Phase behaviour of hard circular arcs: purely entropy-driven cluster phases

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By using Monte Carlo numerical simulations we have investigated the complete phase behavior of systems of hard infinitesimally-thin circular arcs in two dimensions and sketched their phase diagram (Fig.1) in the plane subtended angle, θ, versus the inverse of the number density, $1/\rho$ [1]. Despite their simplicity, systems of hard infinitesimally-thin circular arcs manifest a rich auto-assembly phenomenology driven by the sole entropy. In particular, these systems form a filamentary phase (Fig.3) for arcs denotable as minor ($\theta < \pi$) and a hexagonal cluster phase (Fig.2) for arcs denotable as major ($\theta > \pi$) [2]. Interestingly, in the latter phase, hard circular arcs intertwine and pack on the same parent circle, forming circular clusters which, in turn, arrange on a triangular lattice. These circular clusters are naturally chiral structures but the cluster hexagonal phase is globally non-chiral.

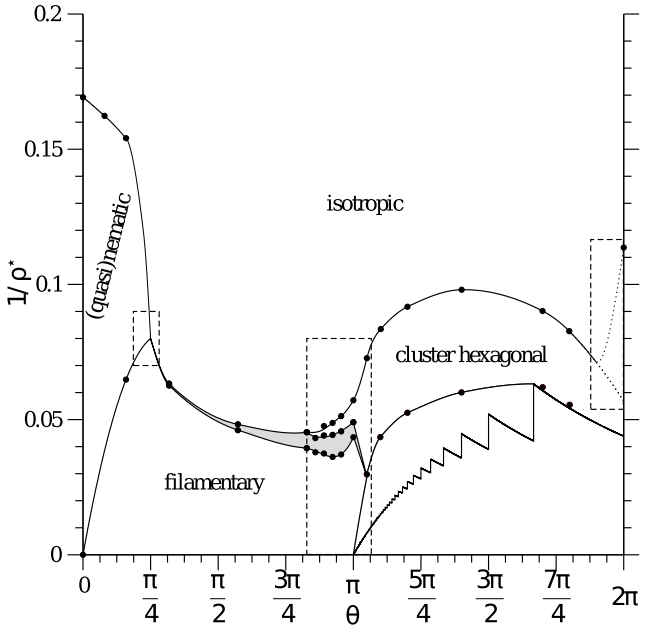

Fig. 1. Phase diagram of systems of hard circular arcs in the plane aperture angle θ versus inverse of number density $1/\rho$.

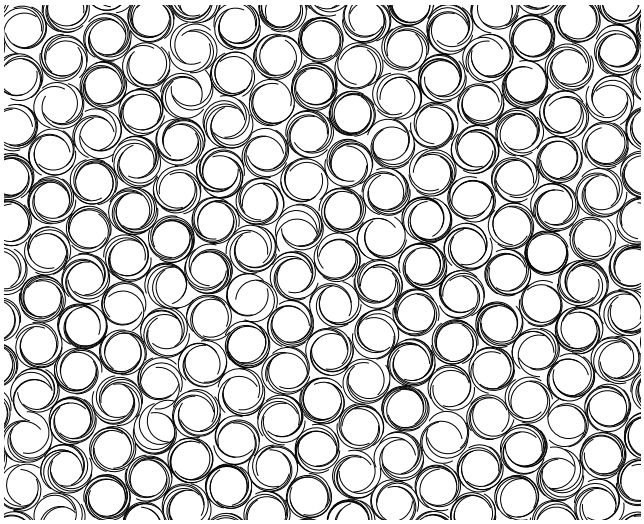

Fig. 2. Example of a hexagonal cluster phase for major arcs subtending an angle $\theta = 1.1\pi$.

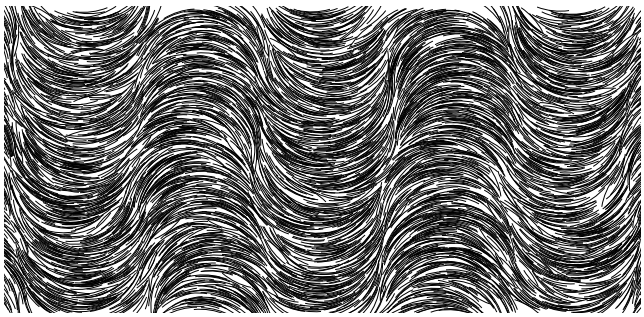

Fig. 3. Example of a filamentary phase for minor arcs subtending an angle $\theta = 0.5$.

[1] J.P. Ramrez Gonzlez and, G. Cinacchi, *Phase behavior of hard circular arcs*, Phys. Rev. E **104**, 054604 (2021).

[2] J.P. Ramrez Gonzlez and, G. Cinacchi, *Dense packings of hard circular arcs*, Phys. Rev. E **102**, 042903 (2020).