kinetic theory of gases, the dynamics of a nonionized monatomic rarefied gas system is described by the celebrated Boltzmann equation. But the numerical approximation of the Boltzmann dynamics is a formidable challenge due mainly to the complicated structure of the collision operator. To circumvent these difficulties, Bhatnagar, Gross, and Krook, and independently Welander, proposed a model equation for the Boltzmann equation where the collision operator was replaced by a relaxation operator. Since then, the BGK model has been widely used in place of the Boltzmann equation in various fields of science and engineering because it mimics the dynamics of the Boltzmann equation very well at much lower computational costs. In this lecture, I will provide a brief survey of various topics on the BGK model and several variants of it.