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Active matter: A treasure trove of novel universality classes

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A hallmark of living organisms is the ability to move around in their environments. In the fluid state, i.e., when the motile agents can exchange neighbours freely, the equations of motion that describes the system are called the Toner-Tu (TT) equations. The TT equations govern active fluids the same way that the Navier-Stokes equations govern simple fluids. Since the inception of the TT equations in 1995, dynamic renormalization group (DRG) analyses on the TT equations have led to the discovery of diverse novel nonequilibrium states of matter (or phases), and novel critical phenomena. In this talk, I will focus on the incompressible limit of the TT equations and elucidate the associated universal behaviour [1–5]. I will also discuss how exact RG may enable us to solve some key open questions in active matter physics. References: [1] Chen L, Lee C F, Maitra A and Toner J 2022 Packed swarms on dirt: two dimensional incompressible flocks with quenched and annealed disorder arXiv:2202.02865 [2] Chen L, Lee C F, Maitra A and Toner J 2022 Incompressible polar active fluids with quenched disorder in dimensions $d > 2$ arXiv:2203.01892 [3] Chen L, Lee C F and Toner J 2018 Incompressible polar active fluids in the moving phase in dimensions $d > 2$ New J. Phys. 20 113035 [4] Chen L, Lee C F and Toner J 2016 Mapping two-dimensional polar active fluids to two-dimensional soap and one-dimensional sandblasting Nat. Commun. 7 12215 [5] Chen L, Toner J and Lee C F 2015 Critical phenomenon of the order–disorder transition in incompressible active fluids New J. Phys. 17 042002

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