Electronic Supplementary Information for:
Orientational 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],

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

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 ($\hat{n}_r$) 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 $\mu$). The extracted eigenvalues are shorted as $S_+^{cl} > S_0^{cl} > S_-^{cl}$, giving the corresponding eigenvectors $\hat{n}_r^{cl}$, $\hat{n}_s^{cl}$ and $\hat{n}_r^{cl}$ (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]

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

where $\Delta V$ is the volume of a spherical shell. Representative $g(r)$ are shown in Fig. 1.
We have also calculated the single particle time correlation function (dipole-dipole auto-correlation function)
\[ C(t) = \frac{1}{3N_s} \left\langle \sum_{i=1}^{N_s} \hat{\mu}_i(t) \cdot \hat{\mu}_i(0) \right\rangle, \]  

(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.