Effects of protoplanetary multiplicity and migration on late-stage accretion of solids onto gas giants

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In recent years, many extrasolar gas giants have been discovered, and detailed observation reveals common characteristics of those gas giants. Their envelopes are thought to have come from protoplanetary disks, whose composition must be almost the same as that of central stars, namely, composed mainly of hydrogen and helium. Several studies of the bulk composition of gas giants, however, indicate that the envelopes of many gas giants, including Jupiter and Saturn, are much richer in heavy elements than the central stars. To explain the origin of the heavy elements, previous studies performed N-body simulations of planetesimals around growing gas giants and estimated the amount of heavy elements captured by gas giants. The estimated total masses are about a few Earth masses, which are too small to explain the observation. In this study, for the effects that enhance solid accretion, we take the multiplicity and migration of protoplanets into account. We demonstrate that the existence of another protoplanet can help supplying planetesimals to the protoplanet by scattering and also protoplanetary migration enhances the capture of planetesimals by sweeping. As a result, since planetesimals in broader area are captured by the planet, the envelopes end up being richer in heavy elements than previously thought.

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