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Implications of (Less) Accurate Mass-Radius-Measurements for the Habitability of Extrasolar Terrestrial Planets: Why Do We Need PLATO?

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Several space missions (CoRoT, Kepler and others) already provided promising candidates for terrestrial exoplanets (i.e. with masses less than about 10 Earth masses) and thereby triggered an exciting new research branch of planetary modelling to investigate the possible habitability of such planets. Earth analogues (low-mass planets with an Earth-like structure and composition) are likely to be found in the near future with new missions such as the proposed M3 mission PLATO.

Planets may be more diverse in the universe than they are in the solar system. Our neighbouring planets in the habitable zone are all terrestrial by the means of being differentiated into an iron core, a silicate mantle and a crust. To reliably determine the interior structure of an exoplanet, measurements of mass and radius have to be sufficiently accurate (around +/-2% error allowed for the radius and +/-5% for the mass). An Earth-size planet with an Earth-like mass but an expected error of $\sim$15% in mass for example may have either a Mercury-like, an Earth-like or a Moon-like (i.e. small iron core) structure [1,2]. Even though the atmospheric escape is not strongly influenced by the interior structure, the outgassing of volatiles and the likeliness of plate tectonics and an ongoing carbon-cycle may be very different. Our investigations show, that a planet with a small silicate mantle is less likely to shift into the plate-tectonics regime, cools faster (which may lead to the loss of a magnetic field after a short time) and outgasses less volatiles than a planet with the same mass but a large silicate mantle and small iron core.

To be able to address the habitability of exoplanets, space missions such as PLATO, which can lead up to 2% accuracy in radius [3], are extremely important. Moreover, information about the occurrence of different planetary types helps us to better understand the formation of planetary systems and to further constrain the Drake's equation, which gives an estimate of the expected number of potentially habitable exoplanets in the universe.

References

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