On the surface composition of planet-harboring stars: Impact of protostellar accretion

*Masanobu Kunitomo[1], Tristan Guillot[2], Shigeru Ida[3], Taku Takeuchi

1. The University of Tokyo, 2. Observatoire de la Cote d' Azur, 3. Tokyo Institute of Technology

Recent observations have suggested a correlation between the existence of planet and the surface composition of the host star: The Sun, harboring many planetary objects, is depleted in refractory elements compared to most solar twins (Melendez et al. 2009) and in some binary systems the stellar surface compositions depend on the total mass of their planets (e.g., Ramirez et al. 2011). Since the stellar surface composition is one of the important quantities in exoplanetary sciences to characterize the planetary systems, the understanding of the observed correlations is crucial. In this study, we explore the possibility that planet formation processes affect the stellar surface compositions. The formation of planetary objects in protoplanetary disks implies that the composition of disk gas is not constant with time. The stellar surface composition must then differ from the primordial one. In order to determine the magnitude of this effect, a key ingredient is the stellar surface convective zone whose thickness determines the dilution of the "planet pollution" signature. First, we investigate the evolution of young stellar objects in the new framework of disk accretion. From stellar evolution calculations, we find that the evolution can significantly deviate from the classical picture. Using up-to-date stellar evolution models, we estimate the compositional changes due to planet formation. We find that the magnitude of the modification is sensitive to the entropy of accreting materials during the protostellar phase. Last, we apply our models to determine whether the composition anomaly between the Sun and solar twins may be explained by the retention of refractories during solar system formation. We find that this is possible, but only if the ice-to-rock ratio in the solar-system planets is less than 0.23.

Keywords: Planet formation, Stellar surface abundances, Pre-main-sequence stars

