Geophysical Research Abstracts
Vol. 19, EGU2017-7959-1, 2017
EGU General Assembly 2017

Escape and fractionation of volatiles and noble gases: from Mars-sized planetary embryos to growing protoplanets

Petra Odert (1), Helmut Lammer (1), Nikolai V. Erkaev (2,3), Athanasia Nikolaou (4,5), Herbert I. M. Lichtenegger (1), Colin P. Johnstone (6), Kristina G. Kislyakova (1), Martin Leitzinger (7), Nicola Tosi (4,5)

(1) Space Research Institute, Austrian Academy of Sciences, Graz, Austria (petra.odert@oeaw.ac.at), (2) Institute for Computational Modelling, Siberian Division of Russian Academy of Sciences, Krasnoyarsk, Russian Federation, (3) Siberian Federal University, Krasnoyarsk, Russian Federation, (4) Institute for Planetary Research, German Aerospace Center (DLR), Berlin, Germany, (5) Technical University Berlin, Germany, (6) University of Vienna, Department of Astrophysics, Vienna, Austria, (7) Institute of Physics/IGAM, University of Graz, Austria

Planetary embryos form larger planetary objects via collisions. Such Moon- to Mars-sized bodies can have magma oceans. During the solidification of their magma oceans planetary embryos may therefore degas significant amounts of their volatiles, forming H_2O/CO_2 dominated steam atmospheres. Such atmospheres may escape efficiently due to the low gravity of these objects and the high EUV emission of the young host star. Planets forming from such building blocks could therefore be drier than expected. We model the energy-limited outflow of hydrogen which is able to drag along heavier species such as O and CO_2. We take into account different stellar EUV evolution tracks to investigate the loss of steam atmospheres from Mars-sized planetary embryos at different orbital distances. We find that the estimated envelopes are typically lost within a few to a few tens of Myr. Moreover, we address the influence on protoplanet evolution using Venus as an example. We investigate different early evolution scenarios and constrain realistic cases by comparing modeled noble gas isotope ratios with presently observed ones. We are able to reproduce current ratios by assuming either a pure steam atmosphere or a mixture with accreted hydrogen from the protoplanetary nebula. Despite being able to find solutions for different parameter combinations, our results favor a low-activity Sun with possibly a small amount of residual H from the protoplanetary nebula. In other cases too much CO_2 is lost during evolution, which is inconsistent with Venus' present atmosphere. A critical issue is likely the time at which the initial steam atmosphere is outgassed.