Study of the Dynamical Mass Loss by Young Star Clusters. Virial Stability Analysis.

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We investigate the Milky Way star clusters dynamical evolution and dissolution. We are modelling the young star clusters inside the Galactic disk with different masses (6,000 M_{sol}, 10,000 M_{sol}, 15,000 M_{sol}) and also with different global Star Formation Efficiencies (SFE). Processes of stellar evolution are taken into account for all models. We have in total 41 models, which were built by the help of the GPU accelerated phi-GRAPE+GPU dynamical code. We study the relations between the star cluster main parameters and also their time evolution, such as the virial ratio E_{kin}/E_{pot}, half-mass radius r_{hm} of the bound stellar system, tidal radius r_{tid}, as well as the dependency between r_{hm}/r_{tid}. The models initial Plummer distributions was generated taking in to account the total “gas” + “star” mass at the initial moment. The total stellar mass is controlled by the total SFE for each models = 0.15, 0.17, 0.20, 0.25. The models initial parameters we already present in our earlier work Shukirgaliyev et al. 2017. In the future we will continue our work of star clusters virial equilibrium study.

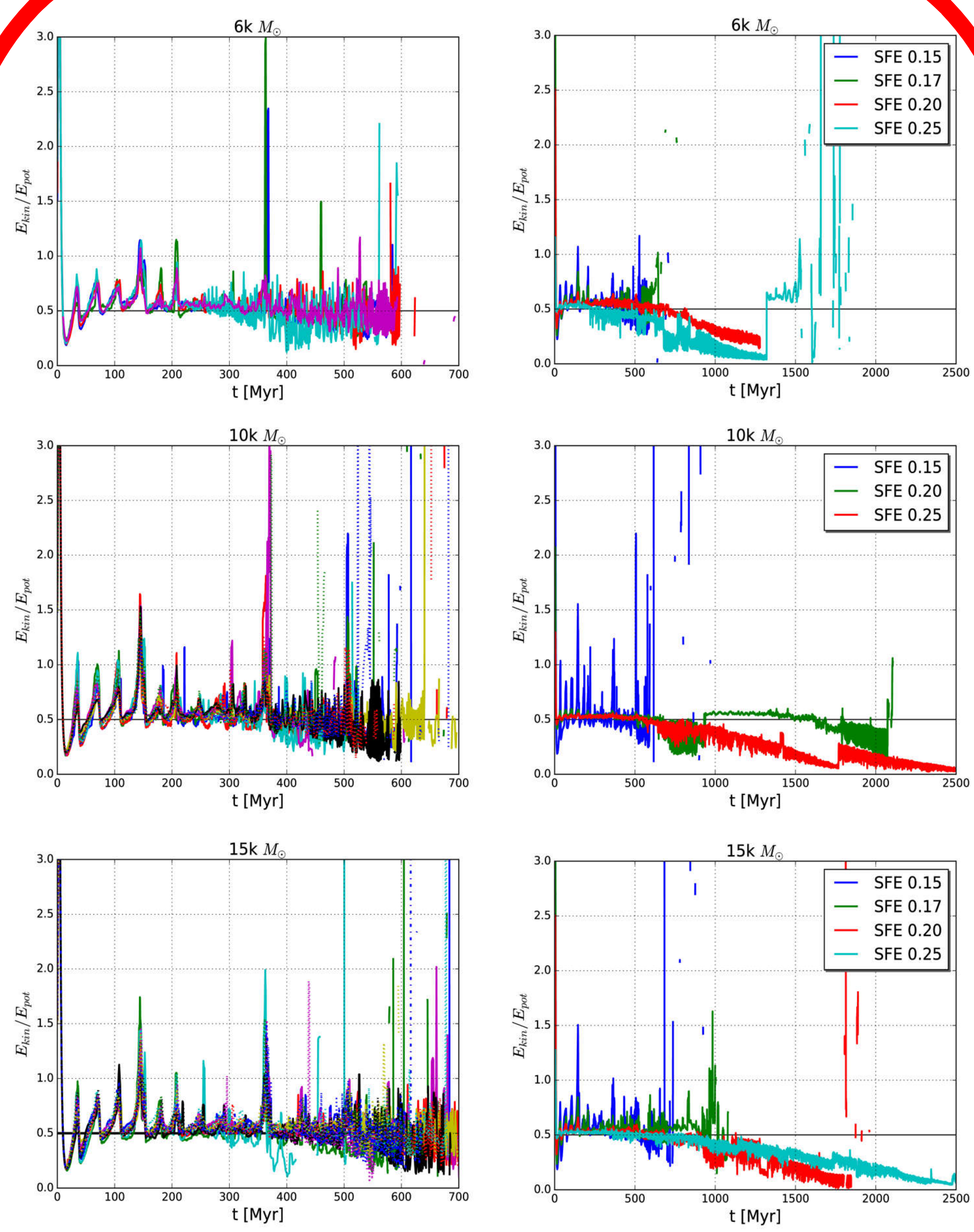

Fig. 1. We observe that the relationship at the early, violent relaxation, stage of evolution the ratio of kinetic to potential energy decreases sharply to reach a value of 0.5, which is virial equilibrium. But due to the vertical oscillation of unbound stars in the Galactic potential that are crossing the cluster volume again the virial ratio also oscillates. The cluster dissolves slowly due to stellar evolution mass loss of the stars and due to the external tidal field. In the final phase strong chaotic fluctuations of this value occur, mostly due to an ill-defined cluster center, that indicate the full dissolution of the cluster. On the left pane we show the virial ratio evolution of the fixed SFE = 0.15 for different random realizations of the cluster Initial Mass Function (IMF). On the right pane we show the virial ratio time evolution for different global SFE values.

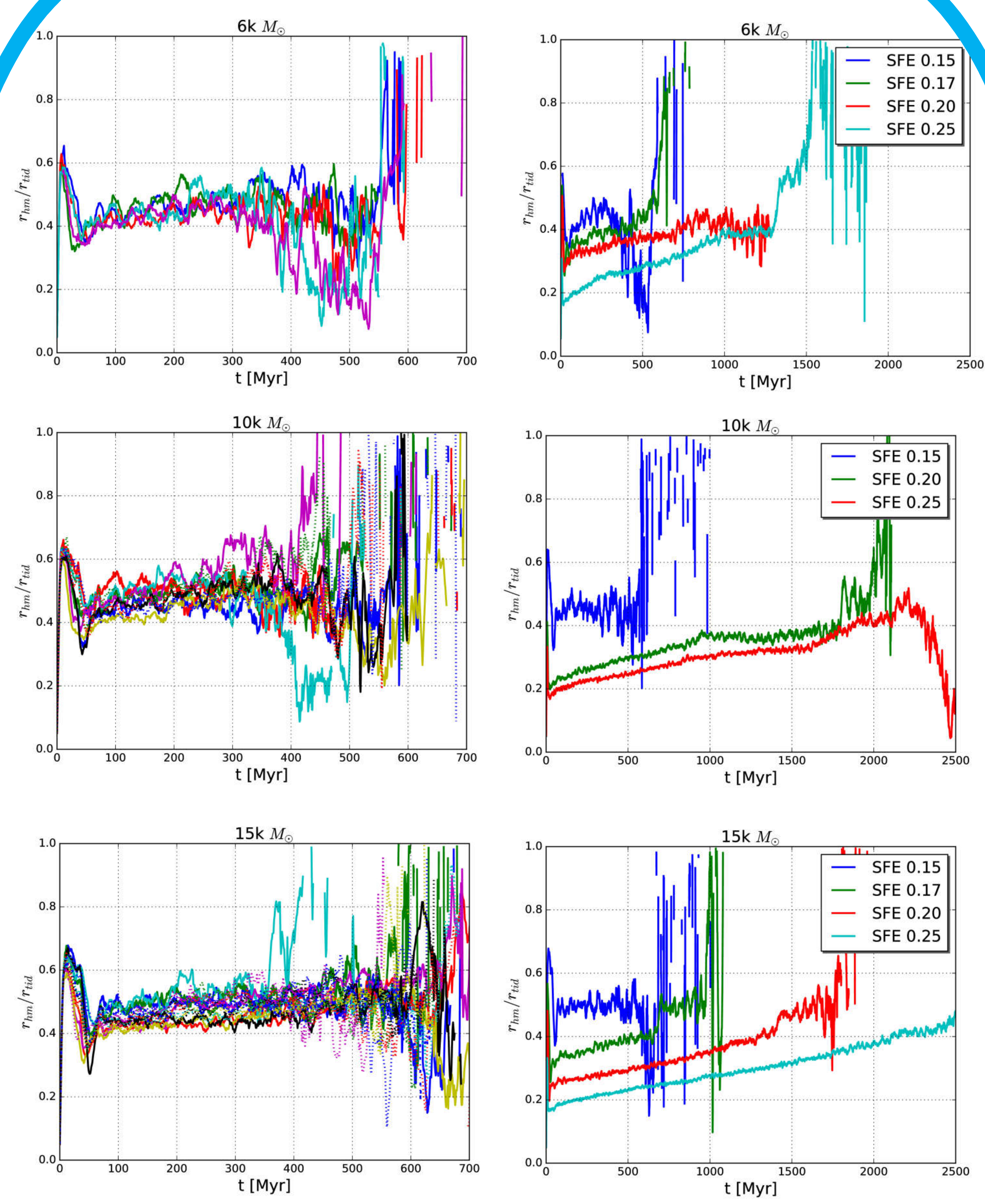

Fig. 2. Here we present the ratio of cluster half mass radius to the tidal radius. On the right panes we clearly see the different initial ratios depending on the global SFE values. The cluster with higher SFE(i.e. higher initial stellar mass of the cluster) clearly has a smaller r_{hm}/r_{tid} ratio (i.e. initially more massive and more compact). As a result, the models with higher SFE live relatively longer and have less fluctuation in their structural parameter evolution. The dissolution time of our simulated clusters also depends on the random realization of IMF (see right pane). Generally the time evolution of r_{hm}/r_{tid} ratio growing with time and around dissolution gets to the value close to 1.

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