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On the Evolution and Internal Structure of Giant Planets

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Abstract

Giant Planets have historically been assumed to have a simple structure of a fully-mixed H-He envelope, with possibly a compact heavy-element core. However, planet formation models suggest that a more complicated layered-structure with composition gradients is a natural outcome of the formation process. Additionally, recent interior models for Jupiter that match observational constraints indicate the presence of such layers.

We present a theoretical framework to follow the formation and evolution of giant planets in which the heavy-elements are included self-consistently. The energy transport mechanisms within the planet are affected by such composition gradients, and determine the planetary cooling history. We investigate the evolution of giant planets with various masses and compositions, and explore under what conditions planets become homogeneously mixed.

Our study is relevant for the interpretation of exoplanetary data, as it determines under what conditions (and masses) the planetary atmospheric composition can be assumed to represent the bulk composition. In the future, these theoretical predictions can be compared against atmospheric measurements. In addition, we provide a range of planetary luminosities for different masses, and explore how they change with different formation histories. The luminosity determination is important for the interpretation of direct imaging measurements of young giant planets.