

# Anion Chemistry in the Cold Cloud TMC-1

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Carbon-chain negative ions have been seen in various sources. The  $C_nH^-$  family ( $n=4,6,8$ ) has been detected in IRC+10216 ( $C_4H^-$ ,  $C_6H^-$ ,  $C_8H^-$ , and the possible detection of  $C_2H^-$ ), TMC-1 ( $C_6H^-$  and  $C_8H^-$ ), and L1527 ( $C_4H^-$  and  $C_6H^-$ ). The  $C_nN^-$  family ( $n=3,5$ ) was also detected in IRC+10216<sup>1</sup>. Following the previous study of Millar et al. (2007)<sup>2</sup>, we investigated in more detail the effect of anions in interstellar chemistry in the cold cloud TMC-1. Since some anion reactions become major formation reactions for longer carbon-chain species, anions enhance the predicted abundances of the  $C_n$ ,  $C_nH$ ,  $C_nH_2$ , and cyanopolyne families. Anions may explain the observed abundances of cyanopolyynes, which were under-produced in the model without them. Some hydrocarbon species may be over-produced with anions. A higher carbon-to-oxygen elemental abundance ratio than the standard one produces even higher abundances of longer carbon-chain species, making longer chains more abundant than shorter chain species. It has been claimed that the presence of PAH molecules allows a fair agreement with observation even for so-called high-metal elemental abundances, which typically do not allow molecular growth<sup>3</sup>. The reason is that the production of negatively charged PAHs contrains the free electron abundance; otherwise, an excess electron abundance suppresses some species. For the model with carbon-chain anions but no PAHs, high-metal elemental abundances are still inconsistent with molecular growth.

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<sup>1</sup>See Cernicharo et al. 2008, *ApJ*, in press, for  $C_5N^-$  and  $C_2H^-$ . For other species, see Harada & Herbst *ApJ*, **685**, 272, 2008 for a list of references.

<sup>2</sup>Millar et al. *ApJ*, **662**, L87, 2007

<sup>3</sup>Wakelam & Herbst *ApJ*, **680**, 371, 2008