ASTROCHEMISTRY OF SOLAR SYSTEM PRECURSORS: THE MISSING EVIDENCE OF LARGE CARBON CHAINS

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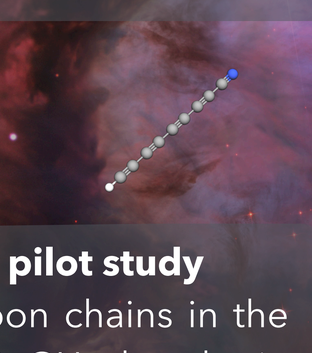
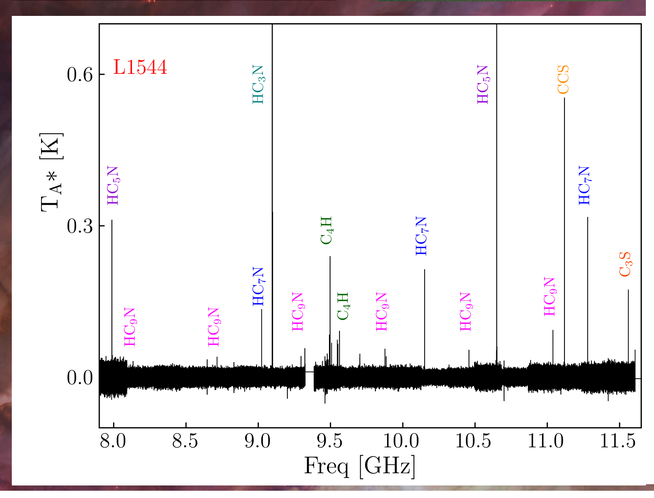
ABSTRACT

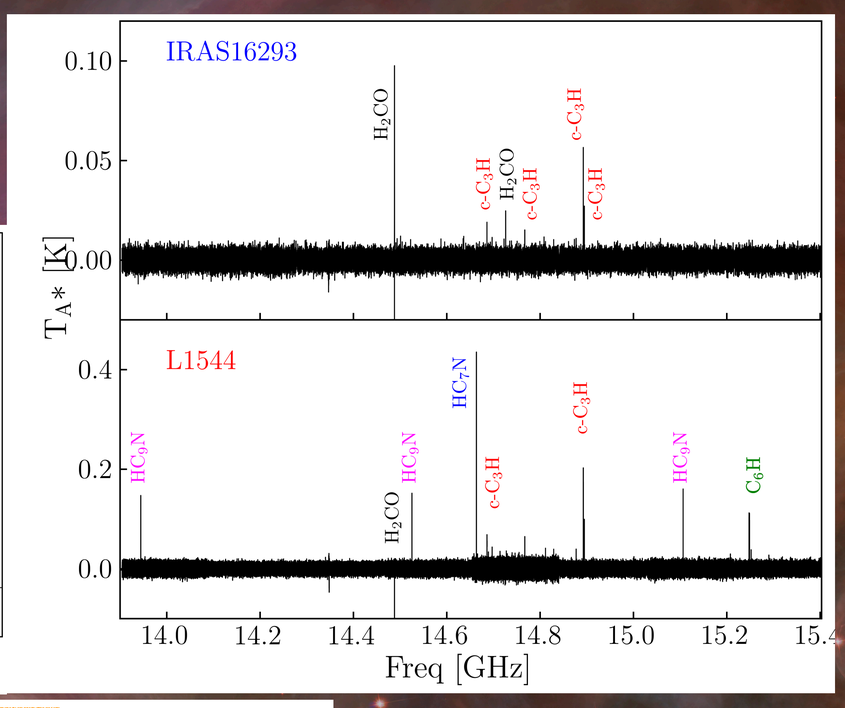
The vast majority of the observations dedicated to explore the chemical variety of solar-type protostars has been obtained via (sub-) millimeter telescopes, where several relatively light molecules, such as interstellar complex organic molecules (iCOMs) or the small carbon chains have their peak of emission. In contrast, lines of heavy molecules (e.g. chains and rings with more than seven C-atoms) at mm wavelengths are substantially weaker. Their observation could add an important piece of the overall puzzle as they might have a crucial role in the heritage of organic material from the pre- and proto- stellar phase to the objects of the newly formed planetary system, like asteroids and comets (e.g. Mumma & Charnley 2011, McGuire et al. 2020).

GREEN BANK TELESCOPE pilot study

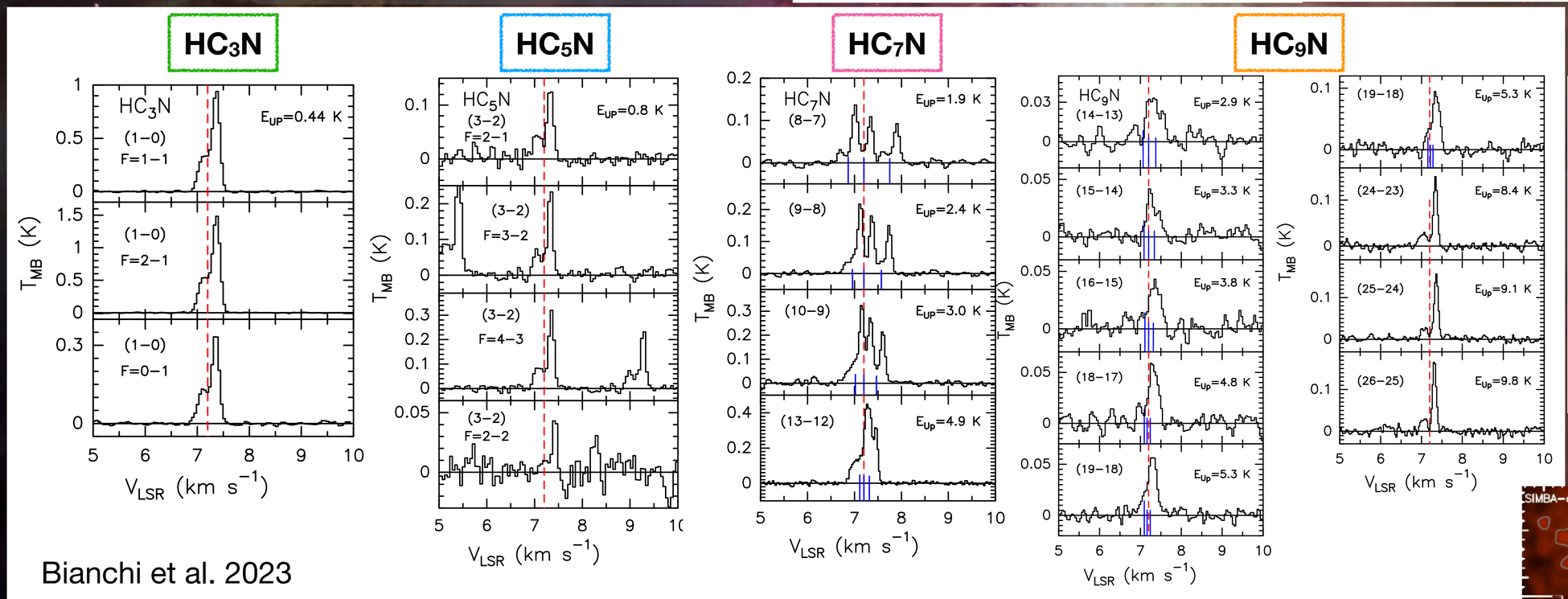
We observe several crucial carbon chains in the 8.0 – 11.5 GHz and 14.0–15.4 GHz bands, in L1544 and IRAS16293-2422, which are the two archetypes of prestellar cores and protostars, respectively. GBT observations reveal richness of C-chains (e.g. C_4H, C_6H, HC_7N, HC_9N, C_3S) and a chemical differentiation between the two sources at large angular scales (Bianchi et al. 2023).





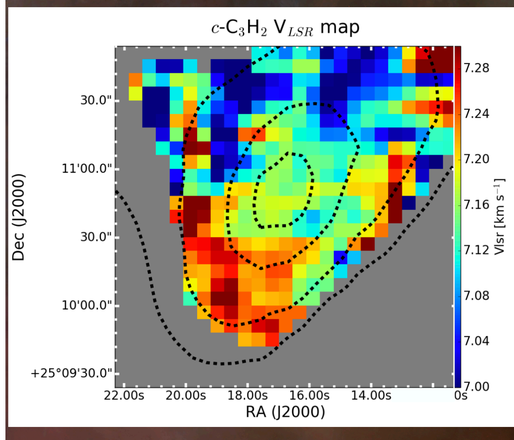


CYANOPOLYYNES IN L1544

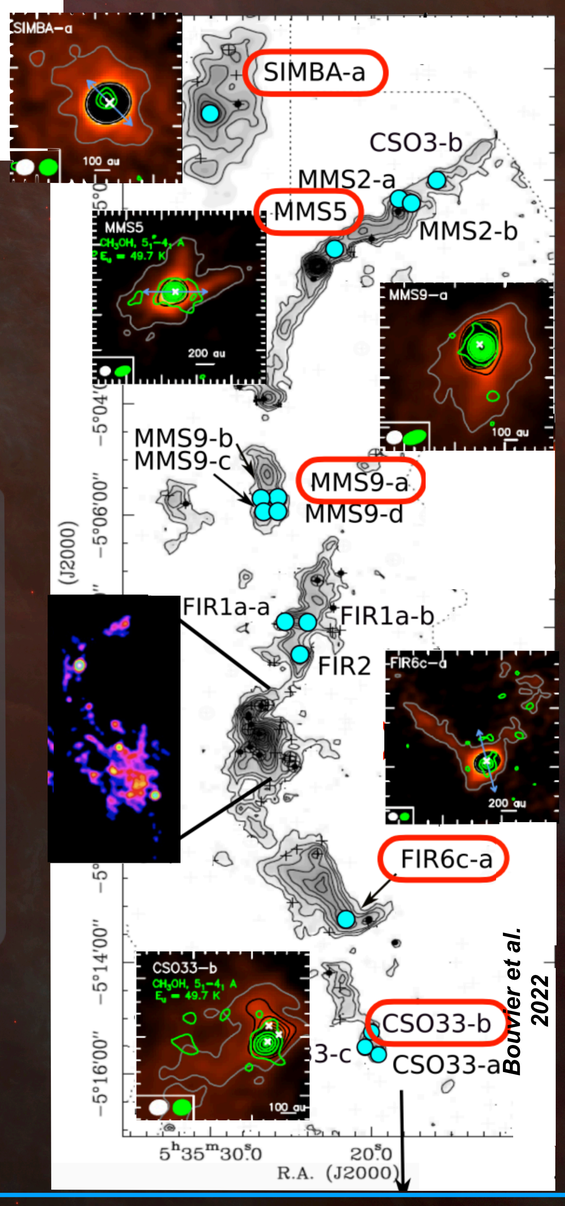


Bianchi et al. 2023

Spezzano et al. 2016



We performed a non-LTE LVG analysis of cyanopolyynes using new estimation of the collisional coefficients. Cyanopolyynes emission is dominant in the outer layers of the core (size =80", T_{kin}= 7.5 K, $n_{H2} \geq 100$ cm^{-3}). The red-shifted line profiles suggests emission from the southern part of the core, where free carbon is released in the gas -phase by UV illumination. The $HC_5N/HC_7N/HC_9N$ abundance ratios are 1/6/4 in L1544, lower by a factor 2-5 than those measured in TMC-1.



SKA will be able to investigate if **large carbon chains and iCOMs coexist in the planets formation region.**

We develop a **SKA1-MID Scientific Use case in the framework of the Cradle Of Life working group,** to observe the Orion molecular cloud (OMC) 2 region. We propose to image the spatial distribution of carbon chains in Band 5 at angular scales of 0.5" (corresponding to ~ 200 au). This will perfectly complement the already performed ALMA iCOMs, probing the hot corino sources, e.g. ORANGES (Bouvier et al. 2022).

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REFERENCES

Bianchi, E., Remijan, A., Codella, C., et al. 2023, ApJ, 944,208; **Bouvier, M.**, Ceccarelli, C., López-Sepulcre, A., et al. 2022, ApJ, 929,10; **Mumma, M. J.,** & Charnley, S. B. 2011, ARA&A, 49, 471; **McGuire, B. A.,** Burkhardt, A. M., Loomis, R. A., et al. 2020, ApJL, 900, L10 ; **Spezzano, S.,** Bizzocchi, L., Caselli, P., Harju, J., & Brunken, S. 2016, A&A, 592, L11

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