Name: Kenji Kurosaki
Email: kkurosaki@eps.s.u-tokyo.ac.jp
Institution: The University of Tokyo

Title: Threshold Masses and Radii for Survival of Photo-Evaporating Low-Density Low-Mass Planets Orbiting G-Type and M-Type Stars

Type: Poster

Session: Characterizing Transiting Planets

Abstract: Co-authors: Masahiro IKOMA, Yasunori HORI
The Kepler mission has enabled us to detect transiting planets down to the Earth in size. From measured radii and masses, we can infer planetary internal compositions. The mass-radius relationship suggested the existence of water-rich low-mass planets with short periods, for example, Kepler-11 b (Lopez et al. 2012) and GJ 1214 b (Nettelmann et al. 2011). Volatile contents such as water are important clues to understanding the origin and evolution of low-mass exoplanets. Close-in low-mass planets experience loss of volatile material due to stellar X-ray and EUV (XUV) irradiation. Previously, several studies have examined atmospheric escape of close-in planets with hydrogen-rich envelopes (e.g. Rogers et al. 2011, Lopez & Fortney 2013). However, it is uncertain how efficiently close-in water-rich planets lose their water envelope via the energy-limited escape. To obtain theoretical predictions to future observations, we investigate the relationships among masses, radii, and semi-major axes of water-rich super-Earths and also sub-Earths that have undergone photo-evaporative mass loss. In this study, we aim to investigate the threshold mass or radius for survival of water-rich planets under intense irradiation conditions. We consider a three-layered planet at 0.01-0.1 AU around solar-type and M-type stars: a rocky core surrounded by a water envelope with a water-vapor atmosphere. We have simulated thermal evolution of water-rich planets for 10 giga years, including the effect of mass loss driven by XUV flux. We have found that water-rich planets above a minimum mass can maintain water envelopes, regardless of initial water content from 0 wt% to 100 wt%. The threshold value decreases with the semi-major axis. Our results predict a habitat area for water-rich planets orbiting solar-type and M-type stars on a planetary mass/radius-period diagram. This helps us know the origin and planetary compositions of close-in low-mass planets from the Kepler and other planet surveys.