The evolution outcome of the planetary systems predicted from the observed protoplanetary disk of HL Tau

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The ring/gap substructure of HL Tau has been intensively studied. Conventionally, it is interpreted as a result of unseen massive planets located inside the gaps. Motivated by this interpretation, we carried out N-body simulations to evolve the HL Tau planetary system from the current configuration to eventually 10 Gyrs after the disk dispersal. At the disk phase, we implement both planetary migration and mass growth effects coupled with the evolution of the disk profile. By varying the disk parameters, we produced a variety of widely-separated planetary systems consisting of three super-Jupiters at the end of the disk dispersal. We showed how the final configuration and planetary mass depend on disk parameters. We found no planet-pair has a period ratio less than 2.1 due to convergent migration. We continue integrating the orbits up to 10 Gyrs after the disk dispersal using pure gravitational N-body simulations. Most of the systems are found to be stable for at least 10 Gyr in only marginal resonance state. We discuss implications of our results in terms of the observed widely-separated planetary systems HR 8799 and PDS 70.

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