

Technical Note 1380

Trapped Ions and Laser Cooling IV

Selected publications of the Ion Storage Group of the Time and Frequency Division

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Supported in part by

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January 1996



U.S. DEPARTMENT OF COMMERCE, Ronald H. Brown, Secretary
TECHNOLOGY ADMINISTRATION, Mary L. Good, Under Secretary for Technology
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, Arati Prabhakar, Director

**National Institute of Standards and Technology Technical Note
Natl. Inst. Stand. Technol., Tech. Note 1380, 204 pages (January 1996)
CODEN:NTNOEF**

**U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1996**

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325

PREFACE

This collection of papers represents the work of the Ion Storage Group, Time and Frequency Division, National Institute of Standards and Technology, from May 1992 to January 1996. It follows the collections of papers contained in NBS Technical Note 1086, *Trapped Ions and Laser Cooling* (June 1985), NIST Technical Note 1324, *Trapped Ions and Laser Cooling II* (September 1988), and NIST Technical Note 1353, *Trapped Ions and Laser Cooling III* (April 1992). Although the primary goal of this work has been the development of techniques necessary for achieving high resolution spectroscopy, we have also been able to investigate related areas of research.

Papers listed on page viii were published or prepared during the period May 1992 to January 1996 but are not included here. Copies can be obtained on request. We intend to update this publication periodically to include new work. We hope this collection of papers will be useful to our colleagues in this and related fields.

We acknowledge the contributions of many colleagues to this collection. In particular, we thank Amy Barton, Ed Bell, Dana Berkeland, Flavio Cruz, Dan Dubin, Ulli Eichmann, Jon Gilligan, Phil Gould, Dan Heinzen, Steve Jefferts, Brana Jelenković, Brian King, Dawn Meekhof, John Miller, Fred Moore, Martin Poitzsch, Mark Raizen, Norman Ramsey, Max Rauner, Andy Steinbach, Carl Weimer, and Joseph Tan. We gratefully acknowledge the continued support of the U.S. Office of Naval Research and the U.S. Army Research Office. We thank Wendy Ortega Henderson for assembling this collection.

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Boulder, Colorado
February 1996

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2. "Ionic crystals in a linear Paul trap," M. G. Raizen, J. M. Gilligan, J. C. Bergquist, W. M. Itano, and D. J. Wineland, <i>Phys. Rev. A</i> <u>45</u> , 6493-6501 (1992).	TN-19
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2. "Quantum projection noise: population fluctuations in two-level systems," W. M. Itano, J. C. Bergquist, J. J. Bollinger, J. M. Gilligan, D. J. Heinzen, F. L. Moore, M. G. Raizen, and D. J. Wineland, *Phys. Rev. A* 47, 3554-3570 (1993). TN-61
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6. "Demonstration of a fundamental quantum logic gate," C. Monroe, D. M. Meekhof, B. E. King, W. M. Itano, and D. J. Wineland, *Phys. Rev. Lett.* 75, 4714-4717 (1995). TN-112

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1. "Young's interference experiment with light scattered from two atoms," U. Eichmann, J. C. Bergquist, J. J. Bollinger, J. M. Gilligan, W. M. Itano, D. J. Wineland, and M. G. Raizen, *Phys. Rev. Lett.* 70, 2359-2362 (1993). TN-116
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| 5. | "Laser-cooled positron source," D. J. Wineland, C. S. Weimer, and J. J. Bollinger, <i>Proc., Anti-Hydrogen workshop</i> , Munich, July 30-31, 1992, ed. by J. Eades, in <i>Hyperfine Interactions</i> <u>76</u> , 115-125 (1993). | TN-175 |
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ADDITIONAL PUBLICATIONS

The following publications were published or prepared during the period between May 1992 and January 1996, but are not included in this technical note.

1. "Experimental results on normal modes in cold, pure ion plasmas," J. J. Bollinger, D. J. Heinzen, F. L. Moore, C. S. Weimer, W. M. Itano, and D. J. Wineland, in *Strongly Coupled Plasma Physics*, ed. by Van Horn and Ichimaru (University of Rochester Press, Rochester, NY, 1993), pp. 393-398.
2. "Quantum measurements of trapped ions," W. M. Itano, J. C. Bergquist, J. J. Bollinger, J. M. Gilligan, D. J. Heinzen, F. L. Moore, M. G. Raizen, and D. J. Wineland, Proc., Intl. Symp. on Quantum Physics and the Universe, Waseda Univ., Tokyo, Japan, Aug. 19-22, 1992, ed. by M. Namiki, K. Maeda, and I. Ohba, *Vistas in Astronomy* 37, 169-183 (1993).
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4. "Non-neutral ion plasmas and crystals, laser cooling, and atomic clocks," J. J. Bollinger, D. J. Wineland, and D. H. E. Dubin, *Phys. Plasmas* 1, 1403-1414 (1994).
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10. "Quantum effects in measurements on trapped ions," D. J. Wineland, J. C. Bergquist, J. J. Bollinger, and W. M. Itano, *ibid.*, pp. 286-293.

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12. "Laser-cooled trapped-ion experiments at NIST," J. N. Tan, J. J. Bollinger, A. S. Barton, and D. J. Wineland, in *Non-neutral Plasma Physics II*, ed. by J. Fajans and D. H. E. Dubin, AIP Conf. Proc. 331 (AIP Press, New York, NY, 1995), pp. 215-228.
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14. "Quantum mechanically correlated states and atomic clocks," C. Monroe, D. M. Meekhof, B. E. King, W. M. Itano, J. J. Bollinger, and D. J. Wineland, Proc. 1995 Moriond Workshop (Editions Frontieres, Gif-sur-Yvette, France, 1996).
15. "Experiments at NIST with trapped ions: 3-D zero-point cooling, quantum gates, Bragg scattering, and atomic clocks," C. Monroe, A.S. Barton, J.C. Bergquist, D. J. Berkeland, J.J. Bollinger, F. Cruz, W.M. Itano, S.R. Jefferts, B.M. Jelenković, B.E. King, D.M. Meekhof, J.D. Miller, M.E. Poitzsch, J.N. Tan, and D.J. Wineland, Proc., 12th Intl. Conf. on Laser Spectroscopy, Capri, Italy, June 1995 (World Scientific), to be published.
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17. "Primary atomic frequency standards: New developments," R. E. Drullinger, S. L. Rolston, and W. M. Itano, in *Review of Radio Science*, in press.
18. "CW second harmonic generation with elliptical Gaussian beams," A. Steinbach, M. Rauner, F. C. Cruz, and J. C. Bergquist, Opt. Commun., in press.
19. "Generation of non-classical motional states of a trapped atom," D. M. Meekhof, C. Monroe, B. King, W. M. Itano, and D. J. Wineland, Phys. Rev. Lett., in press.
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21. "Optimal frequency measurements with maximally correlated states," J. J. Bollinger, W. M. Itano, D. J. Wineland, and D. J. Heinzen, submitted to Phys. Rev. Lett.