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Mass-radius relations of terrestrial-type extrasolar planets

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The discovery of terrestrial-type exoplanets relies on current detection limits of ground-based observational methods. Mass and radius of small planets transiting their host stars are provided by radial velocity and photometric observations. Structural models of solid exoplanet interiors are then constructed by using equations of state (EoS) for the radial density distribution, which are compliant with the thermodynamics of the high-pressure limit. Model calculations for different EoS and fixed bulk compositions indicate that the trade-off in calculated planetary radius will be much smaller than typical measurement uncertainties from transit photometry. Nevertheless, planetary mass and radius impose equally important constraints on model planets as massive as the Earth, whereas in the upper mass range structural models are chiefly constrained by precise determinations of planetary radius. For planets more massive than 10 Earth masses, ground-based surveys with measurement uncertainties of ±10 % would suffice to distinguish between the principal classes of low-mass exoplanets. In the intermediate mass range from 5 to 10 Earth masses, space telescopes like CoRoT and Kepler with measurement uncertainties of ±5 % are well suited to distinguish between terrestrial-type and atmosphere enshrouded, water-rich ocean planets. For solid exoplanets of Earth's size, however, future space missions such as PLATO, combined with equally precise mass determinations, are needed to reliably deduce planetary bulk compositions. This implies that mass-radius relationships are robust and can be used for the classification of extrasolar planets and their characterization in terms of bulk composition.