On Warp Propagation in Dusty Protoplanetary Discs

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Warps are thought to be caused by flybys and other dynamical interactions, which are now thought to be common in stellar systems. While warp diffusion/propagation within gas discs are well understood, here we look at how the dust component reacts to these warps. We present results of simulations of warped dust + gas discs around a single point source for a relatively wide disc (100 au) with small (St ~0.1) and large (St ~100) dust components. All simulations were performed with PHANTOM using the 2-fluid algorithm

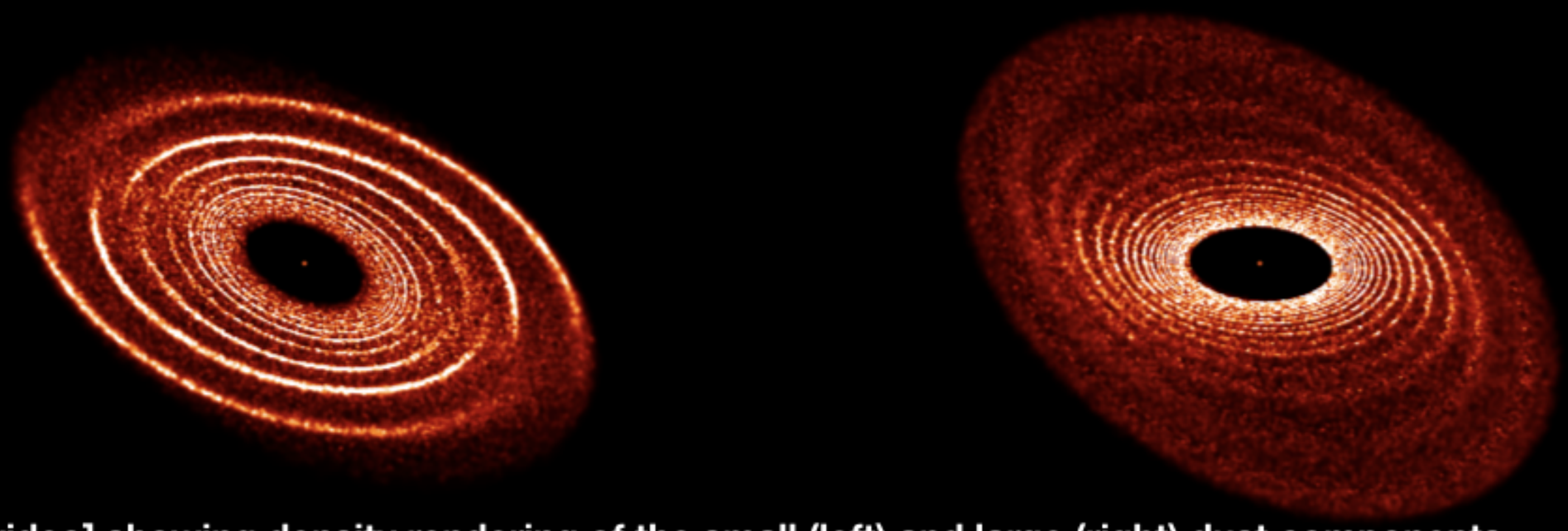

Fig [video] showing density rendering of the small (left) and large (right) dust components

Low St: The dust disc aligns quickly because of the high drag force. However, the gas velocity perturbations result in a fluctuating component in the drag force causing significant oscillatory perturbations to the dust disc. The density enhancements could be significant for planetesimal formation.

High St: While the perturbations are much less pronounced than the the low St case, as expected, the large dust grains retain the initial misalignment as it is not hugely affected by the drag force from the gas disc, which aligns very quickly. The outer dust disc retains its high inclination for the lifetime of the simulation, which extends to 2 *10^5 years. Could this mechanism be an explanation for **inclined planetesimal formation?**

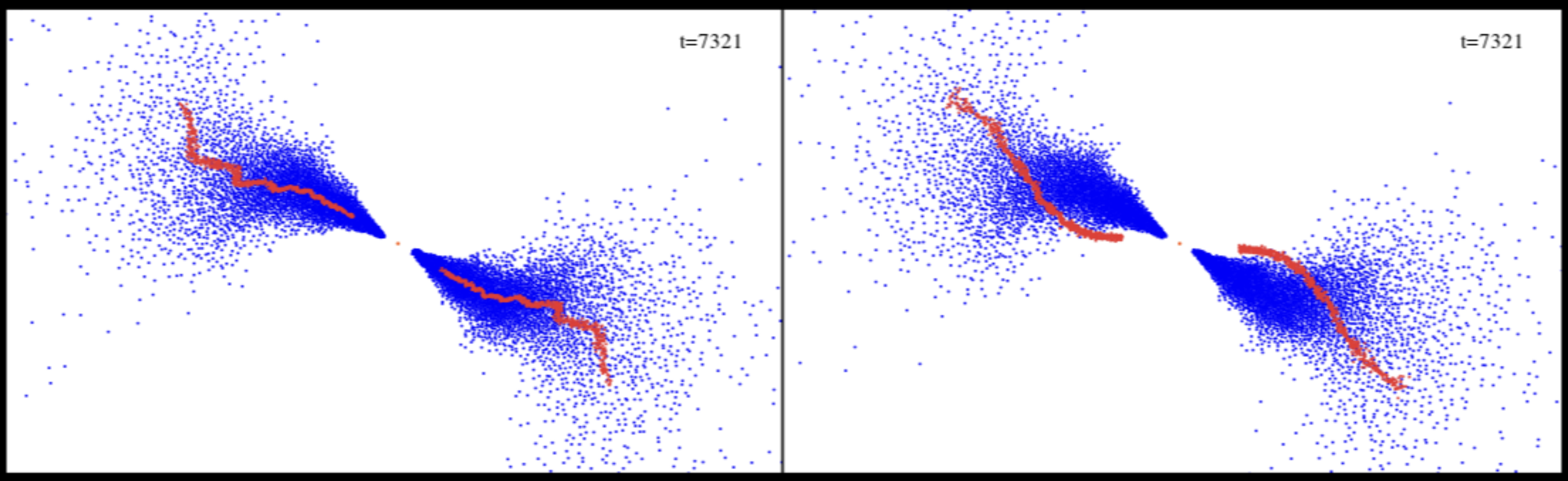

**Fig [video] showing Z-X cross section the small (left) and large (right) dust components.
Gas is shown in blue and dust in red.**