On the other hand, the DF approach in Ref. 2 leads to length scales $\tilde{a}_L(Q^4)$ which do not satisfy (4) for small values of $Q^4$ even though they seem to approach this relation for large $Q^4$. Furthermore, the scales for small $Q^4$ are found to depend on the microscopic interparticle potential. In general, such a dependence, which cannot be obtained from phenomenological models as in (2), is indeed to be expected.

The length scales $\tilde{a}_L(Q^4)$ determine the critical behavior of the surface OP's, $M(Q^4,z=0)$. As pointed out in Ref. 1, all surface OP's vanish simultaneously at the melting temperature, $T=T_*$, but with different rates. For systems governed by short-range forces, the critical behavior is given by (Ref. 1)

$$M(Q^4,z=0) = - (T_* - T)^{\beta_1} \tilde{a}_L(0) \frac{b_{\tilde{a}_L}(Q^4)}{\tilde{a}_L(Q^4)}$$

(5)

For the models considered in Ref. 1, the scales $\tilde{a}_L(Q^4)$ satisfy the relation (4), $\tilde{a}_L(0) = a_{L,0}$, and $b = 1$ or $b = \frac{1}{2}$. These models have, however, one important limitation since the density $M(Q^4=0,z)$ which has the largest decay length is, in fact, not treated as an OP density (which would vanish at $T=T_*$) but rather as a nonordering density which stays finite at $T=T_*$. This limitation is not present if one considers the densities $M(Q^4,Q^4,z)$ with decay lengths $\tilde{a}_L(Q^4,Q^4)$. Indeed, the largest decay length $\tilde{a}_L(Q^4)$ can now belong to the nonordering density $M(0,0,z)$ or to one of the OP densities $M(0, Q^4,z)$ with $Q^4 \neq 0$. The power-law behavior as in (5) still applies but three cases must be distinguished depending on the relative size of the two length scales $\kappa = \tilde{a}_L(Q^4=0,Q^4=0)$ and $\xi_0 = \max_{Q^4} \{ \tilde{a}_L(Q^4=0,Q^4) \}$, where the maximum is taken over all $Q^4 \neq 0$. In terms of these scales, the coefficient $b$ in (5) is given by $b=1$, $b=k/\xi_0$, and $b = \frac{1}{2}$ for $\tilde{a}_L(0) = \kappa > \xi_0$, $\tilde{a}_L(0) = \xi_0 > \kappa > \xi_0/2$, and $\tilde{a}_L(0) = \xi_0/2 > \kappa$, respectively.

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3One should note, however, that the densities $\tilde{M}(Q^4,Q^4,z)$ are not uniquely defined by (1).


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