

University of Groningen

Interaction dynamics in collisions of ions with molecules and clusters

Postma, Jos Jacob Uilke

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2011

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Postma, J. J. U. (2011). *Interaction dynamics in collisions of ions with molecules and clusters*. s.n.

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Bibliography

- [1] M. H. Anderson, J. R. Ensher, M. R. Matthews, C. E. Wieman, and E. A. Cornell, *Science* **269**, 198 (1995).
- [2] R. Wilson, *Radiology* **47**, 487 (1946).
- [3] M. M. Seibert, T. Ekeberg, F. R. N. C. Maia, M. Svenda, J. Andreasson, O. Jönsson, D. Odić, B. Iwan, A. Rocker, D. Westphal, M. Hantke, D. P. Deponte, A. Barty, J. Schulz, L. Gumprecht, N. Coppola, A. Aquila, M. Liang, T. A. White, A. Martin, C. Caleman, S. Stern, C. Abergel, V. Seltzer, J. . Claverie, C. Bostedt, J. D. Bozek, S. Boutet, A. A. Miahnahri, M. Messerschmidt, J. Krzywinski, G. Williams, K. O. Hodgson, M. J. Bogan, C. Y. Hampton, R. G. Sierra, D. Starodub, I. Andersson, S. Bajt, M. Barthelmess, J. C. H. Spence, P. Fromme, U. Weierstall, R. Kirian, M. Hunter, R. B. Doak, S. Marchesini, S. P. Hau-Riege, M. Frank, R. L. Shoeman, L. Lomb, S. W. Epp, R. Hartmann, D. Rolles, A. Rudenko, C. Schmidt, L. Foucar, N. Kimmel, P. Holl, B. Rudek, B. Erk, A. Hömke, C. Reich, D. Pietschner, G. Weidenspointner, L. Strder, G. Hauser, H. Gorke, J. Ullrich, I. Schlichting, S. Herrmann, G. Schaller, F. Schopper, H. Soltau, K. . Kühnel, R. Andritschke, C. . Schröter, F. Krasnqi, M. Bott, S. Schorb, D. Rupp, M. Adolph, T. Gorkhover, H. Hirsemann, G. Potdevin, H. Graafsma, B. Nilsson, H. N. Chapman, and J. Hajdu, *Nature* **470**, 78 (2011).
- [4] L. Pauling, *Journal of the American Chemical Society* **53**, 1367 (1931).
- [5] G. H. Herbig, *The diffuse interstellar bands*, volume 33 of *Annual Review of Astronomy and Astrophysics*, 1995.
- [6] A. G. G. M. Tielens, *Interstellar polycyclic aromatic hydrocarbon molecules*, volume 46 of *Annual Review of Astronomy and Astrophysics*, 2008.
- [7] M. Povich, J. Stone, E. Churchwell, E. Zweibel, M. Wolfire, B. Babler, R. Indebetouw, M. Meade, and B. Whitney, *Astrophysical Journal* **660**, 346 (2007).
- [8] L. Armus, V. Charmandaris, J. Bernard-Salas, H. Spoon, J. Marshall, S. Higdon, V. Desai, H. Teplitz, L. Hao, D. Devost, B. Brandl, Y. Wu, G. Sloan, B. Soifer, J. Houck, and T. Herter, *Astrophysical Journal* **656**, 148 (2007).
- [9] A. Tappe, J. Rho, and W. Reach, *Astrophysical Journal* **653**, 267 (2006).

- [10] E. Micelotta, A. Jones, and A. Tielens, *Astronomy and Astrophysics* (2009).
- [11] E. R. Micelotta, A. P. Jones, and A. G. G. M. Tielens, *Astronomy and Astrophysics* **510** (2010).
- [12] NASA/Jet Propulsion Laboratory-Caltech.
- [13] NASA/Smithsonian Astrophysical Observatory/CANDRA X-ray Center.
- [14] Y. Gotkis, M. Oleinikova, M. Naor, and C. Lifshitz, *Journal of Physical Chemistry* **97**, 12282 (1993).
- [15] H. Jochims, E. Rühl, H. Baumgärtel, S. Tobita, and S. Leach, *Astrophysical Journal* **420**, 307 (1994).
- [16] A. Tielens, *The physics and chemistry of the interstellar medium*, Cambridge College Press, 2005.
- [17] J. Maier, A. Boguslavskiy, H. Ding, G. Walker, and D. Bohlender, *Astrophysical Journal* **640**, 369 (2006).
- [18] R. Dörner, V. Mergel, O. Jagutzki, L. Spielberger, J. Ullrich, R. Moshhammer, and H. Schmidt-Böcking, *Physics Report* **330**, 95 (2000).
- [19] J. Ullrich, R. Moshhammer, A. Dorn, R. Dörner, L. P. H. Schmidt, and H. Schmidt-Böcking, *Reports on Progress in Physics* **66**, 1463 (2003).
- [20] J. Postma, S. Bari, R. Hoekstra, A. G. G. M. Tielens, and T. Schlathölder, *Astrophysical Journal* **708**, 435 (2010).
- [21] R. Geller, *Electron cyclotron resonance ion sources and ECR plasmas*, Institute of Physics Pub., 1996.
- [22] R. Geller, *Review of Scientific Instruments* **69**, 1302 (1998).
- [23] A. G. Drentje, H. R. Kremers, J. Mulder, and J. Sijbring, *Review of Scientific Instruments* **69**, 728 (1998).
- [24] W. Wiley and I. McLaren, *Review of Scientific Instruments* **26**, 1150 (1955).
- [25] B. A. Mamyrin, V. I. Karataev, D. V. Shmikk, and V. A. Zagulin, *Sov.Phys.JETP* **37**, 45 (1973).
- [26] B. A. Mamyrin, *International Journal of Mass Spectrometry* **206**, 251 (2001).
- [27] A. Tielens, *Annual Review of Astronomy and Astrophysics* **46**, 289 (2008).
- [28] M. Frenklach and E. Feigelson, *Astrophys. J.* **341**, 372 (1989).
- [29] I. Cherchneff, J. Barker, and A. Tielens, *Astrophysical Journal* **401**, 269 (1992).

- [30] J. De Vries, R. Hoekstra, R. Morgenstern, and T. Schlathölter, *Journal of Physics B: Atomic, Molecular and Optical Physics* **35**, 4373 (2002).
- [31] O. Hadjar, R. Hoekstra, R. Morgenstern, and T. Schlathölter, *Physical Review A. Atomic, Molecular, and Optical Physics* **63**, 332011 (2001).
- [32] Y. Ling and C. Lifshitz, *Journal of Physical Chemistry A* **102**, 708 (1998).
- [33] Y. Ling, J. Martin, and C. Lifshitz, *Journal of Physical Chemistry A* **101**, 219 (1997).
- [34] L. Robson, K. Ledingham, A. Tasker, P. McKenna, T. McCanny, C. Kosmidis, D. Jaroszynski, D. Jones, R. Issac, and S. Jamieson, *Chemical Physics Letters* **360**, 382 (2002).
- [35] M. Murakami, R. Mizoguchi, Y. Shimada, T. Yatsunami, and N. Nakashima, *Chemical Physics Letters* **403**, 238 (2005).
- [36] T. Schlathölter, M. Newman, T. Niedermayr, G. Machicoane, J. McDonald, T. Schenkel, R. Hoekstra, and A. Hamza, *European Physical Journal D* **12**, 323 (2000).
- [37] A. Van Orden and R. Saykally, *Chemical Reviews* **98**, 2313 (1998).
- [38] W. Weltner Jr. and R. Van Zee, *Chemical Reviews* **89**, 1713 (1989).
- [39] H. Kroto, J. Heath, S. O'Brien, R. Curl, and R. Smalley, *Astrophys. J.* **314**, 352 (1987).
- [40] T. Ferrell, P. Echenique, and R. Ritchie, *Solid State Communications* **32**, 419 (1979).
- [41] A. Närmann, R. Monreal, P. Echenique, F. Flores, W. Heiland, and S. Schubert, *Physical Review Letters* **64**, 1601 (1990).
- [42] T. Schlathölter, O. Hadjar, R. Hoekstra, and R. Morgenstern, *Physical Review Letters* **82**, 73 (1999).
- [43] O. Hadjar, P. Földi, R. Hoekstra, R. Morgenstern, and T. Schlathölter, *Physical Review Letters* **84**, 4076 (2000).
- [44] M. Frisch, *Gaussian* **3** (2004).
- [45] M. Puska and R. Nieminen, *Physical Review B* **27**, 6121 (1983).
- [46] A. Arnau, M. Peñalba, P. Echenique, F. Flores, and R. Ritchie, *Physical Review Letters* **65**, 1024 (1990).
- [47] M. Peñalba, A. Arnau, and P. Echenique, *Nucl. Instrum. Methods B*, 56/57 (1991).
- [48] M. Yamauchi, Y. Yamakita, H. Yamakado, and K. Ohno, *Journal of Electron Spectroscopy and Related Phenomena* **88-91**, 155 (1998).
- [49] A. Rentenier, *Phys. Rev. Lett.* **100**, 183401 (2008).

- [50] D. Biermann and W. Schmidt, *Journal of the American Chemical Society* **102**, 3163 (1980).
- [51] D. Bodewits, R. Hoekstra, B. Seredyuk, R. McCullough, G. Jones, and A. Tielens, *Astrophysical Journal* **642**, 593 (2006).
- [52] A. Barany and C. Setterlind, *Nucl. Instrum. Methods B* **98**, 184 (1995).
- [53] H. Cederquist, A. Fardi, K. Haghghat, A. Langereis, H. Schmidt, S. Schwartz, J. Levin, I. Sellin, H. Lebius, B. Huber, M. Larsson, and P. Hvelplund, *Physical Review A - Atomic, Molecular, and Optical Physics* **61**, 227121 (2000).
- [54] E. Dwek and J. Scalo, *Astrophysical Journal* **239**, 193 (1980).
- [55] T. Nozawa, T. Kozasa, H. Umeda, K. Maeda, and K. Nomoto, *Astrophysical Journal* **598**, 785 (2003).
- [56] T. Kozasa, H. Hasegawa, and K. Nomoto, *Astrophysical Journal* **344**, 325 (1989).
- [57] D. Wooden, D. Rank, J. Bregman, F. Witteborn, A. Tielens, M. Cohen, P. Pinto, and T. Axelrod, *Astrophysical Journal, Supplement Series* **88**, 477 (1993).
- [58] B. Sugerman, B. Ercolano, M. Barlow, A. Tielens, G. Clayton, A. Zijlstra, M. Meixner, A. Speck, T. Gledhill, N. Panagia, M. Cohen, K. Gordon, M. Meyer, J. Fabbri, J. Bowey, D. Welch, M. Regan, and R. Kennicutt Jr., *Science* **313**, 196 (2006).
- [59] F. Bertoldi, C. Carilli, P. Cox, X. Fan, M. Strauss, A. Beelen, A. Omont, and R. Zylka, *Astronomy and Astrophysics* **406**, L55 (2003).
- [60] R. Priddey, K. Isaak, R. McMahon, E. Robson, and C. Pearson, *Monthly Notices of the Royal Astronomical Society* **344**, L74 (2003).
- [61] A. Beelen, P. Cox, D. Benford, C. Dowell, A. Kovács, F. Bertoldi, A. Omont, and C. Carilli, *Astrophysical Journal* **642**, 694 (2006).
- [62] R. Maiolino, R. Schneider, E. Oliva, S. Bianchi, A. Ferrara, F. Mannucci, M. Pedani, and M. Roca Sogorb, *Nature* **431**, 533 (2004).
- [63] T. Nozawa, T. Kozasa, A. Habe, E. Dwek, H. Umeda, N. Tominaga, K. Maeda, and K. Nomoto, *Astrophysical Journal* **666**, 955 (2007).
- [64] B. Nath, T. Laskar, and J. Shull, *Astrophysical Journal* **682**, 1055 (2008).
- [65] S. Messenger, S. Amari, X. Gao, R. Walker, S. Clemett, X. Chillier, R. Zare, and R. Lewis, *Astrophysical Journal* **502**, 284 (1998).
- [66] T. Bernatowicz, R. Cowsik, P. Gibbons, F. J. B. Lodders, K., S. Amari, and R. Lewis, *Astrophysical Journal* **472**, 760 (1996).
- [67] M. Frenklach and E. D. Feigelson, *Astrophys.J.* **341**, 372 (1989).

- [68] A. G. G. M. Tielens, C. F. Mckee, C. G. Seab, and D. J. Hollenbach, *Astrophysical Journal* **431**, 321 (1994).
- [69] K. M. Ferriere, *Rev. Mod. Phys.* **73**, 1031 (2001).
- [70] D. W. Brenner, *Phys. Rev. B* **42**, 9458 (1990).
- [71] G. C. Abell, *Phys. Rev. B* **31**, 6184 (1985).
- [72] J. Tersoff, *Phys. Rev. Lett.* **56**, 632 (1986).
- [73] J. Tersoff, *Phys. Rev. B* **37**, 6991 (1988).
- [74] J. Tersoff, *Phys. Rev. Lett.* **61**, 2879 (1988).
- [75] J. Tersoff, *Phys. Rev. B* **39**, 5566 (1989).
- [76] R. Biswas and D. R. Hamann, *Phys. Rev. B* **36**, 6434 (1987).
- [77] P. M. Morse, *Phys. Rev.* **34**, 57 (1929).
- [78] A. Sommerfeld, *Zeitschrift für Physik A Hadrons and Nuclei* **78**, 283 (1932).
- [79] G. Molière, *Zeitschrift für Naturforschung A* **2**, 133 (1947).
- [80] W. Lenz, *Zeitschrift für Physik A Hadrons and Nuclei* **77**, 713 (1932).
- [81] H. Jensen, *Zeitschrift für Physik A Hadrons and Nuclei* **77**, 722 (1932).
- [82] J. Ziegler, J. Biersack, and U. Littmark, *The stopping and range of ions in solids*, Stopping and ranges of ions in matter, Pergamon, 1985.
- [83] L. Verlet, *Physical Review* **159**, 98 (1967).
- [84] D. Beeman, *Journal of Computational Physics* **20**, 130 (1976).
- [85] J. Che, T. Çagin, and W. A. Goddard III, *Theoretical Chemistry Accounts: Theory, Computation, and Modeling (Theoretica Chimica Acta)* **102**, 346 (1999).
- [86] E. Micelotta, *PhD thesis*, 2009.
- [87] H. W. Jochims, E. Rühl, H. Baumgärtel, S. Tobita, and S. Leach, *Astrophysical Journal* **420**, 307 (1994).
- [88] Y. Ling and C. Lifshitz, *Journal of Physical Chemistry A* **102**, 708 (1998).
- [89] V. Vijaykrishnan, A. Chainani, D. D. Sarma, and C. N. R. Rao, *Journal of Physical Chemistry* **96**, 8679 (1992).
- [90] H. P. Birkhofer, H. Haberland, M. Winterer, and D. R. Worsnop, *Berichte der Bunsengesellschaft/Physical Chemistry Chemical Physics* **88**, 207 (1984).

- [91] W. Kamke, J. de Vries, J. Krauss, E. Kaiser, B. Kamke, and I. V. Hertel, *Zeitschrift für Physik D Atoms, Molecules and Clusters* **14**, 339 (1989).
- [92] E. Rühl, C. Schmale, H. W. Jochims, E. Biller, M. Simon, and H. Baumgärtel, *The Journal of chemical physics* **95**, 6544 (1991).
- [93] J. Matsumoto, A. Leredde, X. Flechard, K. Hayakawa, H. Shiromaru, J. Rangama, C. L. Zhou, S. Guillous, D. Hennecart, T. Muranaka, A. Mery, B. Gervais, and A. Cas-simi, *Physical Review Letters* **105** (2010).
- [94] W. Tappe, R. Flesch, E. Rühl, R. Hoekstra, and T. Schlathölter, *Physical Review Letters* **88**, 143401/1 (2002).
- [95] B. Walch, C. L. Cocke, R. Voelpel, and E. Salzborn, *Physical Review Letters* **72**, 1439 (1994).
- [96] S. Martin, L. Chen, A. Denis, and J. Désesquelles, *Physical Review A - Atomic, Molecular, and Optical Physics* **57**, 4518 (1998).
- [97] T. Schlathölter, R. Hoekstra, and R. Morgenstern, *Journal of Physics B: Atomic, Molecular and Optical Physics* **31**, 1321 (1998).
- [98] J. Opitz, H. Lebius, B. Saint, S. Jacquet, B. A. Huber, and H. Cederquist, *Physical Review A - Atomic, Molecular, and Optical Physics* **59**, 3562 (1999).
- [99] F. Chandezon, C. Guet, B. A. Huber, D. Jalabert, M. Maurel, E. Monnard, C. Ristori, and J. C. Rocco, *Physical Review Letters* **74**, 3784 (1995).
- [100] C. Guet, X. Biquard, P. Blaise, S. A. Blundell, M. Gross, B. A. Huber, D. Jalabert, M. Maurel, L. Plagne, and J. C. Rocco, *Zeitschrift für Physik D-Atoms Molecules and Clusters* **40**, 317 (1997).
- [101] L. Plagne and C. Guet, *Physical Review A - Atomic, Molecular, and Optical Physics* **59**, 4461 (1999).
- [102] A. I. S. Holm, H. Zettergren, H. A. B. Johansson, F. Seitz, S. Rosén, H. T. Schmidt, A. Ł awicki, J. Rangama, P. Rousseau, M. Capron, R. Maisonny, L. Adoui, A. Méry, B. Manil, B. A. Huber, and H. Cederquist, *Physical Review Letters* **105** (2010).
- [103] K. Huang, *Statistical Mechanics*, John Wiley & Sons, Inc., 1987.
- [104] R. Evans, *Advances in Physics* **28**, 143 (1979).
- [105] J. Merikanto, E. Zapadinsky, A. Lauri, and H. Vehkamki, *Physical Review Letters* **98** (2007).
- [106] A. Kantrowitz and J. Grey, *Review of Scientific Instruments* **22**, 328 (1951).
- [107] R. E. Smalley, B. L. Ramakrishna, D. H. Levy, and L. Wharton, *The Journal of Chemical Physics* **61**, 4363 (1974).

- [108] O. Hagena, *Surface Science* **106**, 101 (1981).
- [109] O. F. Hagena, *Zeitschrift für Physik D Atoms, Molecules and Clusters* **4**, 291 (1987).
- [110] R. Karnbach, M. Joppien, J. Stapelfeldt, J. Wörmer, and T. Möller, *Review of Scientific Instruments* **64**, 2838 (1993).
- [111] U. Buck and R. Krohne, *Journal of Chemical Physics* **105**, 5408 (1996).
- [112] R. Campargue, *Journal of Physical Chemistry* **88**, 4466 (1984).
- [113] J. M. Hayes, *Chemical reviews* **87**, 745 (1987).
- [114] G. Scoles, editor, *Atomic and Molecular Beam Methods*, volume 1, Oxford University Press, New York, 1988.
- [115] G. Sanna and G. Tomassetti, *Introduction to Molecular Beams Gas Dynamics*, Imperial College Press, 2005.
- [116] H. Ashkenas and C. Sherman, *Fourth Symposium on Rarefied Gas Dynamics*, volume 2, Academic Press, New York, 1966.
- [117] *Skimmer specifications*, Beam Dynamics Inc.
- [118] G. De Nijs, H. O. Folkerts, R. Hoekstra, and R. Morgenstern, *Journal of Physics B: Atomic, Molecular and Optical Physics* **29**, 85 (1996).
- [119] F. Alvarado, R. Hoekstra, and T. Schlathölter, *Journal of Physics B: Atomic, Molecular and Optical Physics* **38**, 4085 (2005).
- [120] N. Saito, Y. Morishita, I. H. Suzuki, S. D. Stoychev, A. I. Kuleff, L. S. Cederbaum, X. . Liu, H. Fukuzawa, G. Prümper, and K. Ueda, *Chemical Physics Letters* **441**, 16 (2007).
- [121] O. Jagutzki, V. Mergel, K. Ullmann-Pfleger, L. Spielberger, U. Spillmann, R. Dörner, and H. Schmidt-Böcking, *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* **477**, 244 (2002).
- [122] *Position and time sensitive multi-hit MCP delay-line detector system*, Roentdek Handels GmbH.
- [123] M. Tarisien, L. Adoui, F. Frémont, and A. Cassimi, *Physica Scripta T* **80**, 182 (1999).
- [124] M. Tarisien, *PhD thesis (in french)*, 2003.
- [125] H. O. Folkerts, F. W. Blik, M. C. De Jong, R. Hoekstra, and R. Morgenstern, *Journal of Physics B: Atomic, Molecular and Optical Physics* **30**, 5833 (1997).
- [126] F. Lekien and J. Marsden, *International Journal for Numerical Methods in Engineering* **63**, 455 (2005).

