Correlation of charge on C with $\delta^{13}$C in Earth-surface C-bearing materials

This diagram shows something every Earth-surface geochemist knows: the biological processes that reduce carbon favor the lighter isotope of carbon, so that charge on C and $\delta^{13}$C are correlative in the spectrum from bicarbonate and carbon dioxide to organic matter to methane.

The diagram also shows something a bit more subtle: the same correlation of charge and $\delta^{13}$C exists within organic matter, and presumably even within the organic matter of individual organisms. For both marine organic matter and terrestrial organic matter, lipids carry a more negative charge on C and have a lower $\delta^{13}$C, whereas carbohydrates carry a near-neutral charge on C and have a greater $\delta^{13}$C. Thus the trend across the entire diagram also exists within components of organic matter.

Finally, the same trend exists within inorganic atmospheric carbon (carbon dioxide and carbon monoxide): the less charged form (CO) has the lower $\delta^{13}$C.

Sources:
- Marine DOM data are from Loh et al. (2004, Nature 430: 877-881);
- Patterns for terrestrial plant matter are inferred from Fig. 1-34 of Anderson and Arthur (1983, Stable Isotopes in Sedimentary Geology);
- Details of HCO$_3^-$ are from Kroopnick et al. (1972, Earth and Planetary Science Letters 16: 103-110) and Kroopnick (1985 Deep-Sea Research 32: 57-84);
- CO is from Stevens et al. (1972, Earth and Planetary Science Letters 16: 147-165);
- Details of CO$_2$ are from Attendorn and Bowen (1997, Radioactive and Stable Isotope Geology);
- Methane (and HCO$_3^-$ & CO$_2$) are from Anderson and Arthur (1983, Stable Isotopes in Sedimentary Geology);