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The full set of gas giant structures : a tool to predict the planetary mass distributions

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To characterize the planet population around different host stars at small orbital separations (up to 64 days orbital period), we have calculated structures of gas giants in this regime. We have varied the parameters in a scale-free way so that the resulting solution-set of gas-giant structures is representative of the full set of possible gas giants in any protoplanetary disk.

It turns out that there are characteristic masses for each separation, i.e. masses that are far more frequent than others in the full set of structures. This naturally leads to a classification of gas giant planets: They can be grouped into three different classes G, H, and J with distinct properties, e.g. characteristic masses at different orbital separations and for different host stars.

Obviously, it is not a priori known that all physically possible gas giant structures are actually realized in nature and it is even more unlikely that all such states are equally frequent. However, assuming a certain randomizing agent in the process of planet formation the sheer numbers of possible equilibria will dominate the outcome provided that there is no dominant “nebula“-process that singles out only a handful of target planets. Either way, if our predictions are correct or not, we will gain strong insight into the planet formation process by a statistical comparison of predictions and observations: Agreement would confirm the dominance of the full solution set, whereas disagreement would be a strong indication that there is a dominant “nebula“-process involved in planet formation, which selects a dominant mass-scale. The comparison might even allow us to identify the dominant scale and thus the dominant process.

We applied the described method to the corot target fields. Taking into account the known distribution of star masses in the fields, we could compute the expected mass distribution for each orbital separation ranging from 1 to 64 days orbital period. A separate prediction can be made for each corot target field taking into account the mass function of the target stars. We expect different characteristic masses for different orbital periods.