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Detection feasability of an early Earth as an exoplanet

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The search for Earth-like exoplanets has become a tremendous part of planetary research. To date, more than 800 exoplanets have been found, but only a few have been characterized. The main part of an exoplanet that can be studied is obviously its atmosphere. There are two principal ways: transit spectroscopy and secondary transit.

The present work aims at evaluating the feasability of detecting non-thermal emissions from an Earth-like exoplanet, due to excitations of species by extreme UV photons and electron impact.

In this first step of a larger project, we focus on the primary Earth atmosphere. This atmosphere was inherited from the solar nebula. It was mainly composed of H and H2. As there is no available model of this atmosphere, we rescaled a Jovian atmosphere model to the early Earth conditions.
We use a set of codes to compute the excitation and emission rates. The first one is a kinetic transport code. Its inputs are the solar EUV flux, the precipitated electrons, the atmospheric composition and the correlative cross sections. It solves a stationary Boltzmann equation and computes the electron stationary flux, the different ion states productions and excited neutrals. From these outputs, we compute the emission rates through spontaneous deactivation. Finally, we use a radiative transfer code to compute the emission rate of Lyman alpha, which is optically thick. In order to account for the solar emission, we use the prescription proposed by Ribas et al. (2005) out of the Sun in Time program.
We find that the contrast between the early Earth and the Young Sun is around 10-8, very unfavorable for detection purpose.

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