Non conservative Rayleigh scattering. A perturbative approach

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Abstract

The continuous spectrum of stellar and planetary atmospheres may be linearly polarized by Rayleigh or Thomson scattering. If the scattering process is the only source of continuous absorption, the scattering is conservative since all the absorbed photons are reemitted, and the polarization can be described by the Chandrasekhar's law. If true absorptions, due to e.g. bound-free transitions, are also contributing to the continuous absorption coefficient, the scattering becomes non conservative and the polarization decreases.

It will be shown that deviations from the Chandrasekhar's law due to true absorptions can be derived from a perturbation analysis of the polarized radiation field, using as expansion parameter the ratio k c/(k c + s c), with k c and s c the true and scattering absorption coefficients. The perturbation analysis is based on the introduction of an optical depth, rescaled by the thermalization length, and on the description of the radiation field as the sum of an interior field depending only on the rescaled optical depth and a boundary layer contribution going to zero in the interior.

The predictions of the perturbation analysis will be compared to numerical solutions of the full radiative transfer equation for a range of values of the expansion parameter between 10(-10) and 10(-2).

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