

# Analysis of the phase-space structure in the pre-collapse perturbation theory

Shohei Saga (Kyoto University)

collaborator: A. Taruya (Kyoto) and S. Colombi (IAP)

## Large-scale structure of the universe:

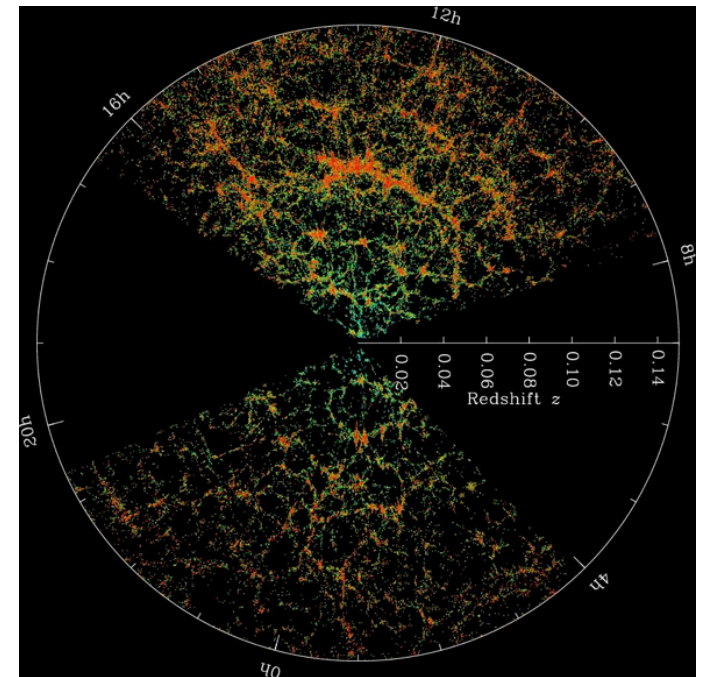
The present large-scale structure is formed by the gravitational potential of dark matters.

## Dark matter:

Collisionless

Self-gravitating particles

→ Vlasov-Poisson eq.

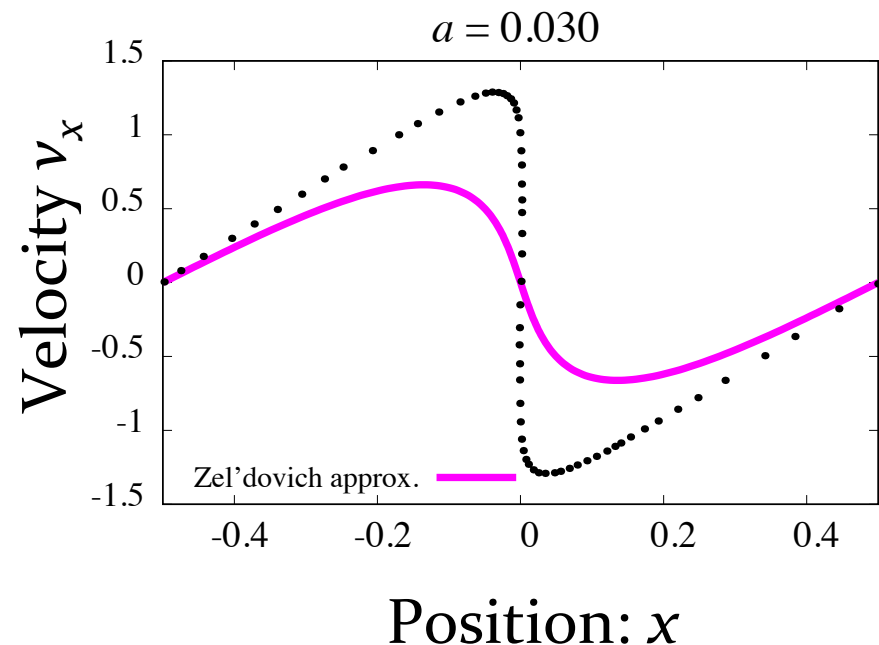
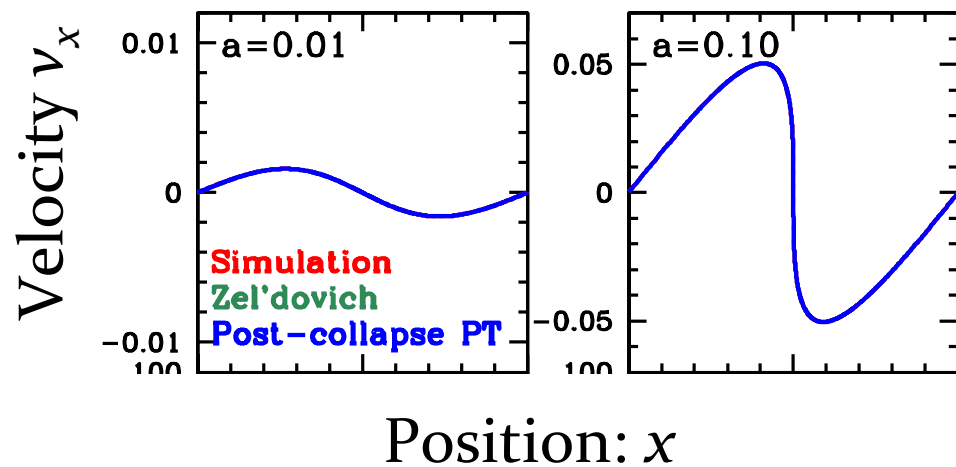


In the early universe, the single-stream approximation works.

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In the single-stream phase

- **1D-cosmology:** an exact solution called **Zel'dovich solution**
- **3D-cosmology:** the Zel'dovich approximation is **no longer correct**.



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- 1D-cosmology: an exact solution called Zel'dovich solution
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**We perform the perturbation theory to improve the pre-collapse dynamics in three-dimensional space.**

