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The disintegration process and orbital evolution of equal-mass hierarchical triple systems

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In collisional system simulations such as globular clusters, stable criteria for hierarchical triple systems are essential. SDAR (Wang et al. 2020) is a method capable of rapidly computing binaries, particularly hierarchical triple systems, but its efficiency depends on the accuracy of the stability criteria for these systems. Traditional criterion is expressed by the parameter $Q = q_{\rm out}/a_{\rm in}$, where $q_{\rm out}$ is pericenter distance of outer orbit and $a_{\rm in}$ is the semi-major axis of inner orbit. Previous stable criteria were determined based on the initial Q's threshold. But it sometimes misjudges stable systems as unstable so that it suppresses the progress of simulation of the entire cluster.

In order to construct more precise criterion, we investigated the dynamical evolution of hierarchical triple systems and observed how they disintegrate by using N-body simulations.
We found that the processes of disruption differ between retrograde and prograde orbits. Retrograde orbits experience disruption through a single close encounter of inner and outer components, while prograde orbits are disrupted by the accumulation of random orbital element changes due to close encounters. This categorization holds even for cases with orbital inclination. These close encounters are more likely to occur when the apocenter of the inner and the pericenter of the outer happen to align coincidentally. Through the evolution of the system, the arrangement of particles gradually evolves into shapes conducive to frequent close encounters.

We also found that Q oscillates during evolution and its amplitude correlates with system destabilization.
Based on these findings, we are constructing more accurate stable criteria for incorporation into N-body simulations. The prospects of this approach will be discussed.

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