

Electronic Supplementary Information for:

Orientalional order and translational dynamics of magnetic particle assemblies in liquid crystals

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This supplementary information is organized in three sections: In Sec. I we present the orientational order parameter we are using in the main manuscript. Representative calculated pair correlation function $g(r)$ is given in Sec. II. Dipole-Dipole autocorrelation function is provided in Sec. III.

I. ORIENTATIONAL ORDER PARAMETER

The orientational order in the Liquid crystalline (LC) matrix is quantified by the nematic order parameter $S^{(a)}$ (with $a=r,s$ for rods and spheres, respectively). The $S^{(a)}$ is obtained by the ordering matrix[1],

$$Q_{bc}^a = \sum_{i=1}^{N_a} [3(K_i^a)_b (K_i^a)_c - \delta_{bc}] / 2N_a \quad (1)$$

where $b,c = x,y,z$ (cartesian components) and K_i^a is the cartesian component of the symmetry axis of rods. Diagonalization of this tensor yields the eigenvalues, S_+ , S_0 and S_- and the corresponding eigenvectors that determine a principal axes frame. The eigenvector of the largest eigenvalue, S_+ , is the director ($\hat{\mathbf{n}}_r$) of the nematic state. The orientational order parameter is $S^{(a)} = S_+$.

For the construction of the ordering matrix of each cluster we note that the summation in Eq. (1) runs over the number of DSS particles of that cluster, and K_i^a is the cartesian component of dipolar sphere (along the direction of μ). The extracted eigenvalues are sorted as $S_+^{cl} > S_0^{cl} > S_-^{cl}$, giving the corresponding eigenvectors $\hat{\mathbf{n}}_+^{cl}$, $\hat{\mathbf{n}}_0^{cl}$ and $\hat{\mathbf{n}}_-^{cl}$ (i.e the local principal axes frame of that cluster).

II. PAIR CORRELATION FUNCTION

We have used the pair correlation function for the characterization of the positional order of the DSS particles[2, 3]

$$g(r) = \left\langle \frac{\sum_{i \neq j} \delta(r - r_{ij})}{\Delta V \rho (N_s - 1)} \right\rangle, \quad (2)$$

where ΔV is the volume of a spherical shell. Representative $g(r)$ are shown in Fig. 1.

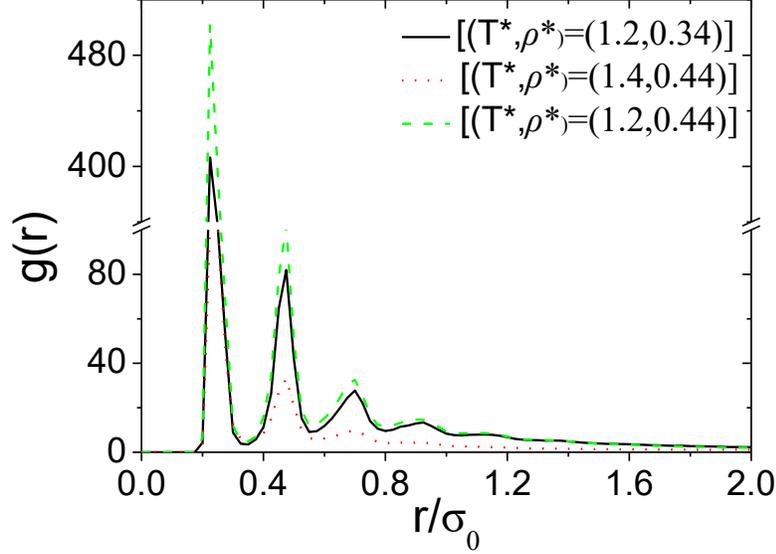


FIG. 1. (Color online) Pair correlation function $g(r)$ at various states: $[(T^*, \rho^*) = (1.2, 0.34)]$ –black–(isotropic state), $[(T^*, \rho^*) = (1.4, 0.44)]$ –red–(N_u state) and $[(T^*, \rho^*) = (1.2, 0.44)]$ –green–(N_u state).

III. DIPOLE–DIPOLE AUTOCORRELATION FUNCTION

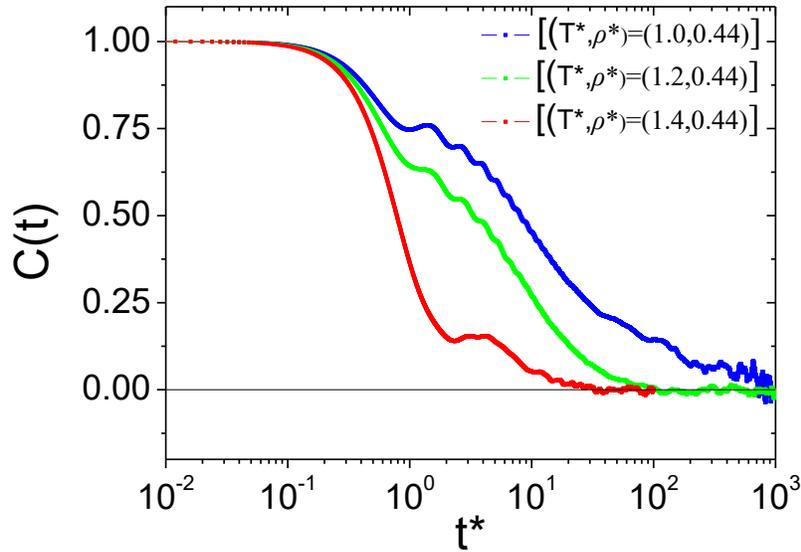


FIG. 2. (Color online) Single particle dipole-dipole time autocorrelation function $C(t)$ at various states: $[(T^*, \rho^*) = (1.1, 0.44)]$ –blue–(SmB state), $[(T^*, \rho^*) = (1.2, 0.44)]$ –green–(N_u state) and $[(T^*, \rho^*) = (1.4, 0.44)]$ –red–(N_u state).

We have also calculated the single particle time correlation function (dipole-dipole auto-correlation function)

$$C(t) = \frac{1}{3N_s} \left\langle \sum_{i=1}^{N_s} \hat{\mu}_i(t) \cdot \hat{\mu}_i(0) \right\rangle, \quad (3)$$

which is shown in Fig. 2. We have considered three representative states for which $C(t)$ decays to zero for the simulation time runs.

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- [1] P. J. Camp, M. P. Allen, and A. J. Masters, J. Chem. Phys. **111**, 9871 (1999).
[2] S. McGrother, D. Williamson, and G. Jackson, J. Chem. Phys. **104**, 6755 (1996).
[3] R. Berardi and C. Zannoni, J. Chem. Phys. **113**, 5971 (2000).