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# On the shape of pancakes: post-collapse perturbation theory

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Cold dark matter is typically modelled as a collisionless and self-gravitating fluid with negligible velocity dispersion and can be thought of as a 2D (3D) sheet of particles in 4D (6D) phase-space whose topology evolves as per the Lagrangian equations of motion of particles. The collapse of dark matter particles in the neighborhood of an initial overdensity into points of singularity, i.e. points with theoretically infinite density, can thus be identified with the folding of the phase-space sheet onto itself marked by a change in the topology of the sheet. Such an event is called as catastrophe and the study of the singularities characterising a collapse falls under the regime of catastrophe theory, which has wide applications, e.g. caustics seen below water surface, edge of rainbows, etc. In this work, I shall present its application to cold dark matter halo formation, particularly in the analytical description of the shape of pancakes, i.e. the earliest structures formed upon the crossing of particle trajectories when an initial overdensity collapses onto itself, in 2D. A perturbative treatment of the post-collapse motion of particles around the collapse location is introduced to improve upon the standard Lagrangian perturbation theory. Finally, I will discuss its extension to 3D cosmology in tracing the 'cosmic web'of our universe.

## Astrophysics Field

Cosmology, dark matter

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