We present an investigation of the deuterium nuclear quadrupole coupling in a series of carbonic acids R-COOH: Among those, the acids with the groups R = CH$_3$ and R = CF$_3$ are two extreme cases for substituent effects on the charge distribution at the carboxyl group. The deuterium nuclear quadrupole coupling serves as a sensitive probe for the electric field gradient at the location of the acidic proton. The rotational spectra and the quadrupole coupling hyperfine structures of several R-substituted carbonic acids R-COOH in the range of 6 to 26.5 GHz are reported.

Quantum chemical calculations were performed to determine the nuclear quadrupole coupling tensor of $^2$H. The analysis of the nuclear quadrupole coupling in the rotational spectra provided experimental information on the tensors.