Watching Conformations of Biomolecules: A Microwave Spectroscopy Approach

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Microwave spectroscopy, considered the most definitive gas phase structural probe, can distinguish between different conformational structures since they have unique spectroscopic constants and give separate rotational spectra. However it suffers a serious limitation: it has been limited to molecular specimens having an appreciable vapour pressure. In general, large molecules, in particular those of biological importance, have low vapour pressures and tend to undergo thermal reactions and degradation upon heating, making them out of reach for structural studies in the gas phase. Recently, rotational studies of biomolecules have entered in a new stage with the LA-MB-FTMW experiment. It combines laser ablation with Fourier transform microwave spectroscopy in supersonic jets overcoming the problems of thermal decomposition associated with conventional heating methods. To date different α- and β-amino acids [1] have been studied using this technique, making possible the characterization of their preferred conformations. Even in conformationally challenging systems these can be identified by rotational spectroscopy, as has been illustrated with the assignment of seven low-energy conformers in serine [2] and threonine [1], six in cysteine [3] and aspartic acid [4], and nine in γ-amino butyric (gaba). The nucleic acid bases uracil [5], thymine [6], cytosine and guanine [7] have also been studied and their preferred tautomeric forms determined. Among the neurotransmitters the most stable conformers of ephedras [8] and adrenaline have also been investigated.

This technique has been successfully applied to the study of monosaccarides. Three conformers of the prototype α-D-glucose have been characterized for the first time in the gas phase.

After the first experimental observation of the monohydrated cluster of glycine [9], complexes between amino acids and nucleic acid bases with water have also been investigated to obtain information on the changes induced in the conformational or tautomeric preferences by the addition of solvent molecules.

[1]J.L.Alonso,C.Pérez,M.E.Sanz,J.C.López,S.Blanco,*PCCP*,**11**,617-627(2009)references therein.
[2] S.Blanco, M.E.Sanz, J.C.López,J.L.Alonso,*Proc.Natl.Acad.Sci.USA*,104,20183-20188 (2007).
[3] M.E.Sanz, S.Blanco, J.C.López, J.L.Alonso, *Angew. Chem. Int. Ed.* 47, 6216-6220 (2008).
[4] M.E.Sanz, J.C. López,J.L.Alonso, *PCCP*, 12, 3573-3578 (2010).
[5] V.Vaquero, M. E. Sanz, J.C. López, J. L. Alonso, *J. Phys. Chem. A.*,111, 3443 (2007).
[6] J.C.López, M.I.Peña, M.E.Sanz, J.L.Alonso, *J.Chem.Phys.*,126,191103 (2007).
[7] J.L.Alonso,I.Peña,J.C.López,V.Vaquero, *Angew. Chem. Int. Ed.* 49, 6141-6143 (2009).
[8]J.L.Alonso,M.E.Sanz,J.C.Lopez,V.Cortijo, *J. Am. Chem. Soc.*, 131, 4320-4326 (2009).
[9]J.L.Alonso,E.J.Cocinero,A.Lesarri,M.E.Sanz,J.C.López,*Angew.Chem.Int.Ed.*45,3471 (2006).