The effect of carbon grain destruction on the chemical structure of protoplanetary disks

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The bulk composition of the Earth is dramatically carbon poor compared to that of the interstellar medium, and it extends to the asteroid belt (Figure 1). This indicate that carbonaceous component in grains must have been converted into the gas-phase in the inner regions of disks prior to planetary formation. We examine the effect of carbon grain destruction using a chemical reaction network, containing both gas-phase reactions and gas-grain interactions. When carbon grains are destroyed, the elemental abundance of the gas becomes carbon-rich and the abundances of carbon-bearing molecules, such as HCN and carbon-chain molecules, increase dramatically near the midplane, while oxygen-bearing molecules are depleted. We compare the results with the observed solid carbon fraction in the solar system. It shows a carbon depletion gradient with some quantitative discrepancies: the model shows a higher value at the position of asteroid belt and a lower value at the location of the Earth. In addition, using the obtained molecular abundances distributions, coupled with line radiative transfer calculations, it indicate that HCN, $H^{13}CN$ and c-C_3H_2 may be good tracers to examine the effect of carbon grain destruction in the protoplanetary disk by ALMA.

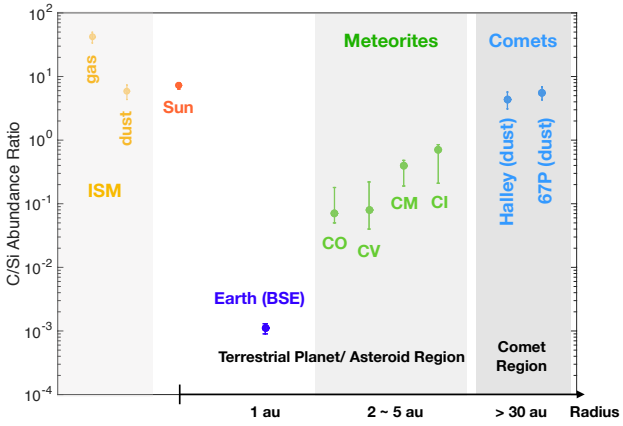

Figure 1: The carbon to silicon abundance ratio with error bars in the protosun [1], Earth, four classes of carbonaceous chondritic meteorites [2], cometary dust of Halley [3] and 67P/C-G [4], and ISM [2].

References

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