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# Mass-Radius Contribution of Sub-Neptunian Atmospheres

**Jasmine MacKenzie** (1), Philipp Baumeister (1), Mareike Godolt (1), and Nicola Tosi (1,2)
(j.mackenzie@tu-berlin.de)
(1) Zentrum für Astronomie und Astrophysik, Technische Universität Berlin, Berlin, Germany
(2) Institut für Planetenforschung, Deutsches Zentrum für Luft- und- Raumfahrt, Berlin, Germany

## Abstract

As the number of discovered exoplanets has increased and the methods used to characterize them have improved, more and more focus has been given to how the atmosphere of a transiting planet affects the observed radius. This is especially true for planets with masses $M < 20M_\oplus$ and radii $R < 4R_\oplus$, the so-called sub-Neptunian regime. These planets have densities that can be modeled by a wide variety of interior structures, whose solutions are highly degenerate. Therefore, how one calculates the physical radius of a planet and the contribution by its atmosphere to the measured transiting radius is of great importance to the study and characterization of exoplanets.

For planets that can be modeled with an extended atmosphere, which includes many sub-Neptunes, small differences in atmospheric mass can result in a large contribution to the radius, particularily if the atmosphere mainly consists of hydrogen and helium accreted during its formation. The atmospheric composition affects the measured transit radius, which is defined as where the atmosphere becomes optically thick for a given wavelength. Therefore, the variation in planetary radius at different wavelengths could then be used to infer the atmospheric composition.

In the literature, there are many different approaches for calculating the radius contribution of an atmosphere in interior structure modelling. We will review these approaches and investigate the influence of the paramters used. We will further more compare different approaches used to evaluate the potential atmospheric escape as a first step in determining whether the planets hold a primodial or secondary atmosphere. In particular, the importance of stellar models in the X-ray and EUV regiem, and how the composition of the primoridal atmosphere affects the planetary surface and interior, which in turn will affect the composition of the secondary atmosphere.

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