The bar-halo interaction - II. Secular evolution and the religion of N-body simulations

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Comments

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Abstract

This paper explores resonance-driven secular evolution between a bar and dark matter halo using N-body simulations. We make direct comparisons to our analytic theory to demonstrate the great difficulty that an N-body simulation has representing these dynamics for realistic astronomical interactions. In a dark matter halo, the bar's angular momentum is coupled to the central density cusp (if present) by the inner Lindblad resonance. Owing to this angular momentum transfer and self-consistent re-equilibration, strong realistic bars WILL modify the cusp profile, lowering the central densities within about 30 per cent of the bar radius in a few bar orbits. Past results to the contrary may be the result of weak bars or numerical artefacts. The magnitude of the effect depends on many factors and we illustrate the sensitivity of the response to the dark matter profile, the bar shape and mass and the galaxy's evolutionary history. For example, if the bar length is comparable to the size of a central dark matter core, the bar may exchange angular momentum without changing its pattern speed significantly. We emphasize that this apparently simple example of secular evolution is remarkably subtle in detail and conclude that an N-body exploration of any astronomical scenario requires a deep investigation into the underlying dynamical mechanisms for that particular problem to set the necessary requirements for the simulation parameters and method (e.g. particle number and Poisson solver). Simply put, N-body simulations do not divinely reveal truth and hence their results are not infallible. They are unlikely to provide useful insight on their own, particularly for the study of even more complex secular processes such as the production of pseudo-bulges and disc heating.

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