Rapidly Varying Coma of Comet Wirtanen Revealed by ALMA

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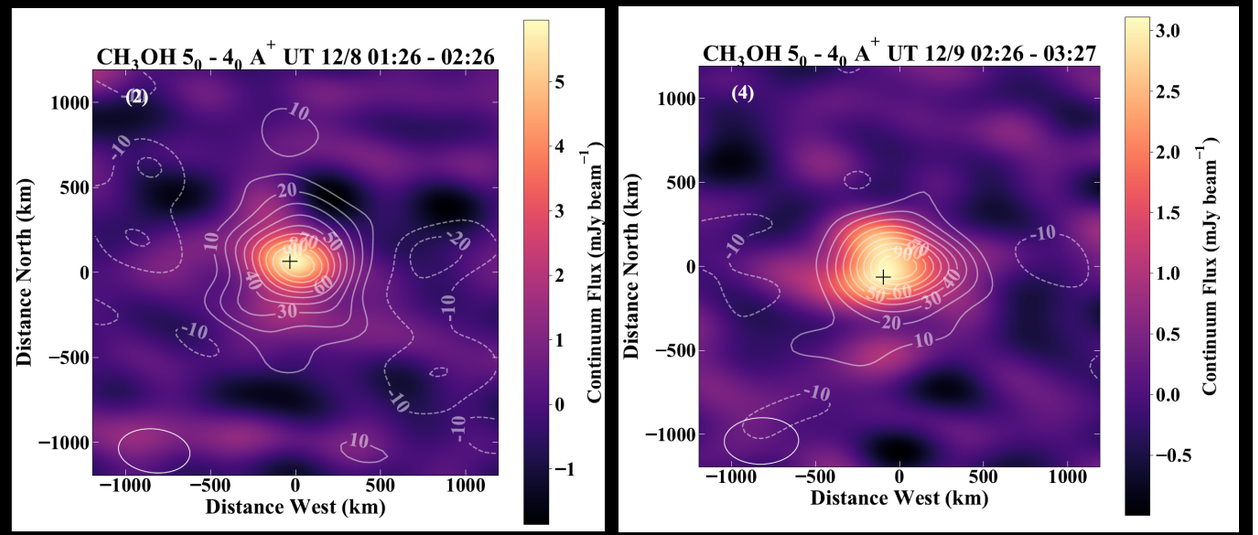
Comets are “fossils” from the early solar system; determining their compositions helps us to understand not only the formation of planets, but also the source of water and prebiotic molecules delivered to the early Earth. In December 2018, comet 46P/Wirtanen passed within 30 lunar distances of the Earth, providing one of the best chances in a decade to study clues to solar system formation imprinted in the ices of its nucleus.

We observed comet 46P with the Atacama Compact Array (ACA) at the Atacama Large Millimeter Array (ALMA), as part of a coordinated multi-wavelength campaign involving investigators at NASA GSFC and elsewhere. We detected methanol (CH_3OH) in the coma of comet 46P, revealing an unexpectedly non-uniform distribution (anisotropy) of outgassing around the nucleus. Furthermore, we found that this anisotropy varied with time on the scale of minutes. This work represents the first reported detection of cometary volatiles using the ACA.

Further analysis of the shapes of the spectra suggested that the variations are tied to the comet’s rotation, with changes in outgassing occurring as active sites on its elliptical nucleus rotated into or out of the sunlight. The spectra also suggested that methanol was produced at higher rates on the sun-facing side, perhaps from icy dust grains in the coma. This work demonstrated the exceptional capabilities of the ACA for time-resolved measurements of comets such as 46P/Wirtanen.



ALMA map of methanol emission (contours) and continuum (color map) in the coma of comet 46P/Wirtanen. Two observations show asymmetric profiles that are likely tied to the rotation of the comet’s nucleus.

The antennas of the Atacama Large Millimeter/ submillimeter Array (ALMA) against a starry night sky. ESO/B. Tafreshi (twanight.org)

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