EQUATION OF STATE FOR THE TWO-COMPONENT VAN DER WAALS GAS WITH RELATIVISTIC EXCLUDED VOLUMES

G. Zeeb, K.A. Bugaev[1]*, P.T. Reuter*[2]*, H. StÖcker*

Institut für Theoretische Physik,
J.-W.-Goethe Universität, Frankfurt am Main
(*1, Max von Laue Str., Frankfurt am Main 60438, Germany; e-mail: gzeeb@th.physik.uni-frankfurt.de*),
[1]Bogolyubov Institute for Theoretical Physics,
Nat. Acad. Sci. of Ukraine
(*14b, Metrologichna Str., Kyiv 03680, Ukraine; e-mail: bugaev@th.physik.uni-frankfurt.de*),
[2]Triumf, Canada
(*4004, Wesbrook Mall, Vancouver, Canada V6T 2A3; e-mail: reuter@triumf.ca*)

S u m m a r y

A canonical partition function for the two-component excluded volume model is derived, leading to two different van der Waals equations of state. The one of them is known as the Lorentz–Berthelot mixture, and the other has been proposed recently. Both models are analyzed in the canonical and grand canonical ensembles. In comparison with the one-component van der Waals excluded volume model, the suppression of particle densities is reduced in these two-component formulations, but in two essentially different ways. Presently used multicomponent models have no such reduction. They are shown to be not correct when used for the mixture of particles with different hard-core radii.

For high temperatures, the excluded volume interaction is refined by accounting for the Lorentz contraction of the spherical excluded volumes, which leads to a distinct enhancement for the light particle contributions into thermodynamic functions. The resulting influence of two hard-core radii and Lorentz contraction on pion and nucleon yields is studied in detail for AGS and SPS data.