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The atmospheric escape at Mars: complementing the scenario

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In the recent years, the presence of dications in the atmospheres of Mars, Venus, Earth and Titan has been modeled and assessed. These studies also suggested that these ions could participate to the escape of the planetary atmospheres because a large fraction of them is unstable and highly ener- getic. When they dissociate, their internal energy is transformed into kinetic energy which may be larger than the escape energy.
This study assesses the impact of the doubly-charged ions in
the escape of CO_2-dominated planetary atmospheres and to compare it to
the escape of thermal photo-ions.We solve a Boltzmann transport equation at daytime taking into account the dissociative states of CO++ for a simplified single constituent atmosphere of a 2
case-study planet. We compute the escape of fast ions using a Beer-Lambert approach.
We study three test-cases. On a Mars-analog planet in today's conditions, we retrieve the measured electron escape flux. When comparing the two mechanisms (i.e. excluding solar wind effects, sputtering ...), the escape due to the fast ions issuing from the dissociation of dications may account for up to 6% of the total and the escape of thermal ions for the remaining. We show that these two mechanisms cannot explain the escape of the atmosphere since the magnetic field vanished but complement the other processes and allow writing the scenario of the Mars escape. We show that the atmosphere of a Mars analog planet would empty in another giga years and a half. At Venus orbit, the contribution of the dications in the escape rate is negligible.When simulating the hot Jupiter HD209458b, the two processes cannot explain the measured escape flux of C+.