Venus' sulfuric acid clouds cool enough to host RNA and DNA bases, says study

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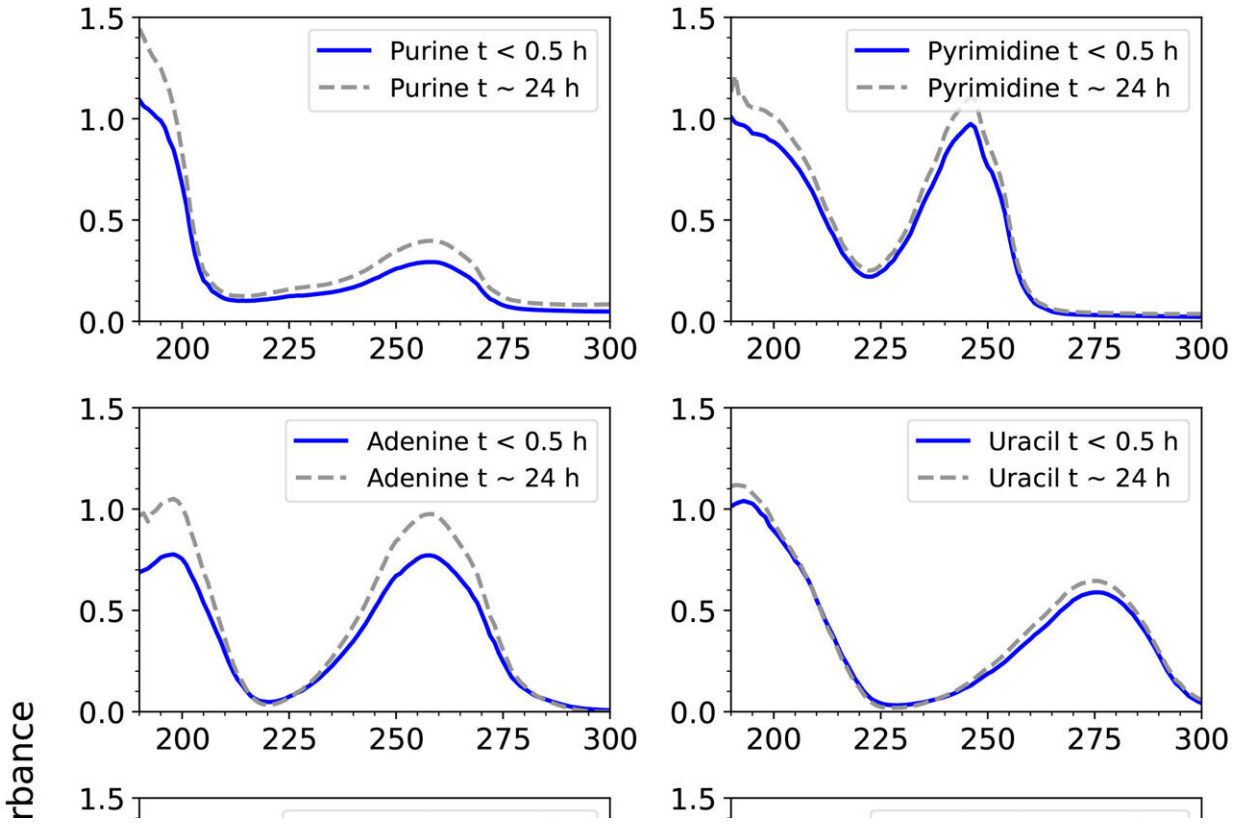

UV spectroscopy of the eight compounds studied in 98% w/w sulfuric acid. The absorbance, defined as A = εLc, where *A* is absorbance (dimensionless), ε is the molar absorption coefficient (in units of $M^{-1}cm^{1}$), L is pathlength (in cm), and c is concentration (in units of M), as a function of wavelength. Each compound shows two characteristic UV peaks, due to π-π conjugated bonds. The blue line shows the UV spectrum measured within about 15 to 20 min after mixing of the compound in 98% w/w H_2SO_4 in H_2O and the gray dashed line is the same compound measured after about 24 h. While some compounds have a higher

absorbance due to more dissolution over the 24 h, the same peak wavelength maximum and peak shape demonstrates stability of each compound in 98% w/w sulfuric acid. Credit: *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2220007120

A team of chemists, biologists and planetary scientists from MIT, Nanoplanet Consulting, Harvard University and the University of Alberta has found via lab experimentation that conditions in Venus' clouds are possibly conducive to hosting life. In their paper published in *Proceedings of the National Academy of Sciences*, the group describes experiments they conducted in their lab and their results.

Prior research has shown that the surface of Venus averages approximately 462°C, much too hot to support life. However, the planet's atmosphere is much cooler, particularly in its clouds—temperatures there are just 30°C to 70°C, well within a range that could support life. But such clouds are composed of sulfuric acid, which are far more acidic than any clouds found on Earth. Still, the possibility that life could exist in such an environment intrigued the research team. They set up experiments to determine whether RNA and/or DNA bases could survive in such an environment.

The experiments involved exposing nucleic acid bases such as cytosine, adenine, thymine, guanin and uracil to chemical conditions similar to those believed to exist in Venusian clouds. The then did the same with pyrimidine and purine nucleic acid base cores and to 2,6-diaminopurine. They then tested the stability of the acid bases using NMR and UV spectroscopy. They found that the acid bases remained stable under such conditions and remained so for up to two weeks—by extension, this meant that they could do the same in Venusian clouds.

The researchers suggest their findings might be shocking to planetary scientists, but doubt many chemists would be surprised. They note that it is common knowledge that refining oil involves the use of concentrations of sulfuric acid, resulting in the production of organic compounds, some of which are aromatic molecules. They suggest that space scientists looking for life elsewhere in the universe may have to expand their possible targets to include the atmospheres of planets, not just their surfaces.

More information: Sara Seager et al, Stability of nucleic acid bases in concentrated sulfuric acid: Implications for the habitability of Venus' clouds, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2220007120