Supporting Information (SI)

2D isotropic-nematic transition in colloidal suspensions of ellipsoids

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1. The sizes of the ellipsoids

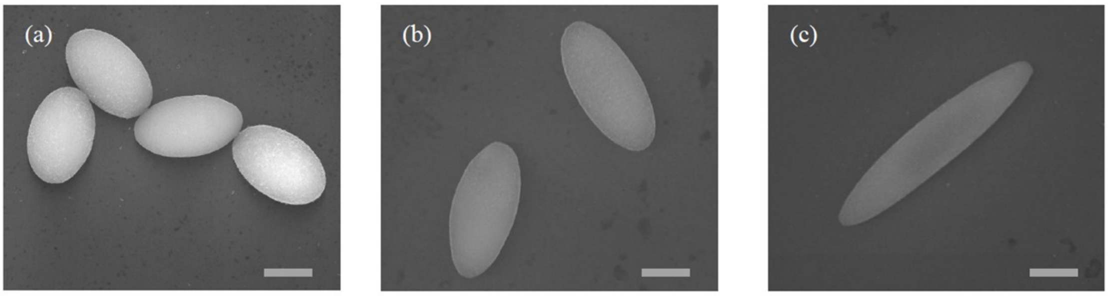

Fig. S1 SEM images of magnetic ellipsoids with three aspect ratios: (a) p = 1.7, (b) p = 2.3, (c) p = 4.9. Scale bar: 2 μm.

To characterize the aspect ratio of the fabricated magnetic ellipsoids, we measured the size from the SEM images (see the typical images in Fig. S1). We obtained the three aspect ratios of ellipsoids: p = L/D = 4.93 μm/2.85 μm = 1.7, 5.85 μm/2.60 μm = 2.3, and 9.98 μm /2.03 μm = 4.9. The corresponding cross-sectional areas are 11.18 ± 0.02 μm^2, 12.21 ± 0.02 μm^2 and 15.21 ± 0.098 μm^2, respectively.

2. The orientational correlation function $g_2(r)$

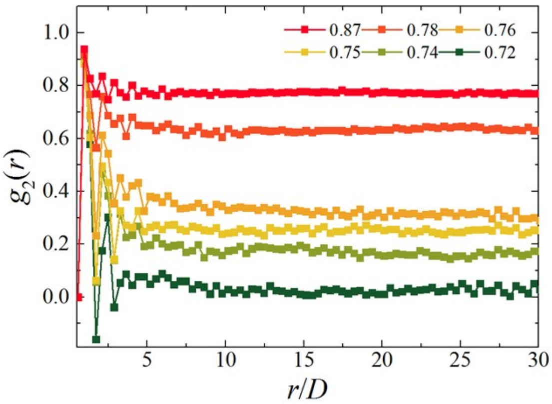

Fig. S2 The orientational correlation function $g_2(r)$ at different ϕ for $p = 2.3$.

The orientational correlation function of monolayers of ellipsoids with aspect ratio $p = 2.3$ is shown in Fig. S2. Similarly, $g_2(r)$ decays to a small value at low ϕ, and decays to a large value at high ϕ. This indicate the formation of nematic phase at high ϕ. Furthermore, $g_2(r)$ exhibits a fluctuation decay, which is similar to the result of $p = 1.7$.

3. The time correlation $g_2(t)$

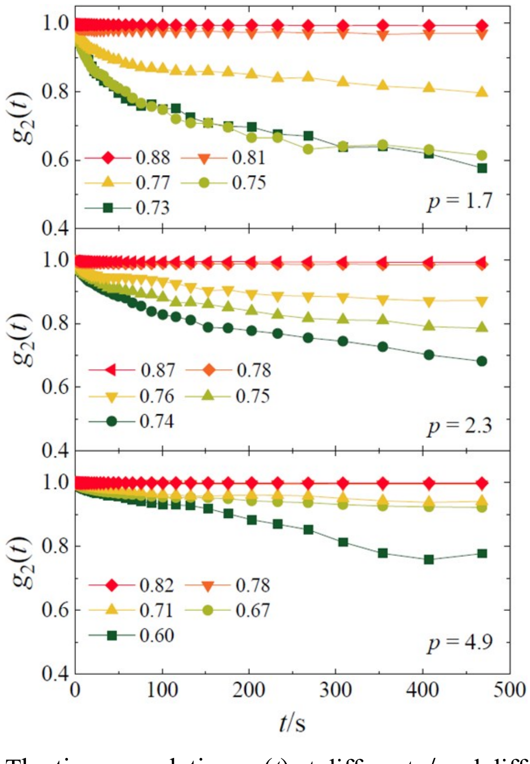

Fig. S3 The time correlation $g_2(t)$ at different ϕ and different p.

The time correlation ($g_2(t)$) is calculated; $g_2(t) = \langle\cos(2[\theta(0) - \theta(t)])\rangle$, where $\theta(t)$ is the orientation of a particle at t. Similar to $g_2(r)$, $g_2(t)$ decays to a small value at low ϕ indicating the isotropic phase, while $g_2(t)$ decays to a large value at high ϕ signifying the nematic phase (Fig. S3). Furthermore, the decay to a large value also emerges at relatively small ϕ for the large p, demonstrating the long ellipsoids favorite to form the nematic phase.

4. The radial distribution $g(r)$

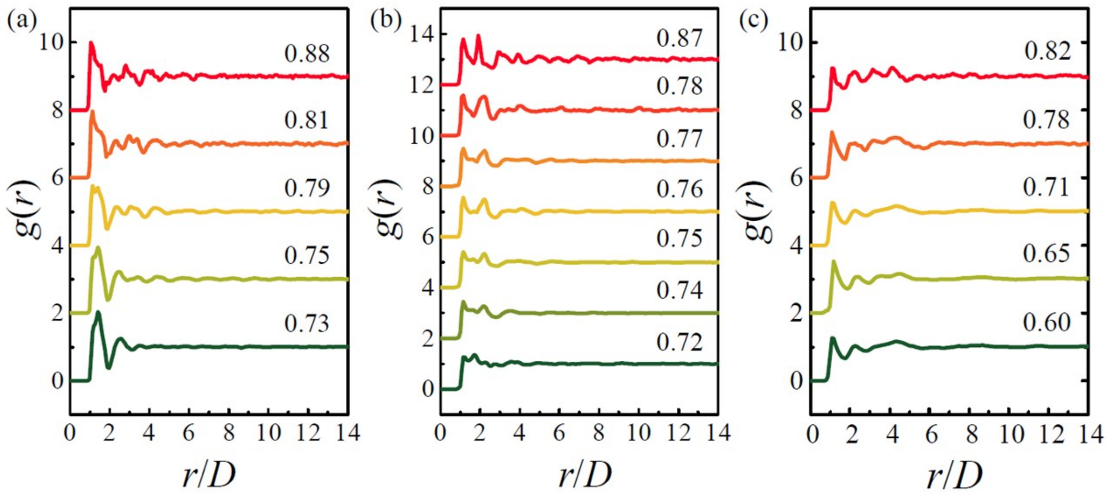

Fig. S4 Radial distribution function for ellipsoidal monolayers at different ϕ for p = 1.7 (a), p = 2.3 (b) and p = 4.9 (c).The curves were shifted vertically for clarity.

The radial distribution $g(r)$ at different packing density ϕ for aspect ratios p = 1.7, 2.3 and 4.9 are shown in Fig. S4; $g(r) = 1/n^2 < \rho(r + \Delta r) - \rho(r)>$, where n is density of ellipsoids, ρ is the distribution of the ellipsoids. The radial distribution functions for the three aspect ratios have similar results. It is found that all the system show a short-range order in the transitional degrees of freedom independent of the shape anisotropy and packing density. This demonstrates that the increase of packing density leads to an isotropic-nematic phase transition rather than an isotropic-solid phase transition in our systems.

5. The distributions of $\Delta\theta$ and the effective potential energy

The distributions of $\Delta\theta$ and the effective potential energy for p = 2.3 and 4.9 are shown in Fig. S5. The results are similar to that for p = 1.7. The probability of parallel configuration increases while the perpendicular configuration decreases as ϕ increases. The parallel configuration has the minimal effective potential energy, and thus the particles prefer to stay in this configuration at high ϕ leading to the nematic phase.

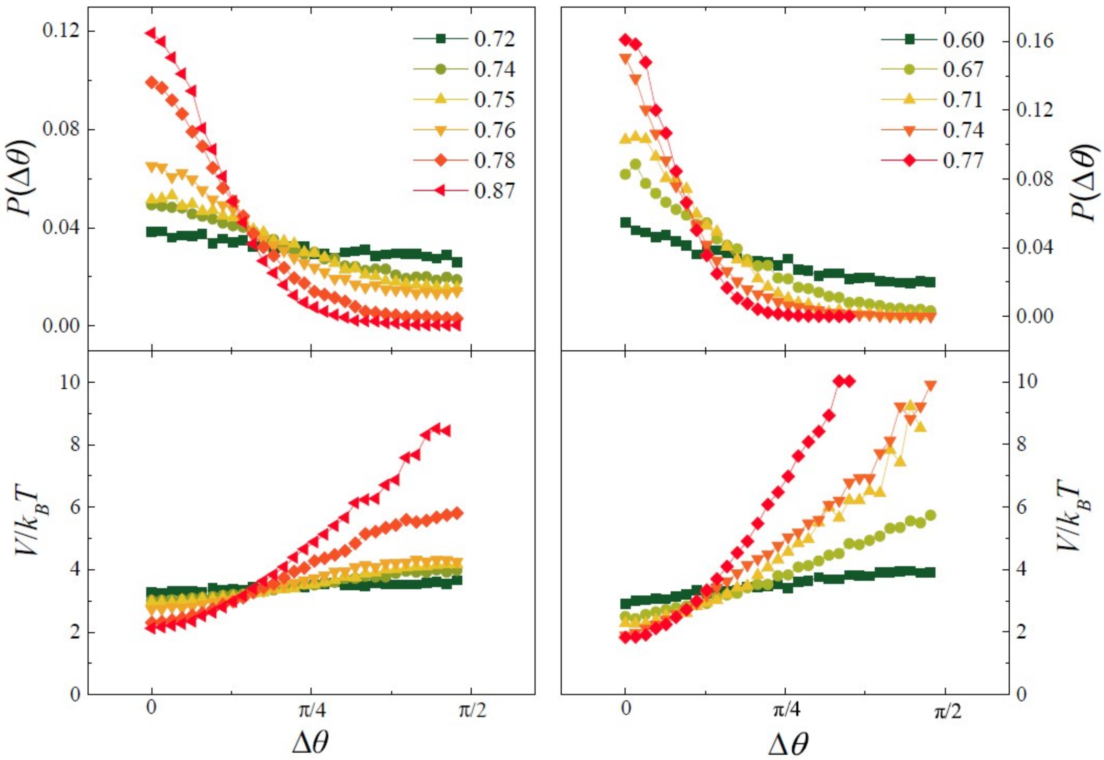

Fig. S5 The probability of orientational configuration $\Delta\theta$ and the potential energy at different ϕ for p = 2.3 (left) and 4.9 (right)

6. Supporting Videos

Video 1. Nematic phase for ellipsoids with p = 1.7.

Video 2. Nematic phase for ellipsoids with p = 2.3.

Video 3. Nematic phase for ellipsoids with p = 4.9.

The play speed for all the videos is 5 frames/s, and the real time between adjacent frames is 30 s.