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Multiple phase spirals suggest multiple origins in Gaia DR3 (online)

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Gaia Data Release 2 revealed that the Milky Way contains significant indications of departures from equilibrium in the form of asymmetric features in the phase space density of stars in the Solar neighbourhood. One such feature is the z - v_z phase spiral, interpreted as the response of the disc to the influence of a perturbation perpendicular to the disc plane, which could be external (e.g. a satellite) or internal (e.g. the bar or spiral arms). In this work, we use Gaia Data Release 3 to dissect the phase spiral by dividing the local data set into groups with similar azimuthal actions, J_ϕ , and conjugate angles, θ_ϕ , which selects stars on similar orbits and at similar orbital phases, thus having experienced similar perturbations in the past. The separation improves the clarity of the z - v_z phase spiral and exposes changes to its morphology across the different action-angle groups. In particular, we discover a transition to two armed 'breathing spirals' in the inner Milky Way. We conclude that the local data contain signatures of not one, but multiple perturbations which we can explain as a transition between internal and external perturbations.

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