

REFERENCES

- Aiba, H., Mizuno, T., and Mizushima, S. (1989). Transfer of phosphoryl group between two regulatory proteins involved in osmoregulatory expression of the *ompF* and *ompC* genes in *Escherichia coli*. *J. Biol. Chem.* *264*, 8563-7.
- Aiba, H., Nakasai, F., Mizushima, S., and Mizuno, T. (1989). Evidence for the physiological importance of the phosphotransfer between the two regulatory components, EnvZ and OmpR, in osmoregulation in *Escherichia coli*. *J. Biol. Chem.* *264*, 14090-14094.
- Altschul, S. F., Madden, T. L., Schäffer, A. A., Zhang, J., Zhang, Z., Miller, W., and Lipman, D. J. (1997). Gapped BLAST and PSI-BLAST: a new generation of protein database search programs. *Nucleic. Acids. Res.* *25*, 3389-3402.
- Archer, S. J., Ikura, M., Torchia, D. A., and Bax, A. (1991). An alternative 3D NMR technique for correlating backbone ^{15}N with side chain H β resonances in larger proteins. *J. Magn. Reson.* *95*, 636-641.
- Bax, A., Clore, M., and Gronenborn, A. M. (1990). ^1H - ^1H correlation via isotropic mixing of ^{13}C magnetization, a New three-dimensional approach for assigning ^1H and ^{13}C spectra of ^{13}C -enriched proteins. *J. Magn. Reson.* *88*, 425-431.
- Bernardini, M. L., Fontaine, A., and Sansonetti, P. J. (1990). The two-component regulatory system ompR-envZ controls the virulence of *Shigella flexneri*. *J. Bacteriol.* *172*, 6274-6281.
- Branden, C., and Tooze, J. (1991). Introduction to protein structure (New York: Garland Publishing, Inc.).
- Braunschweiler, L., and Ernst, R. R. (1983). Coherence transfer by isotropic mixing: application to proton correlation spectroscopy. *J. Magn. Reson.* *53*, 521-528.
- Brissette, R. E., Tsung, K. L., and Inouye, M. (1991). Suppression of a mutation in OmpR at the putative phosphorylation center by a mutant EnvZ protein in *Escherichia coli*. *J. Bacteriol.* *173*, 601-608.
- Brünger, A. T. (1993). X-PLOR Version3.1: A system for X-Ray crystallography and NMR (New Haven, CT: Yale University Press).

- Clore, G. M., Bax, A., and Gronenborn, A. M. (1991). Stereospecific assignment of β -methylene protons in larger proteins using 3D ^{15}N -separated Hartmann-Hahn and ^{13}C -separated rotating frame Overhauser spectroscopy. *J. Biomol. NMR* 1, 13-22.
- Clore, G. M., Gronenborn, A. M., Nilges, M., and Ryan, C. A. (1987). Three-dimensional structure of potato carboxypeptidase inhibitor in solution. A study using nuclear magnetic resonance, distance geometry, and restrained molecular dynamics. *Biochemistry* 26, 8012-8023.
- Delaglio, F., Grzesiek, S., Vuister, G. W., Zhu, G., Pfeifer, J., and Bax, A. (1995). NMRPipe: a multidimensional spectral processing system based on UNIX pipes. *J. Biomol. NMR* 6, 277-293.
- Dutta, R., and Inouye, M. (1996). Reverse phosphotransfer from OmpR to EnvZ in a kinase-/phosphatase+ mutant of EnvZ (EnvZ.N347D), a bifunctional signal transducer of *Escherichia coli*. *J. Biol. Chem.* 271, 1424-1429.
- Egger, L. A., and Inouye, M. (1997). Purification and characterization of the periplasmic domain of EnvZ osmosensor in *Escherichia coli*. *Biochem. Biophys. Res. Commun.* 231, 68-72.
- Egger, L. A., Park, H., and Inouye, M. (1997). Signal transduction via the histidyl-aspartyl phosphorelay. *Genes to Cells* 2, 167-84.
- Feher, V. A., Zapf, J. W., Hoch, J. A., Whiteley, J. M., McIntosh, L. P., Rance, M., Skelton, N. J., Dahlquist, F. W., and Cavanagh, J. (1997). High-resolution NMR structure and backbone dynamics of the *Bacillus subtilis* response regulator, Spo0F: implications for phosphorylation and molecular recognition. *Biochemistry* 36, 10015-10025.
- Feng, J., Atkinson, M. R., McClearly, W., Stock, J. B., Wanner, B. L., and Ninfa, A. J. (1992). Role of phosphorylated metabolic intermediates in the regulation of glutamine synthetase synthesis in *Escherichia coli*. *J. Bacteriol.* 174, 6061-6070.
- Forst, S., Comeau, D., Norioka, S., and Inouye, M. (1987). Localization and membrane topology of EnvZ, a protein involved in osmoregulation of OmpF and OmpC in *Escherichia coli*. *J. Biol. Chem.* 262, 16433-16438.

- Forst, S., Delgado, J., and Inouye, M. (1989). Phosphorylation of OmpR by the osmosensor EnvZ modulates expression of the ompF and ompC genes in *Escherichia coli*. *Proc. Natl. Acad. Sci. USA* 86, 6052-6056.
- Forst, S., Delgado, J., Ramakrishnan, G., and Inouye, M. (1988). Regulation of *ompC* and *ompF* expression in *Escherichia coli* in the absence of *envZ*. *J. Bacteriol.* 170, 5080-5085.
- Forst, S. A., and Roberts, D. L. (1994). Signal transduction by the EnvZ-OmpR phosphotransfer system in bacteria. *Res. Microbiol.* 145, 363-373.
- Garrett, D. S., Powers, R., Gronenborn, A., and Clore, G. M. (1991). A common sense approach to peak picking in two-, three-, and four-dimensional spectra using automatic computer analysis of contour diagrams. *J. Magn. Reson.* 95, 214-220.
- Grzesiek, S., Anglister, J., and Bax, A. (1993). Correlation of backbone amide and aliphatic side-chain resonances in $^{13}\text{C}/^{15}\text{N}$ -enriched proteins by isotropic mixing of ^{13}C magnetization. *J. Magn. Reson. B* 101, 114-119.
- Grzesiek, S., and Bax, A. (1992). Correlating backbone amide and side chain resonances in larger proteins by multiple relayed triple resonance NMR. *J. Am. Chem. Soc.* 114, 6291-6293.
- Guex, N., and Peitsch, M. C. (1997). SWISS-MODEL and the Swiss-PdbViewer: an environment for comparative protein modeling. *Electrophoresis* 18, 2714-2723.
- Hidaka, Y., Park, H., and Inouye, M. (1997). Demonstration of dimer formation of the cytoplasmic domain of a transmembrane osmosensor protein, EnvZ, of *Escherichia coli* using Ni-histidine tag affinity chromatography. *FEBS Lett.* 400, 238-242.
- Hsing, W., Russo, F. D., Bernd, K. K., and Silhavy, T. J. (1998). Mutations that alter the kinase and phosphatase activities of the two-component sensor EnvZ. *J. Bacteriol.* 180, 4538-4546.
- Hsing, W., and Silhavy, T. J. (1997). Function of conserved histidine-243 in phosphatase activity of EnvZ, the sensor for porin osmoregulation in *Escherichia coli*. *J. Bacteriol.* 179, 3729-3735.
- Igo, M. M., Ninfa, A. J., Stock, J. B., and Silhavy, T. J. (1989). Phosphorylation and dephosphorylation of a bacterial transcriptional activator by a transmembrane receptor. *Genes. Dev.* 3, 1725-1734.

- Igo, M. M., and Silhavy, T. J. (1988). EnvZ, a transmembrane environmental sensor of *Escherichia coli* K-12, is phosphorylated in vitro. *J. Bacteriol.* *170*, 5971-5973.
- Ikura, M., Bax, A., Clore, G. M., and Gronenborn, A. M. (1990). Detection of nuclear overhauser effects between degenerate amide proton resonances by heteronuclear three-dimensional nuclear magnetic resonance spectroscopy. *J. Am. Chem. Soc.* *112*, 9020-9022.
- Ikura, M., Clore, G. M., Gronenborn, A. M., Zhu, G., Klee, C. B., and Bax, A. (1992). Solution structure of a calmodulin-target peptide complex by multidimensional NMR. *Science* *256*, 632-638.
- Ikura, M., Kay, L. E., and Bax, A. (1990). A novel approach for sequential assignment of ^1H , ^{13}C , and ^{15}N spectra of proteins: heteronuclear triple-resonance three-dimensional NMR spectroscopy. Application to calmodulin. *Biochemistry* *29*, 4659-4667.
- Ikura, M., Spera, S., Barbato, G., Kay, L. E., Krinks, M., and Bax, A. (1991). Secondary structure and side-chain ^1H and ^{13}C resonance assignments of calmodulin in solution by heteronuclear multidimensional NMR spectroscopy. *Biochemistry* *30*, 9216-9228.
- Inouye, M. (1996). His-Asp phosphorelay. Two components or more? *Cell* *85*, 13-14.
- Jeener, J., Meier, B., Bachmann, P., and Ernst, R. R. (1979). Investigation of exchange processes by two-dimensional NMR spectroscopy. *J. Chem. Phys.* *71*, 4546-4553.
- Kanamaru, K., Aiba, H., and Mizuno, T. (1990). Transmembrane signal transduction and osmoregulation in *Escherichia coli*: I. Analysis by site-directed mutagenesis of the amino acid residues involved in phosphotransfer between the two regulatory components, EnvZ and OmpR. *J. Biochem. (Tokyo)* *108*, 483-487.
- Kato, M., Mizuno, T., Shimizu, T., and Hakoshima, T. (1997). Insights into multistep phosphorelay from the crystal structure of the C-terminal HPT domain of ArcB. *Cell* *88*, 717-723.
- Kay, L. E. (1993). Pulsed-field gradient-enhanced three-dimensional NMR experiment for correlating $^{13}\text{C}\alpha/\beta$, $^{13}\text{C}'$, and $^1\text{H}\alpha$ chemical shifts in uniformly ^{13}C -labeled proteins dissolved in H_2O . *J. Am. Chem. Soc.* *115*, 2055-2057.

- Kay, L. E., and Bax, A. (1990). New methods for the measurement of NH-CaH coupling constants in ^{15}N -labeled proteins. *J. Magn. Reson.* **86**, 110-126.
- Kay, L. E., Ikura, M., Tschudin, R., and Bax, A. (1990). Three-dimensional triple-resonance NMR spectroscopy of isotopically enriched proteins. *J. Magn. Reson.* **89**, 496-514.
- Kay, L. E., Keifer, P., and Saarinen, T. (1992). Pure absorption gradient enhanced heteronuclear single quantum correlation spectroscopy with improved sensitivity. *J. Am. Chem. Soc.* **114**, 10663-10665.
- Kay, L. E., Torchia, D. A., and Bax, A. (1989). Backbone dynamics of proteins as studied by ^{15}N inverse detected heteronuclear NMR spectroscopy: application to staphylococcal nuclease. *Biochemistry* **28**, 8972-8979.
- Kay, L. E., Xu, G. Y., Singer, A. U., Muhandiram, D. R., and Forman-Kay, J. D. (1993). A gradient-enhanced HCCH-TOCSY experiment for recording side-chain ^1H and ^{13}C correlations in H_2O samples of proteins. *J. Magn. Reson. B*, **101**, 333-337.
- King, G. F., Middlehurst, C. R., and Kuchel, P. W. (1986). Direct NMR evidence that prolidase is specific for the trans isomer of imidodipeptide substrates. *Biochemistry* **25**, 1054-1062.
- Kondo, H., Nakagawa, A., Nishihira, J., Nishimura, Y., Mizuno, T., and Tanaka, I. (1997). *Escherichia coli* positive regulator OmpR has a large loop structure at the putative RNA polymerase interaction site [letter]. *Nat. Struct. Biol.* **4**, 28-31.
- Lee, W., Revington, M. J., Arrowsmith, C. H., and Kay, L. E. (1994). A pulsed field gradient isotope-filtered 3D ^{13}C HMQC-NOESY experiment for extracting intermolecular NOE contacts in molecular complexes. *FEBS Lett.* **350**, 87-90.
- Lukat, G. S., Stock, A. M., and Stock, J. B. (1990). Divalent metal ion binding to the CheY protein and its significance to phosphotransfer in bacterial chemotaxis. *Biochemistry* **29**, 5436-5442.
- Madhusudan, M., Zapf, J., Hoch, J. A., Whiteley, J. M., Xuong, N. H., and Varughese, K. I. (1997). A response regulatory protein with the site of phosphorylation blocked by an arginine interaction: crystal structure of Spo0F from *Bacillus subtilis*. *Biochemistry* **36**, 12739-12745.

- Madhusudan, M., Zapf, J., Whiteley, J. M., Hoch, J. A., Xuong, N. H., and Varughese, K. I. (1996). Crystal structure of a phosphatase-resistant mutant of sporulation response regulator Spo0F from *Bacillus subtilis*. *Structure* 4, 679-690.
- Marion, D., Kay, L. E., Sparks, S. W., Torchia, D. A., and Bax, A. (1989). Three-dimensional heteronuclear NMR of ^{15}N -labeled proteins. *J. Am. Chem. Soc.* 111, 1515-1517.
- Matsuyama, S., Mizuno, T., and Mizushima, S. (1986). Interaction between two regulatory proteins in osmoregulatory expression of *ompF* and *ompC* genes in *Escherichia coli*: a novel *ompR* mutation suppresses pleiotropic defects caused by an *envZ* mutation. *J. Bacteriol.* 168, 1309-1314.
- McCleary, W. R., and Stock, J. B. (1994). Acetyl phosphate and the activation of two-component response regulators. *J. Biol. Chem.* 269, 31567-31572.
- Mizuno, T., and Mizushima, S. (1987). Isolation and characterization of deletion mutants of *ompR* and *envZ*, regulatory genes for expression of the outer membrane proteins OmpC and OmpF in *Escherichia coli*. *J. Biochem. (Tokyo)* 101, 387-396.
- Muhandiram, D. R., Farrow, N. A., Xu, G.-Y., Smallcombe, S. H., and Kay, L. E. (1993). A gradient ^{13}C NOESY-HSQC experiment for recording NOESY spectra of ^{13}C -labeled proteins dissolved in H_2O . *J. Magn. Reson.* B102, 317-321.
- Nilges, M. (1995). Calculation of protein structures with ambiguous distance restraints. Automated assignment of ambiguous NOE crosspeaks and disulphide connectivities. *J. Mol. Biol.* 245, 645-660.
- Nilges, M., Clore, G. M., and Gronenborn, A. M. (1988). Determination of three-dimensional structures of proteins from interproton distance data by hybrid distance geometry-dynamical simulated annealing calculations. *FEBS Lett.* 229, 317-324.
- Ninfa, E. G., Atkinson, M. R., Kamberov, E. S., and Ninfa, A. J. (1993). Mechanism of autophosphorylation of *Escherichia coli* nitrogen regulator II (NRII or NtrB): trans-phosphorylation between subunits. *J. Bacteriol.* 175, 7024-7032.
- Nixon, B. T., Ronson, C. W., and Ausubel, F. M. (1986). Two-component regulatory systems responsive to environmental stimuli share strongly conserved domains with the nitrogen assimilation regulatory genes *ntrB* and *ntrC*. *Proc. Natl. Acad. Sci. USA* 83, 7850-7854.

- Park, H., Saha, S. K., and Inouye, M. (1998). Two-domain reconstitution of a functional protein histidine kinase. *Proc. Natl. Acad. Sci. USA* *95*, 6728-6732.
- Parkinson, J. S. (1995). Genetic approaches for signaling pathways and proteins. In *Two-component signal transduction*, J. A. Hoch and T. J. Silhavy, eds. (Washington, D. C.: ASM press), pp. 9-23.
- Pascal, S. M., Muhandiram, D. R., Yamazaki, T., Forman-Kay, J. D., and Kay, L. E. (1994). Simultaneous acquisition of ^{15}N - and ^{13}C -Edited NOE spectra of proteins dissolved in H_2O . *J. Magn. Reson. B* *103*, 197-201.
- Peitsch, M. C. (1996). ProMod and Swiss-Model: Internet-based tools for automated comparative protein modelling. *Biochem. Soc. Trans.* *24*, 274-279.
- Peitsch, M. C. (1995). Protein modeling by e-mail. *Bio. Technol.* *13*, 658-660.
- Powers, R., Garrett, D. S., March, C. J., Frieden, E. A., Gronenborn, A. M., and Clore, G. M. (1992). ^1H , ^{15}N , ^{13}C , and ^{13}CO assignments of human interleukin-4 using three-dimensional double- and triple-resonance heteronuclear magnetic resonance spectroscopy. *Biochemistry* *31*, 4334-4346.
- Russo, F. D., and Silhavy, T. J. (1991). EnvZ controls the concentration of phosphorylated OmpR to mediate osmoregulation of the porin genes. *J. Mol. Biol.* *222*, 567-580.
- Schlosser, A., Hamann, A., Bossemeyer, D., Schneider, E., and Bakker, E. P. (1993). NAD^+ binding to the *Escherichia coli* K(+)-uptake protein TrkA and sequence similarity between TrkA and domains of a family of dehydrogenases suggest a role for NAD^+ in bacterial transport. *Mol. Microbiol.* *9*, 533-543.
- Schroder, I., Wolin, C. D., Cavicchioli, R., and Gunsalus, R. P. (1994). Phosphorylation and dephosphorylation of the NarQ, NarX, and NarL proteins of the nitrate-dependent two-component regulatory system of *Escherichia coli*. *J. Bacteriol.* *176*, 4985-4992.
- Shaka, A. J., Keeler, J., Frenkiel, T. A., and Freeman, R. (1983). *J. Magn. Reson.* *52*, 335-.
- Skarphol, K., Waukau, J., and Forst, S. A. (1997). Role of His243 in the phosphatase activity of EnvZ in *Escherichia coli*. *J. Bacteriol.* *179*, 1413-1416.

- Slauch, J. M., and Silhavy, T. J. (1989). Genetic analysis of the switch that controls porin gene expression in *Escherichia coli* K-12. *J. Mol. Biol.* *210*, 281-292.
- Spera, S., Ikura, M., and Bax, A. (1991). Measurement of the exchange rates of rapidly exchanging amide protons: application to the study of calmodulin and its complex with a myosin light chain kinase fragment. *J. Biomol. NMR* *1*, 155-165.
- Stock, A. M., Martinez-Hackert, E., Rasmussen, B. F., West, A. H., Stock, J. B., Ringe, D., and Petsko, G. A. (1993). Structure of the Mg²⁺-bound form of CheY and mechanism of phosphoryl transfer in bacterial chemotaxis. *Biochemistry* *32*, 13375-13380.
- Stock, J. B., Surette, M. G., Levit, M., and P., P. (1995). Two-component signal transduction systems: Structure-function relationships and mechanisms of catalysis. In *Two-component signal transduction*, J. A. Hoch and T. J. Silhavy, eds. (Washington, D. C.: ASM Press), pp. 25-51.
- Swanson, R. V., Alex, L. A., and Simon, M. I. (1994). Histidine and aspartate phosphorylation: two-component systems and the limits of homology. *Trends. Biochem. Sci.* *19*, 485-490.
- Swanson, R. V., Bourret, R. B., and Simon, M. I. (1993). Intermolecular complementation of the kinase activity of CheA. *Mol. Microbiol.* *8*, 435-441.
- Tanaka, T., Soumitra, K. S., Tomomori, C., Ishima, R., Liu, D., Tong, K. I., Park, H., Dutta, R., Qin, L., Swindells, M., Yamazaki, T., Ono, A. M., Kainosho, M., Inouye, M., and Ikura, M. (1998). NMR structure of the histidine kinase domain of the *E. coli* osmosensor EnvZ. *Nature* *396*, 88-92.
- Tokishita, S., Kojima, A., and Mizuno, T. (1992). Transmembrane signal transduction and osmoregulation in *Escherichia coli*: functional importance of the transmembrane regions of membrane-located protein kinase, EnvZ. *J. Biochem. (Tokyo)* *111*, 707-713.
- Venters, R. A., Farmer II, B. T., Fierke, C. A., and Spicer, L. D. (1996). Characterizing the use of perdeuteration in NMR studies of large proteins: ¹³C, ¹⁵N and ¹H assignments of human carbonic anhydrase II. *J. Mol. Biol.* *264*, 1101-1116.
- Volkman, B. F., Nohaile, M. J., Amy, N. K., Kustu, S., and Wemmer, D. E. (1995). Three-dimensional solution structure of the N-terminal receiver domain of NtrC. *Biochemistry* *34*, 1413-1424.

- Volz, K. (1993). Structural conservation in the CheY superfamily. *Biochemistry* 32, 11741-11753.
- Volz, K., and Matsumura, P. (1991). Crystal structure of *Escherichia coli* CheY refined at 1.7-Å resolution. *J. Biol. Chem.* 266, 15511-15519.
- Vuister, G. W., and Bax, A. (1993). Quantitative J correlation: A new approach for measuring homonuclear three-bond J ($H^N H^{\alpha}$) coupling constants in ^{15}N -enriched proteins. *J. Am. Chem. Soc.* 115, 7772-7777.
- Vuister, G. W., and Bax, A. (1992). Resolution enhancement and spectral editing of uniformly ^{13}C -enriched proteins by homonuclear broadband ^{13}C decoupling. *J. Magn. Reson.* 98, 428-435.
- Wagner, G., Braun, W., Havel, T. F., Schaumann, T., Go, N., and Wüthrich, K. (1987). Protein structures in solution by nuclear magnetic resonance and distance geometry. The polypeptide fold of the basic pancreatic trypsin inhibitor determined using two different algorithms, DISGEO and DISMAN. *J. Mol. Biol.* 196, 611-639.
- Waukau, J., and Forst, S. (1992). Molecular analysis of the signaling pathway between EnvZ and OmpR in *Escherichia coli*. *J. Bacteriol.* 174, 1522-1527.
- Wishart, D. S., Bigam, C. G., Holm, A., Hodges, R. S., and Sykes, B. D. (1995). 1H , ^{13}C , and ^{15}N random coil NMR chemical shifts of the common amino acids. I. Investigation of nearest-neighbor effects. *J. Biomol. NMR* 5, 67-81.
- Wishart, D. S., and Sykes, B. D. (1994). The ^{13}C chemical-shift index: a simple method for the identification of protein secondary structure using ^{13}C chemical-shift data. *J. Biomol. NMR* 4, 171-180.
- Wishart, D. S., Sykes, B. D., and Richards, F. M. (1992). The chemical shift index: a fast and simple method for the assignment of protein secondary structure through NMR spectroscopy. *Biochemistry* 31, 1647-1651.
- Wittekind, M., and Mueller, L. (1993). HNCACB, a High-sensitivity 3D NMR experiment to correlate amide-proton and nitrogen resonances with the α - and β -carbon resonances in proteins. *J. Magn. Reson. B* 101, 201-205.
- Wüthrich, K. (1986). *NMR of proteins and nucleic acids* (New York, USA: John Wiley & Sons).

- Wüthrich, K., Billeter, M., and Braun, W. (1983). Pseudostructures for the 20 common amino acids for use in studies of protein conformations by measurements of intramolecular proton-proton distance constraints with nuclear magnetic resonance. *J. Mol. Biol.* *169*, 949-961.
- Yamazaki, T., Forman-Kay, J. D., and Kay, L. E. (1993). Two-dimensional NMR experiments for correlating ^{13}C and ^1H chemical shifts of aromatic residues in ^{13}C -labeled proteins *via* scalar couplings. *J. Am. Chem. Soc.* *115*, 11054-11055.
- Yang, Y., and Inouye, M. (1991). Intermolecular complementation between two defective mutant signal-transducing receptors of *Escherichia coli*. *Proc. Natl. Acad. Sci. USA* *88*, 11057-11061.
- Yang, Y., and Inouye, M. (1993). Requirement of both kinase and phosphatase activities of an *Escherichia coli* receptor (Taz1) for ligand-dependent signal transduction. *J. Mol. Biol.* *231*, 335-342.
- Yang, Y., Park, H., and Inouye, M. (1993). Ligand binding induces an asymmetrical transmembrane signal through a receptor dimer. *J. Mol. Biol.* *232*, 493-498.
- Zhou, H., Lowry, D. F., Swanson, R. V., Simon, M. I., and Dahlquist, F. W. (1995). NMR studies of the phosphotransfer domain of the histidine kinase CheA from *Escherichia coli*: assignments, secondary structure, general fold, and backbone dynamics. *Biochemistry* *34*, 13858-13870.
- Zhou, H., McEvoy, M. M., Lowry, D. F., Swanson, R. V., Simon, M. I., and Dahlquist, F. W. (1996). Phosphotransfer and CheY-binding domains of the histidine autokinase CheA are joined by a flexible linker. *Biochemistry* *35*, 433-443.
- Zuiderweg, E. R. P., and Fesik, S. W. (1989). Heteronuclear three-dimensional NMR spectroscopy of the inflammatory protein C5a. *Biochemistry* *28*, 2387-2391.
- Zwahlen, C., Legault, P., Vincent, S. J. F., Greenblatt, J., Konrat, R., and Kay, L. E. (1997). Methods for measurement of intermolecular NOEs by multinuclear NMR spectroscopy: application to a bacterio-phage ^1N -peptide/*box* B RNA complex. *J. Am. Chem. Soc.* *119*, 6711-6721.