Synchronous Motion of Active Particles in a Trap

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We propose a numerical model to study active particles which can be trapped in a well. We consider attractive dipolar interactions to define the trap but also some short-range repulsive interactions between active particles. Depending on the competition between particle motion and trap characteristics, a number of particles can be trapped. Orbital motion, as expected in a well, is obtained in dilute cases. But for dense situations, due to their relative motions and short-range interactions, some synchronous motion is observed within the trap. This particular regime is illustrated in the figure below. The conditions for trapping as well as the occurrence of various collective dynamics are emphasized.

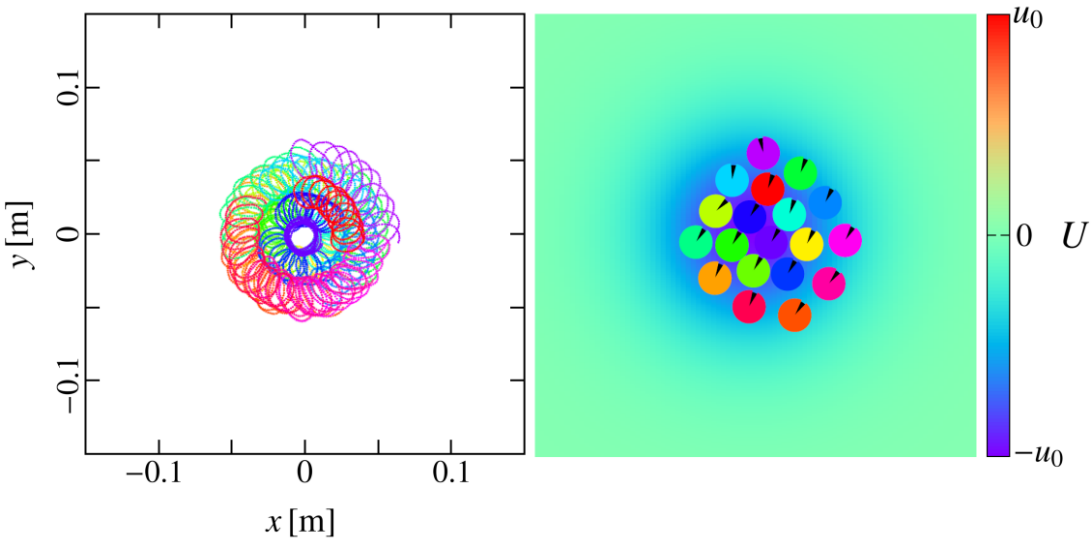

Figure 1. (left) Typical trajectories followed by the trapped particles in a numerical simulation exhibiting synchronized movement. (right) Snapshot of that numerical simulation showing particles moving collectively as a unique entity in the synchronous regime, where all angular velocities and directions are similar. The center of the trap is located in the center of the image.

References

1. O. Dauchot & V. Démery, Dynamics of a Self-Propelled Particle in a Harmonic Trap, *Phys. Rev. Lett.*, **122**, 068002 (2019)
2. P. Baconnier, D. Shohat, C. Hernández López, C. Coulais, V. Démery, G. Düring & O. Dauchot, Selective and collective actuation in active solids, *Nat. Phys.*, **18**, 1234-1239 (2022)