Title:	Volatile Budget of Young Exoplanets in the Habitable Zone of M-Stars
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Keywords:	Planetary Evolution Model Equilibrium Partitioning Core Segregation
Issue Date:	May-2024
Publisher:	IISER Mohali
Abstract:	The extended duration of the pre-main sequence of M-Stars, characterized by rapid cooling, suggests that a considerable portion of the early evolution of exoplanets within the habitable zone, at a stellar age equivalent to our Sun, would occur in a runaway greenhouse state. During this period, the differences in magma ocean lifetimes and strength of X-Ray and extreme-ultraviolet-driven hydrodynamic winds would result in a diverse range of volatile (specifically Hydrogen, Nitrogen and Carbon) compositions on exoplanets orbiting within the inner and outer habitable zone. The significance of mantle volatile trapping becomes evident, as mantle degassing during later geological stages may replenish surface volatiles, thereby rendering previously desiccated planets habitable. In this study, we wish to investigate the factors affecting the magma ocean solidification, which plays a primary role in determining the volatile budget of exoplanets orbiting M-Stars, M-Exoplanets. As a result, we can then study the variety of volatile budgets within the habitable zone of different M-Stars. Since a comprehensive investigation that integrates volatile partitioning, escape, and related processes is yet to be conducted, this study utilizes numerical modeling to examine the transit of volatiles between various reservoirs such as atmosphere, mantle, core, etc., under the influence of exoplanet processes unique to M-Stars. Our results show that the magma ocean solidification rate is determined by the stellar type, distance of M-Exoplanet from star as well as the initial water inventory. We observe a significantly greater abundance of surface and mantle-trapped volatiles in the outer habitable zone in comparison to the more desiccated inner habitable zone planets, due to the higher magma ocean solidification rate in the former case, which allows larger quantities of volatiles to be trapped in the mantle. We also observe drier budgets within the habitable zone on planets orbitting lower mass stars. Since surface volatile compositions can be deduced from spectroscopic data, our model provides valuable insights in understanding and constraining M-Star habitability.
Description:	Under Embargo Period
URI:	http://hdl.handle.net/123456789/5702
Appears in Collections:	MS-19