Combined effect of 1.5- and double scatterings on the Rayleigh line width near the vapor-liquid critical point

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It is widely believed [1] that the spectrum of molecular light scattering near the vapor-liquid critical point (CP) is formed mainly by single and true multiple (successive reemissions by distant density fluctuations satisfying the wave-zone condition) scattering effects. In contrast, we argue [2-4] that these mechanisms must be complemented by the 1.5-scattering, formed by triplets of density fluctuations spaced by distances $r \ll r_c < \lambda$ (λ and r_c being the wavelength and the correlation radius in the fluid, respectively). This mechanism is of the most significance along noncritical isochores in the pre-asymptotic vicinity of the CP. The presence of 1.5-scattering in the overall scattering pattern was demonstrated in [3,4] by processing experimental data [5] on the depolarization factor for xenon and those [6] on the Landau-Plazcek ratio near the λ-line.

The results [3] also reveal an asymptotic nature of the iterative series for the overall scattering intensity: (1) the magnitudes of the 1.5 and double scattering intensities can become comparable with that of the single scattering intensity; (2) the first two intensities can have opposite signs, tending to compensate for each other.

In this report, results [3,4] are used to evaluate the spectral intensity distribution for the 1.5-scattering; reproduce that for the double scattering; and scrutinize the combined effect of both mechanisms on the overall spectrum. In particular, this effect can manifest itself in the form of a stronger narrowing (temperature dependence) of the Rayleigh line, compared to that in the single scattering spectrum, as the CP is approached. The corresponding critical exponent and multiplicative renormalization coefficient are estimated and compared with experiment.

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