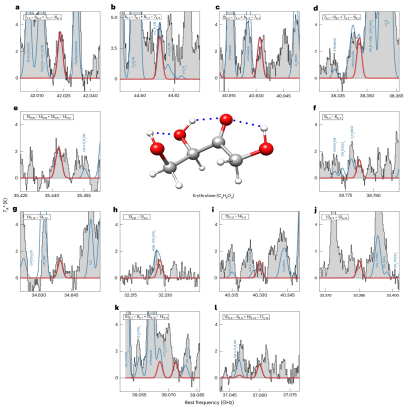
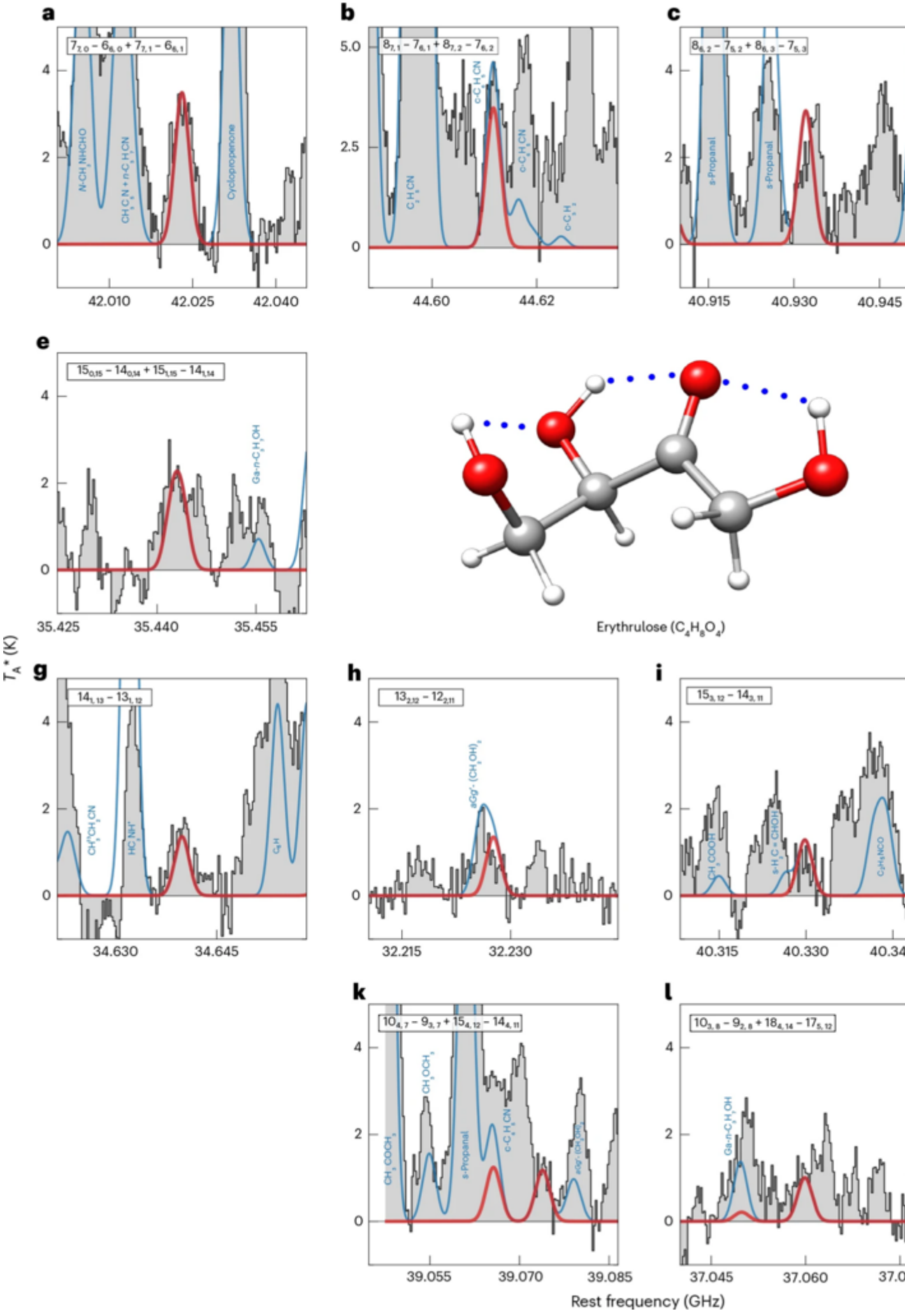


Detection of a four-carbon sugar (erythrulose) in interstellar space

Description

Sugars are essential biomolecules, serving as metabolic fuels, components of nucleic acid backbones, and structural or energy-storage polymers. A central question in origin-of-life research is how monosaccharides formed on the primitive Earth, as laboratory experiments under prebiotic conditions yield insufficient concentrations. The detection of ribose, glucose, and other monosaccharides in asteroids and meteorites suggests an exogenous origin, possibly in the interstellar medium (ISM) before meteoritic parent-body formation. However, no sugar has been observed in the ISM to date. Here the authors report the discovery of erythrulose, a chiral four-carbon ketose. Erythrulose, with 14 atoms in its structure, represents the largest non-cyclic molecular species identified so far. The detection was achieved through ultrasensitive, broadband spectral surveys of the Galactic Center molecular cloud G+0.693â??0.027, using the Yebes 40â??m and IRAM 30â??m telescopes. Erythrulose appears to be at least eight times more abundant than analogous three-carbon sugars, which remain undetected in our ultrasensitive observations. Quantum chemical and astrochemical models indicate that erythrulose forms efficiently on interstellar dust grains from simpler two-carbon aldehydes and alcohols. As ketoses readily isomerize into aldoses under aqueous conditions, interstellar erythrulose could have contributed to the sugar inventory available for early metabolic and replication processes.


a
b
c
e
g
h
i
k
l
Erythrulose ($C_4H_8O_4$)
T_A^* (K)
Rest frequency (GHz)

Filled histograms report the observed spectra; red lines show the line profiles of the erythrulose transitions fitted with MADCUBA-SLIM, and blue lines present the total fit to the spectra considering all the molecules identified towards the cloud. The intensity of the observed spectra is shown in units of antenna temperature, T_A*. The quantum numbers of each transition of erythrulose are given in the upper part of each graph. Blue labels indicate the molecular species contributing to the observed spectra in the vicinity of the erythrulose lines. The transitions are sorted from the brightest to the weakest lines according to the LTE model.

Category

1. News