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# The chemical diversity and isotopic ratio in comets

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For the last 3 decades, infrared and especially microwave techniques have enabled the detection of up to 26 different parent molecules in the coma of comets. Several molecules have been detected in over 40 different comets. A large diversity of composition is seen in the sample, comprising comets of various dynamical origin. Abundances relative to water for the molecules can vary by a factor 3 to more than 10. The taxonomic study of a sample of comets in which the abundances of several molecules (e.g., HCN, $CH_3OH$, CO, $CH_4$, $C_2H_6$, $H_2S$, $H_2CO$, $CH_3CN$, CS,...) have been measured does not show any clear grouping. Except for fragments of a common parent comet, every comet observed shows a different composition. Isotopic ratios such as $^{13}C/^{12}C$, $^{34}S/^{32}S$, $^{15}N/^{14}N$ and D/H have been measured in some molecules and could also give clues on the origin of cometary ices. In comparison to Earth values, a twofold enrichment in $^{15}N$ is observed and the D/H ratio in water varies between 1x and 4x the Earth oceans value. The absence of any clear correlation between the volatile content and the D/H ratio of the comets and their dynamical origin (Kuiper Belt versus Oort Cloud) suggest that there is no clear dychotomy between two origins for the comets. Their diversity in composition may also suggest that radial and temporal mixing in the early protoplanetary nebula may have played an important role.

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