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Potential Biosignatures in Super-Earth atmospheres

H. Rauer (1,2), S. Gebauer (2), Ph. v. Paris (1), J. Cabrera (1), M. Godolt (2), J. L. Grenfell (2), A. Belu (3), F. Selsis (3), P. Hedelt (3)

(1) Institut für Planetenforschung, DLR, Berlin, (2) Technische Universität Berlin, (3) Laboratoire d'Astrophysique de Bordeaux, Univ. Bordeaux

Abstract

We study terrestrial exoplanets around different classes of M dwarfs to analyze the potential for the detection of possible biomarker molecules with a JWST-aperture telescope during planet transits. We focus on the study of Earth analogue systems since Earth is the only proto-type of a habitable planet with biosphere which we know.

1. Introduction

While the number of known extrasolar planets is steadily increasing, recent years have marked the beginning of a new phase of our understanding of exoplanets due to the spectroscopic determination of their atmospheric composition. Atmospheres of hot extrasolar giant gas planets have already been investigated by UV, optical and IR spectroscopy methods. In future, spectroscopy of large, terrestrial planets ("super-Earths"), in particular planets in the habitable zone of their parent star, will be a major goal of investigation. In this study we present numerical model simulations of Earth-like hypothetical terrestrial exoplanets around M dwarfs to investigate conditions of habitability and the detection of possible biomarker molecules.

2. Models and tools

We use a 1D coupled climate and chemistry model to calculate mean atmospheric conditions of Earth-like terrestrial exoplanets (Segura et al. 2003, Grenfell et al. 2007). Different central stars are considered, from M0 to M7. Temperature-pressure profiles are calculated as well as atmospheric abundance ratios. Finally, the spectral appearance of the planets is simulated using a line-by-line radiative transfer model (Schreier et al. 2003) and the signal-to-noise ratios are calculated for a photon-limited 6.5m-aperture telescope.

3. Summary

Results (Rauer et al., submitted to A&A) suggest that the different spectral energy distribution of M dwarfs has a potentially large effect on the atmospheric T-p-profiles and on the chemical profiles of various molecules such as H_2O, CH_4, O_3, N_2O and HNO_3. Spectral detection of biomarker molecules as well as atmospheric CO_2 may be possible for super-Earth planets around cool M dwarfs with a 6.5m aperture telescope for transiting exoplanets, if observations of several transits can be co-added.

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