

Supplementary Information

Description of the Supplementary Videos:

Transient evolutions of the system at $\rho = 1.03$, with uniformly distributed initial positions $\{\mathbf{r}_i\}$ and orientations $\{\hat{\mathbf{p}}_i\}$. Video durations are: 25τ .

Video 1: Gas state at $\tau^{-1} = 0.4$.

Video 2: Liquid state at $\tau^{-1} = 10$.

Video 3: Liquid state at $\tau^{-1} = 40$.

Video 4: Crystal state at $\tau^{-1} = 200$.