EPSC Abstracts
Vol. 14, EPSC2020-390, 2020
https://doi.org/10.5194/epsc2020-390
Europlanet Science Congress 2020
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Recycling of Planetary Proto-Atmospheres

Tobias Moldenhauer[1], Rolf Kuiper[1], Wilhelm Kley[1], and Chris Ormel[2]
[1]University of Tuebingen, Physics, Computational Physics, Germany (tobias.moldenhauer@uni-tuebingen.de)
[2]Department of Astronomy, Tsinghua University, 30 Shuangqing Rd, Haidian District, Beijing, China

Protoplanets formed by core accretion can become massive enough to accrete gas from the disk they are born in. If the
planetary proto-atmosphere exceeds a critical mass, runaway gas accretion starts and the planetary atmosphere collapses into a gas
giant. In recent years, many close-in super-Earths have been observed which raises the question on how they avoided becoming hot
Jupiters. We investigate the recycling hypothesis as a possible mechanism to avoid the collapse of the atmosphere.
We use three-dimensional radiation-hydrodynamics to simulate the formation of proto-atmosphere in the local frame around
the planet. In post-processing we use tracer particles to calculate the shape of the atmosphere and determine the non-uniform recycling
timescale in a quantitative manner. Our simulations converge to a quasi-steady state where the velocity field of the gas does not change anymore. For the
parameter space explored, a = 0.1 au, m_c □ [1, 2, 5, 10] M_Earth, we find that recycling of the atmosphere counteracts the collapse by
preventing the gas from cooling efficiently.