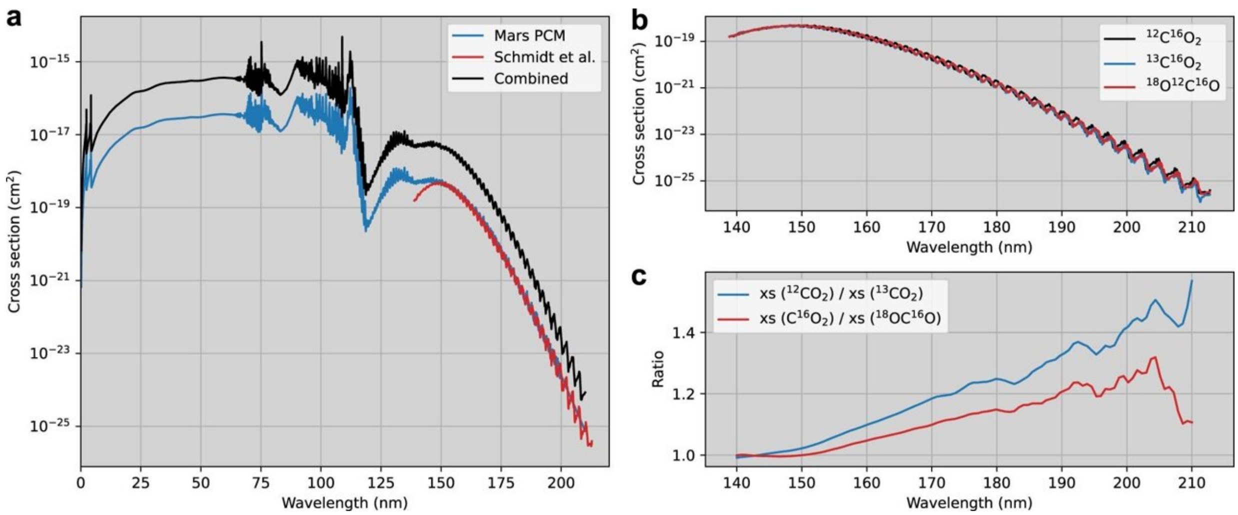
Space scientists provide new insight into the evolution of Mars' atmosphere

May 12 2023, by Laura Bandell



Summary of the photolysis cross sections used in the study. Panel a shows a comparison between the cross sections tabulated in the Mars PCM (blue line) and those calculated by Schmidt et al (red line) at 295 K. In addition, the combined cross sections used in this study are shown with a x10 offset (black line). Panel b shows the cross sections calculated by Schmidt et al for the different isotopologues. Panel c shows the ratio between the cross sections of the major and minor isotopes, convolved with a Gaussian function with a FWHM of 2.5 nm to smooth out high frequency variations. Credit: *Nature Astronomy* (2023). DOI: 10.1038/s41550-023-01974-2

Scientists at The Open University (OU) have analyzed isotopic measurements in the atmosphere of Mars, providing new information on the evolution of the Martian climate throughout history and the origin of surface organics on Mars.

The atmosphere of Mars, which is mostly made of carbon dioxide (CO_2), is relatively enriched in "heavy" carbon (^{13}C) with respect to Earth due to the preferential escape of "light" carbon (^{12}C) to space over several billion years.

Scientists from the OU's Atmospheric Research and Surface Exploration group have analyzed data from the ExoMars Trace Gas Orbiter (TGO) mission, which indicate that Martian carbon monoxide (CO) is depleted in heavy carbon instead.

Dr. Juan Alday, lead author of the study which is published in *Nature Astronomy*, explains, "The key for understanding why there is less ^{13}C in CO lies in the chemical relationship between CO_2 and CO. When CO_2 molecules are destroyed by sunlight to form CO, $^{12}CO_2$ molecules are more efficiently destroyed than $^{13}CO_2$, leading a depletion of ^{13}C in CO over long periods of time."

Despite the small amount of CO in the atmosphere of Mars (less than 0.1%), these new measurements have important implications to our understanding of the evolution of the Martian climate and can help determine the historical climate conditions that enabled the presence of liquid water on the surface of early Mars.

Dr. Alday commented, "We do not know what the atmosphere of early Mars was like nor what conditions allowed liquid water to flow on the surface. The isotopes of carbon on Mars' atmosphere can help us estimate how much CO_2 there was in the past.

"The new measurements by the ExoMars TGO suggest that less CO_2 has escaped the planet than previously thought and provide new constraints on the composition of this early atmosphere of Mars."

Recent measurements made by NASA's Curiosity Rover on the surface revealed a depletion of ^{13}C in surface organic material.

Manish Patel, who leads the OU ExoMars research group, said, "There is a long-standing debate on whether organic material on the surface of Mars was produced by biological or non-biological processes.

"The fact that both atmospheric CO and surface organics share this ^{13}C-depleted isotopic signature that Juan has measured may indicate these organics are more likely to be non-biological in origin, although other origins cannot be ruled out based solely on this information."

More information: Juan Alday et al, Photochemical depletion of heavy CO isotopes in the Martian atmosphere, *Nature Astronomy* (2023). DOI: 10.1038/s41550-023-01974-2

Provided by The Open University