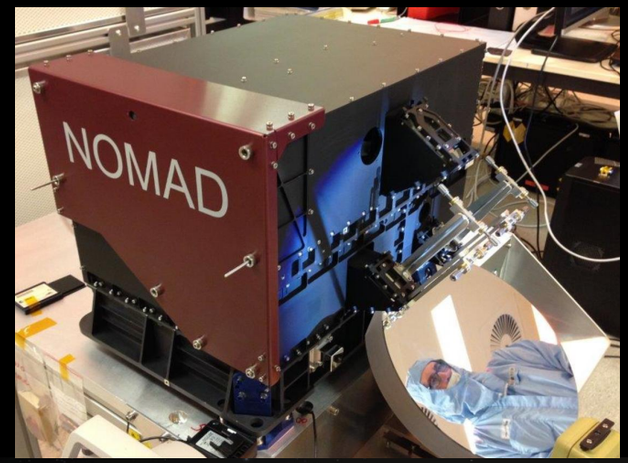
Using Hydrogen to Follow the Journey of Water on Mars

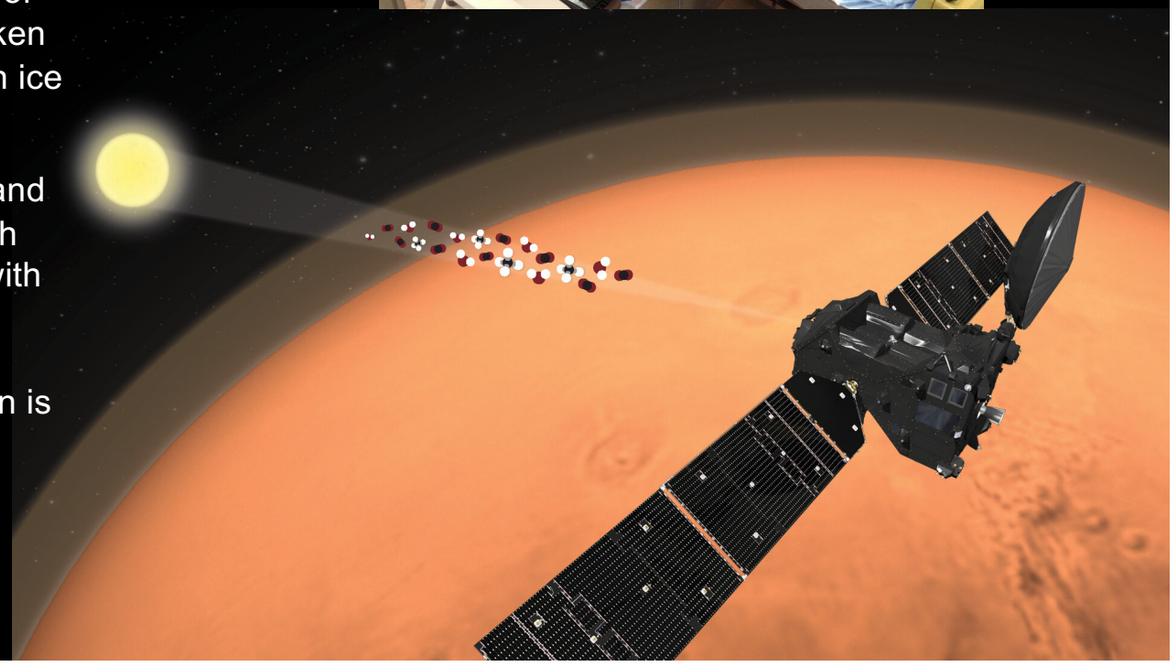
We are exploring new details of the history and of the presence of water on Mars. At what point of its history, if ever, did Mars had enough water to be considered habitable?

To understand how Mars lost its water over time, we have a powerful tool in the ratio of regular Hydrogen and its heavier version, deuterium. Deuterium has an extra neutron and more mass, so less escapes to space. Over time, the more water lost, the more deuterium there is compared to Hydrogen (D/H).

Using observations from the NOMAD instrument suite aboard ESA's ExoMars Trace Gas Orbiter and ground-based observations, we were able to obtain both global and vertical measurements of D/H, creating the first 3D seasonal view of how water rises into and escapes from the Martian atmosphere. Data was taken over several events, including a global dust storm, summer over the Southern ice cap, and an intense local dust storm.

Interestingly, we observed dramatic variability in the D/H ratio across terrain and seasons, as well as evidence that different "reservoirs" of water on Mars, each with its own distinct D/H ratio (such as polar ice and water in rocks) interact with each other. We also demonstrated that water loss is accelerated during dust events and during southern summer. The data suggest that Mars undergoes periods of active water cycles, which can be millions of times more active than is currently observed.





G. L. Villanueva, G. Liuzzi, M. M. J. Crismani, S. Aoki, A. C. Vandaele, F. Daerden, M. D. Smith, M. J. Mumma et al., Water heavily fractionated as it ascends on Mars as revealed by ExoMars/NOMAD. Sci. Adv. 7(7), (2021).