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Most probable path of an active Brownian particle

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In this study, we investigate the transition path of a free active Brownian particle (ABP) on a two-dimensional plane between two given states. The extremum conditions for the most probable path connecting the two states are derived using the Onsager-Machlup integral and its variational principle. We provide explicit solutions to these extremum conditions and demonstrate their nonuniqueness through an analogy with the pendulum equation indicating possible multiple paths. The pendulum analogy is also employed to characterize the shape of the globally most probable path obtained by explicitly calculating the path probability for multiple solutions. Interestingly, the numerical and theoretical analyses reveal that the shape of the most probable path changes from an I to a U shape and to the ℓ shape with an increase in the transition process time.

[1] K. Yasuda and K. Ishimoto, arXiv:2206.08115 (2022).