Global Models of Planetary System Formation

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A key problem in developing a theory of planet formation is how to compare theoretical predictions against the observational data. This problem is becoming ever more pressing as the amount of data increases, and the launch of the ESA mission PLATO in 2026 is going to dramatically increase the number of known exoplanet systems. One approach to this problem is to develop a computational model of planet formation that can produce many thousands of synthetic systems from different initial conditions, and to compare the results of the simulations with the observational data. The computational costs of doing this have required simplifications to be made to the models so that computing them is tractable. At QMUL we have important leadership roles in the PLATO mission, and in preparation for its launch we have developed an N-body code with prescriptions for many processes involved in planet formation (see figures below). Improvements in computational hardware mean it is now possible to achieve a new level of realism with these models by combining N-body and multi-dimensional hydrodynamical simulations, and a PhD project in this area will involve developing such a code. The outcomes of this project will make predictions about the diversity of planetary systems to be observed by PLATO after its launch in 2026, and to interpret the observational data once it is received on Earth.

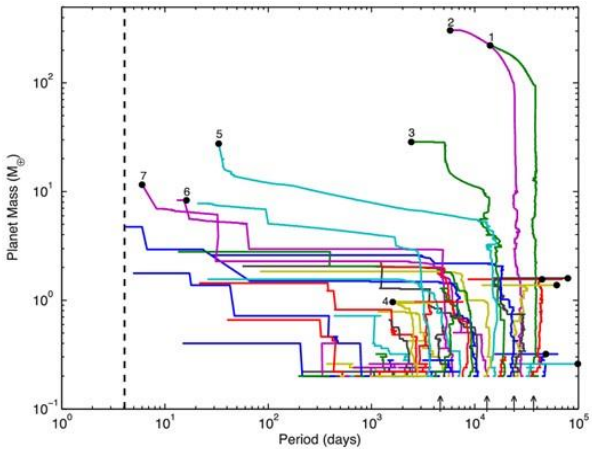

Figure 1 An example N-body simulation of planetary system formation showing the growth in mass of planets and their radial migration. The simulation shown leads to the formation of two gas giant planets orbiting at large radius and numerous lower mass planets at shorter periods.

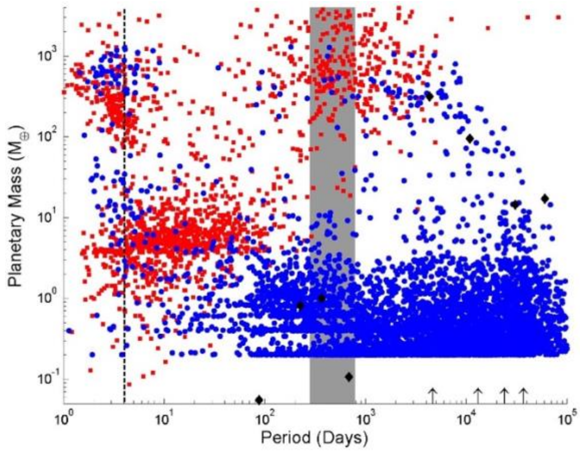

Figure 2 Comparison between observational data (red points) and the results of numerous N-body simulations (blue dots) showing the masses versus orbital periods of planets. The simulations produce hot Jupiters, cold Jupiters and systems of terrestrial planets and super-Earths in agreement with observations.

Recent relevant publications

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