



Universiteit
Leiden
The Netherlands

Molecules during Stellar Formation and Death

Li, X.

Citation

Li, X. (2015, February 12). *Molecules during Stellar Formation and Death*. PhD Thesis.
Retrieved from <https://hdl.handle.net/1887/31856>

Version: Not Applicable (or Unknown)

License: [Leiden University Non-exclusive license](#)

Downloaded from: <https://hdl.handle.net/1887/31856>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/31856> holds various files of this Leiden University dissertation

Author: Xiaohu Li

Title: Molecules during stellar formation and death

Issue Date: 2015-02-12

Bibliography

- Abgrall, H., Roueff, E., Launay, F., Roncin, J. Y., & Subtil, J. L. 1993a, *A&AS*, 101, 273
- Abgrall, H., Roueff, E., Launay, F., Roncin, J. Y., & Subtil, J. L. 1993b, *A&AS*, 101, 323
- Agúndez, M. & Cernicharo, J. 2006, *ApJ*, 650, 374
- Agúndez, M., Cernicharo, J., & Goicoechea, J. R. 2008a, *Astron. Astrophys.*, 483, 831
- Agúndez, M., Cernicharo, J., & Guélin, M. 2010a, *ApJ*, 724, L133
- Agúndez, M., Cernicharo, J., Guélin, M., et al. 2010b, *A&A*, 517, L2
- Agúndez, M., Fonfría, J. P., Cernicharo, J., et al. 2012, *A&A*, 543, A48
- Agúndez, M., Fonfría, J. P., Cernicharo, J., Pardo, J. R., & Guélin, M. 2008b, *A&A*, 479, 493
- Agúndez, M. & Wakelam, V. 2013, *Chemical Reviews*, 113, 8710
- Aikawa, Y., van Zadelhoff, G. J., van Dishoeck, E. F., & Herbst, E. 2002, *A&A*, 386, 622
- Aikawa, Y., Wakelam, V., Garrod, R. T., & Herbst, E. 2008, *ApJ*, 674, 984
- Ajello, J. M., James, G. K., Franklin, B. O., & Shemansky, D. E. 1989, *Phys. Rev. A*, 40, 3524
- André, M. K., Oliveira, C. M., Howk, J. C., et al. 2003, *ApJ*, 591, 1000
- Asplund, M., Grevesse, N., Sauval, A. J., & Scott, P. 2009, *ARA&A*, 47, 481
- Atahan, S., Alexander, M. H., & Rackham, E. J. 2005, *J. Chem. Phys.*, 123, 204306
- Atahan, S., Klos, J., Zuchowski, P. S., & Alexander, M. H. 2006, *Phys. Chem. Chem. Phys.*, 8, 4420
- Balakrishnan, N. 2003, *J. Chem. Phys.*, 119, 195
- Balakrishnan, N. 2004, *J. Chem. Phys.*, 121, 6346
- Baulch, D. L., Bowman, C. T., Cobos, C. J., et al. 2005, *Journal of Physical and Chemical Reference Data*, 34, 757
- Baulch, D. L., Cobos, C. J., Cox, R. A., et al. 1992, *J. Phys. Chem. Ref. Data*, 21, 411
- Baulch, D. L., Cobos, C. J., Cox, R. A., et al. 1994, *J. Phys. Chem. Ref. Data*, 23, 847
- Bergin, E. A., Aikawa, Y., Blake, G. A., & van Dishoeck, E. F. 2007, *Protostars and Planets V*, 751
- Bergin, E. A., Alves, J., Huard, T., & Lada, C. J. 2002, *ApJ*, 570, L101
- Bethell, T. & Bergin, E. 2009, *Science*, 326, 1675
- Bettens, R. P. A., Lee, H.-H., & Herbst, E. 1995, *ApJ*, 443, 664
- Biegging, J. H. & Rieu, N.-Q. 1988, *ApJ*, 329, L107
- Black, J. H. & van Dishoeck, E. F. 1987, *ApJ*, 322, 412
- Boersma, C., Hony, S., & Tielens, A. G. G. M. 2006, *A&A*, 447, 213
- Bohlin, R. C., Savage, B. D., & Drake, J. F. 1978, *ApJ*, 224, 132
- Bowman, J. M., Wagner, A. F., Walch, S. P., & Thom. H. Dunning, J. 1984, *J. Chem. Phys.*, 81, 1739
- Brandão, J., Mogo, C., & Silva, B. C. 2004, *J. Chem. Phys.*, 121, 8861
- Braunstein, M., Adler-Golden, S., Maiti, B., & Schatz, G. C. 2004, *J. Chem. Phys.*, 120, 4316
- Cernicharo, J., Guélin, M., Agúndez, M., McCarthy, M. C., & Thaddeus, P. 2008, *ApJ*, 688, L83
- Cernicharo, J., Guélin, M., & Kahane, C. 2000, *A&AS*, 142, 181
- Cernicharo, J., Waters, L. B. F. M., Decin, L., et al. 2010, *A&A*, 521, L8
- Chatfield, D. C., Friedman, R. S., Lynch,

- G. C., Truhlar, D. G., & Schwenke, D. W. 1993, *J. Chem. Phys.*, 98, 342
- Cherchneff, I. 2006, *A&A*, 456, 1001
- Cherchneff, I. 2011, in *EAS Publications Series*, ed. C. Joblin & A. G. G. M. Tielens, Vol. 46, 177–189
- Cherchneff, I. 2012, *A&A*, 545, A12
- Cho, S.-H. & Ukita, N. 1998, *AJ*, 116, 2495
- Chu, T.-S., Zhang, X., & Han, K.-L. 2005, *J. Chem. Phys.*, 122, 214301
- Chu, T. S., Zhang, Y., & Han, K. L. 2006, *Int. Rev. Phys.Chem.*, 25, 201
- Codella, C., Viti, S., Ceccarelli, C., et al. 2013, *ApJ*, 776, 52
- Cohen, N. & Westberg, K. R. 1983, *J. Phys. Chem. Ref. Data*, 12, 531
- Cordiner, M. A. & Millar, T. J. 2009, *ApJ*, 697, 68
- Crapsi, A., Caselli, P., Walmsley, C. M., et al. 2005, *ApJ*, 619, 379
- D'Alessio, P., Calvet, N., Hartmann, L., Lizano, S., & Cantó, J. 1999, *ApJ*, 527, 893
- Dalgarno, A. 2008, *ARA&A*, 46, 1
- Danilovich, T., Bergman, P., Justtanont, K., et al. 2014, *A&A*, 569, A76
- Daranlot, J., Hincelin, U., Bergeat, A., et al. 2012, *Pro. Natl. Acad. Sci.*, 109, 10233
- De Beck, E., Decin, L., de Koter, A., et al. 2010, *A&A*, 523, A18
- De Beck, E., Kamiński, T., Patel, N. A., et al. 2013, *A&A*, 558, A132
- De Beck, E., Lombaert, R., Agúndez, M., et al. 2012, *A&A*, 539, A108
- de Graauw, T., Helmich, F. P., Phillips, T. G., et al. 2010, *A&A*, 518, L6
- De Luca, M., Gupta, H., Neufeld, D., et al. 2012, *ApJ*, 751, L37
- Decin, L. 2012, *Advances in Space Research*, 50, 843
- Decin, L., Agúndez, M., Barlow, M. J., et al. 2010, *Nature*, 467, 64
- Decin, L., Cherchneff, I., Hony, S., et al. 2008, *A&A*, 480, 431
- Decin, L., De Beck, E., Brünken, S., et al. 2010a, *A&A*, 516, A69
- Decin, L., Justtanont, K., De Beck, E., et al. 2010b, *A&A*, 521, L4
- Dinh-V-Trung & Lim, J. 2008, *ApJ*, 678, 303
- Draine, B. T. 1978, *ApJ*, 36, 595
- Duari, D., Cherchneff, I., & Willacy, K. 1999, *A&A*, 341, L47
- Dunne, L. J. & Murrell, J. N. 1983, *Mol. Phys.*, 50, 635
- Dutrey, A., Henning, T., Guilloteau, S., et al. 2007, *A&A*, 464, 615
- Eichelberger, B., Snow, T. P., Barckholtz, C., & Bierbaum, V. M. 2007, *ApJ*, 667, 1283
- Evans, II, N. J., Dunham, M. M., Jørgensen, J. K., et al. 2009, *ApJ*, 181, 321
- Fernandez-Ramos, A., Ellingson, B. A., Garrett, B. C., & Truhlar, D. G. 2007, *POLYRATE-9.7*
- Fernandez-Ramos, A., Ellingson, B. A., Garrett, B. C., & Truhlar, D. G. 2013, *NIST Chemical Kinetics Database Nist.*, <http://kinetics.nist.gov/kinetics/index.jsp>
- Fong, D., Meixner, M., & Shah, R. Y. 2003, *ApJ*, 582, L39
- Fong, D., Meixner, M., Sutton, E. C., Zalucha, A., & Welch, W. J. 2006, *ApJ*, 652, 1626
- Fontani, F., Palau, A., Caselli, P., et al. 2011, *A&A*, 529, L7
- Fuchs, G. W., Cuppen, H. M., Ioppolo, S., et al. 2009, *A&A*, 505, 629
- Garashchuk, S., Rassolov, V. A., & Schatz, G. C. 2006, *J. Chem. Phys.*, 124, 244307
- Garrod, R. T. & Herbst, E. 2006, *A&A*, 457, 927
- Garton, D. J., Brunsvold, A. L., Minton, T. K., et al. 2006, *J. Phys. Chem. A*, 6, 110, 1327
- Garton, D. J., Minton, T. K., Maiti, B., Troya, D., & Schatz, G. C. 2003, *J. Chem. Phys.*, 118, 1585
- Geppert, W. D., Hamberg, M., Thomas, R. D., et al. 2006, *Faraday Discuss.*, 133, 177
- Gerin, M., de Luca, M., Black, J., et al. 2010, *A&A*, 518, L110
- Gerin, M., de Luca, M., Lis, D. C., et al. 2013,

- J. Phys. Chem. A, 117, 10018
- Gielen, C., Cami, J., Bouwman, J., Peeters, E., & Min, M. 2011, *A&A*, 536, A54
- Glassgold, A. E. 1996, *ARA&A*, 34, 241
- Gobrecht, D., Cherchneff, I., Sarangi, A., Plane, J. M. C., & Bromley, S. T. 2014, *A&A*, submitted
- Gondhalekar, P. M., Phillips, A. P., & Wilson, R. 1980, *A&A*, 85, 272
- Graff, M. M. & Dalgarno, A. 1987, *Astrophys. J.*, 317, 432
- Guélin, M. 2011, in *EPJ Web of Conferences*, 18, 1002
- Guélin, M., Neininger, N., & Cernicharo, J. 1998, *A&A*, 335, L1
- Guélin, M., Neininger, N., Lucas, R., & Cernicharo, J. 1999, in *The Physics and Chemistry of the Interstellar Medium*, ed. V. Ossenkopf, J. Stutzki, & G. Winnewisser, 326
- Habing, H. J. 1968, *Bull. Astron. Inst. Netherlands*, 19, 421
- Han, B. & Zheng, Y. 2011, *J. Comput. Chem.*, 32, 3520
- Hase, W. L., Duchovic, R. J., Hu, X., et al. 1996, *Quantum Chem. Progr. Exch.*, 16, 671
- Haverd, V. E., Lewis, B. R., Gibson, S. T., & Stark, G. 2005, *J. Chem. Phys.*, 123, 214304
- Heays, A. N. 2011, PhD thesis, The Australian National University
- Heays, A. N., Dickenson, G. D., Salumbides, E. J., et al. 2011, *J. Chem. Phys.*, 135
- Heays, A. N., Lewis, B. R., Stark, G., et al. 2009, *J. Chem. Phys.*, 131, 194308
- Heays, A. N., Visser, R., Gredel, R., et al. 2014, *A&A*, 562, A61
- Helm, H., Hazell, I., & Bjerre, N. 1993, *Phys. Rev. A*, 48, 2762
- Henning, T. & Semenov, D. 2013, *Chemical Reviews*, 113, 9016
- Herbst, E., Green, S., Thaddeus, P., & Klemperer, W. 1977, *ApJ*, 215, 503
- Herbst, E. & Klemperer, W. 1973, *ApJ*, 185, 505
- Herbst, E. & Osamura, Y. 2008, *ApJ*, 679, 1670
- Herbst, E. & Yates, Jr., J. T. 2013, *Chemical Reviews*, 113, 8707
- Herwig, F. 2005, *ARA&A*, 43, 435
- Hoffmann, M. R. & Schatz, G. C. 2000, *J. Chem. Phys.*, 113, 9456
- Hollenbach, D. J. & Tielens, A. G. G. M. 1997, *ARA&A*, 35, 179
- Howard, M. J. & Smith, I. W. M. 1982, *J. Chem. Soc. Faraday Trans. 2 Mol. Chem. Phys.*, 78, 1403
- Howard, R. E., McLean, A. D., & W. A. Lester, J. 1979, *J. Chem. Phys.*, 71, 2412
- Huber, K. P. & Herzberg, G. 1979, *Molecular spectra and molecular structure IV: Constants of diatomic molecules* (Van Nostrand, New York)
- Huggins, P. J., Olofsson, H., & Johansson, L. E. B. 1988, *ApJ*, 332, 1009
- Iben, Jr., I. & Renzini, A. 1983, *ARA&A*, 21, 271
- Jansen, D. J., Spaans, M., Hogerheijde, M. R., & van Dishoeck, E. F. 1995a, *A&A*, 303, 541
- Jansen, D. J., van Dishoeck, E. F., Black, J. H., Spaans, M., & Sosin, C. 1995b, *A&A*, 302, 223
- Johnson, B. R. & Winter, N. W. 1977, *J. Chem. Phys.*, 66, 4116
- Joseph, T., Truhlar, D. G., & Garrett, B. C. 1988, *J. Chem. Phys.*, 88, 6982
- Ju, L. P., Han, K. L., & Zhang, J. Z. H. 2009, *J. Comput. Chem.*, 30, 305
- Jura, M. & Morris, M. 1981, *ApJ*, 251, 181
- Justtanont, K., Khouri, T., Maercker, M., et al. 2012, *A&A*, 537, A144
- Karplus, M., Porter, R. N., & Sharma, R. D. 1965, *J. Chem. Phys.*, 43, 3259
- Kim, H., Wyrowski, F., Menten, K. M., & Decin, L. 2010, *A&A*, 516, A68
- Knauth, D. C., Andersson, B.-G., McCandliss, S. R., & Warren Moos, H. 2004, *Nature*, 429, 636
- Kumar, S. S., Hauser, D., Jindra, R., et al. 2013, *ApJ*, 776, 25
- Kwon, Y.-J. & Suh, K.-W. 2012, *J. Korean.*

- Astron. Soc., 45, 139
- Langer, W. D. & Graedel, T. E. 1989, *ApJ*, 69, 241
- Le Bertre, T. 1997, *Lecture Notes in Physics*, Vol. 497, *Stellar Atmospheres: Theory and Observations*, ed. J. P. Greve, R. Blomme, & H. Hensberge (Berlin, Heidelberg: Springer Berlin Heidelberg), 133
- Le Petit, F., Nehmé, C., Le Bourlot, J., & Roueff, E. 2006, *ApJ*, 164, 506
- Lee, H.-H., Herbst, E., Pineau des Forets, G., Roueff, E., & Le Bourlot, J. 1996, *A&A*, 311, 690
- Lefebvre-Brion, H. & Field, R. W. 2004, *The spectra and dynamics of diatomic molecules* (Elsevier)
- Lewis, B. R., Baldwin, K. G. H., Heays, A. N., et al. 2008a, *J. Chem. Phys.*, 129, 204303
- Lewis, B. R., Baldwin, K. G. H., Sprengers, J. P., et al. 2008b, *J. Chem. Phys.*, 129, 164305
- Lewis, B. R., Gibson, S. T., Sprengers, J. P., et al. 2005a, *J. Chem. Phys.*, 123, 236101
- Lewis, B. R., Gibson, S. T., Zhang, W., Lefebvre-Brion, H., & Robbe, J.-M. 2005b, *J. Chem. Phys.*, 122, 144302
- Lewis, B. R., Heays, A. N., Gibson, S. T., Lefebvre-Brion, H., & Lefebvre, R. 2008c, *J. Chem. Phys.*, 129, 164306
- Li, B. & Han, K.-L. 2009, *J. Phys. Chem. A*, 113, 10189
- Li, X., Heays, A. N., Visser, R., et al. 2013, *A&A*, 555, A14
- Li, X., Millar, T. J., Walsh, C., Heays, A. N., & van Dishoeck, E. F. 2014, *A&A*, 568, A111
- Liang, M.-C., Heays, A. N., Lewis, B. R., Gibson, S. T., & Yung, Y. L. 2007, *ApJ*, 664, L115
- Light, G. C. 1978, *J. Chem. Phys.*, 68, 2831
- Lis, D. C., Phillips, T. G., Goldsmith, P. F., et al. 2010, *A&A*, 521, L26
- Liu, S. & Shi, Y. 2010, *Chinese J. Chem. Phys.*, 23, 649
- Liu, X., Shemansky, D. E., Malone, C. P., et al. 2008, *J. Geophys. Res.*, 113, A02304
- Liu, X.-L., Wang, J.-J., & Xu, J.-L. 2013, *MNRAS*, 431, 27
- Lucas, R., Guélin, M., Kahane, C., Audinos, P., & Cernicharo, J. 1995, *Ap&SS*, 224, 293
- Lutz, B. L., Snow, Jr., T. P., & Owen, T. 1979, *ApJ*, 227, 159
- Lyons, J. R. 2009, *Meteoritics and Planetary Science Supplement*, 72, 5437
- Lyons, J. R. 2010, *Meteoritics and Planetary Science Supplement*, 73, 5424
- Lyons, J. R. & Young, E. D. 2003, *Geochimica et Cosmochimica Acta Supplement*, 67, 263
- MacKay, D. D. S. & Charnley, S. B. 2001, *MNRAS*, 325, 545
- Maercker, M., Mohamed, S., Vlemmings, W. H. T., et al. 2012, *Nature*, 490, 232
- Maercker, M., Schöier, F. L., Olofsson, H., et al. 2009, *A&A*, 494, 243
- Maercker, M., Schöier, F. L., Olofsson, H., Bergman, P., & Ramstedt, S. 2008, *A&A*, 479, 779
- Maillard, J. P., Chauville, J., & Mantz, A. W. 1976, *J. Mol. Spectrosc.*, 63, 120
- Maiti, B. & Schatz, G. C. 2003, *J. Chem. Phys.*, 119, 12360
- Mandell, A. M., Bast, J., Dishoeck, E. F. v., et al. 2012, *Astrophys. J.*, 747, 92
- Maret, S., Bergin, E. A., & Lada, C. J. 2006, *Nature*, 442, 425
- Margitan, J. J., Kaufman, F., & Anderson, J. G. 1975, *Chem. Phys. Lett.*, 34, 485
- Marvel, K. B. 2005, *AJ*, 130, 261
- Mathis, J. S., Mezger, P. G., & Panagia, N. 1983, *A&A*, 128, 212
- Mauersberger, R. & Henkel, C. 1991, *A&A*, 245, 457
- Mauron, N. & Huggins, P. J. 1999, *A&A*, 349, 203
- McElroy, D., Walsh, C., Markwick, A. J., et al. 2013, *A&A*, 550, A36
- McKee, C. F. & Hollenbach, D. J. 1980, *ARA&A*, 18, 219
- Meier, D. S. & Turner, J. L. 2005, *ApJ*, 618, 259
- Meier, R. R., Samson, J. A. R., Chung, Y.,

- Lee, E.-M., & He, Z.-X. 1991, *Planet. Space Sci.*, 39, 1197
- Melnick, G. J., Neufeld, D. A., Ford, K. E. S., Hollenbach, D. J., & Ashby, M. L. N. 2001, *Nature*, 412, 160
- Menten, K. M., Wyrowski, F., Alcolea, J., et al. 2010, *A&A*, 521, L7
- Milam, S. N., Apponi, A. J., Woolf, N. J., & Ziurys, L. M. 2007, *ApJ*, 668, L131
- Milam, S. N., Halfen, D. T., Tenenbaum, E. D., et al. 2008, *ApJ*, 684, 618
- Millar, T. J., Herbst, E., & Bettens, R. P. A. 2000, *MNRAS*, 316, 195
- Morris, M. 1975, *ApJ*, 197, 603
- Morris, M. & Jura, M. 1983, *ApJ*, 264, 546
- Muller, S., Beelen, A., Guélin, M., et al. 2011, *A&A*, 535, A103
- Ndome, H., Hochlaf, M., Lewis, B. R., et al. 2008, *J. Chem. Phys.*, 129, 164307
- Nejad, L. A. M. & Millar, T. J. 1987, *A&A*, 183, 279
- Neufeld, D. A. & Dalgarno, A. 1989, *ApJ*, 340, 869
- Neufeld, D. A., Roueff, E., Snell, R. L., et al. 2012, *ApJ*, 748, 37
- Öberg, K. I., Qi, C., Fogel, J. K. J., et al. 2010, *ApJ*, 720, 480
- Ohishi, M., McGonagle, D., Irvine, W. M., Yamamoto, S., & Saito, S. 1994, *ApJ*, 427, L51
- Pascucci, I., Apai, D., Luhman, K., et al. 2009, *ApJ*, 696, 143
- Pettey, L. R. & Wyatt, R. E. 2008, *J. Phys. Chem. A*, 112, 13335
- Pilbratt, G. L., Riedinger, J. R., Passvogel, T., et al. 2010, *A&A*, 518, L1
- Polehampton, E. T., Menten, K. M., van der Tak, F. F. S., & White, G. J. 2010, *A&A*, 510, A80
- Pontoppidan, K. M., Salyk, C., Blake, G. A., et al. 2010, *Astrophys. J.*, 720, 887
- Prasad, S. S. & Huntress, Jr., W. T. 1980, *ApJ*, 43, 1
- Pulliam, R. L., Edwards, J. L., & Ziurys, L. M. 2011, *ApJ*, 743, 36
- Qi, C., Öberg, K. I., & Wilner, D. J. 2013, *ApJ*, 765, 34
- Quan, D., Herbst, E., Osamura, Y., & Roueff, E. 2010, *ApJ*, 725, 2101
- Rachford, B. L., Snow, T. P., Destree, J. D., et al. 2009, *ApJ*, 180, 125
- Radenovic, D. C., van Roijj, A. J. A., Cheshtakov, D. A., et al. 2003, *J. Chem. Phys.*, 119, 9341
- Ramstedt, S., Maercker, M., Olofsson, G., Olofsson, H., & Schöier, F. L. 2011, *A&A*, 531, A148
- Ramstedt, S., Schöier, F. L., & Olofsson, H. 2009, *A&A*, 499, 515
- Ramstedt, S., Schöier, F. L., Olofsson, H., & Lundgren, A. A. 2006, *A&A*, 454, L103
- Reynard, L. M. & Donaldson, D. J. 2001, *Geophys. Res. Lett.*, 28, 2157
- Roberge, W. G., Dalgarno, A., & Flannery, B. P. 1981, *ApJ*, 243, 817
- Roberge, W. G., Jones, D., Lepp, S., & Dalgarno, A. 1991, *ApJ*, 77, 287
- Robie, D. C., Arepalli, S., Presser, N., Kit-sopoulos, T., & Gordon, R. J. 1987, *Chem. Phys. Lett.*, 134, 579
- Robitaille, T. P., Whitney, B. A., Indebetouw, R., Wood, K., & Denzmore, P. 2006, *ApJ*, 167, 256
- Rogers, S., Wang, D., Kuppermann, A., & Walch, S. 2000a, *J. Phys. Chem. A*, 104, 2308
- Rogers, S., Wang, D., Kuppermann, A., & Walch, S. 2000b, *The Journal of Physical Chemistry A*, 104, 2308
- Salyk, C., Pontoppidan, K. M., Blake, G. A., et al. 2008, *Astrophys. J. Lett.*, 676, L49
- Sasselov, D. D. & Lecar, M. 2000, *ApJ*, 528, 995
- Savage, B. D., Bohlin, R. C., Drake, J. F., & Budich, W. 1977, *ApJ*, 216, 291
- Savage, B. D. & Mathis, J. S. 1979, *ARA&A*, 17, 73
- Schatz, G. C. 1985, *J. Chem. Phys.*, 83, 5677
- Schatz, G. C., Wagner, A. F., Walch, S. P., & Bowman, J. M. 1981, *J. Chem. Phys.*, 74, 4984
- Schöier, F. L., Bast, J., Olofsson, H., &

- Lindqvist, M. 2007, *A&A*, 473, 871
- Schöier, F. L., Maercker, M., Justtanont, K., et al. 2011, *A&A*, 530, A83
- Schöier, F. L., Ramstedt, S., Olofsson, H., et al. 2013, *A&A*, 550, A78
- Sheffer, Y., Rogers, M., Federman, S. R., et al. 2008, *ApJ*, 687, 1075
- Smith, I. W. M. 2011, *ARA&A*, 49, 29
- Spelsberg, D. & Meyer, W. 2001, *J. Chem. Phys.*, 115, 6438
- Sprengers, J. P., Reinhold, E., Ubachs, W., Baldwin, K. G. H., & Lewis, B. R. 2005, *J. Chem. Phys.*, 123, 144315
- Sprengers, J. P., Ubachs, W., Baldwin, K. G. H., Lewis, B. R., & Tchang-Brillet, W.-Ü. L. 2003, *J. Chem. Phys.*, 119, 3160
- Sprengers, J. P., Ubachs, W., Johansson, A., et al. 2004, *J. Chem. Phys.*, 120, 8973
- Stark, G., Lewis, B. R., Heays, A. N., et al. 2008, *J. Chem. Phys.*, 128, 114302
- Sternberg, A. & Dalgarno, A. 1995, *ApJ*, 99, 565
- Sternberg, A. & Dalgarno, A. 1995, *Astrophys. J. Suppl.*, 99, 565
- Strobel, D. F. 1982, *Origins of Life*, 12, 244
- Sultanov, R. A. & Balakrishnan, N. 2004, *J. Chem. Phys.*, 121, 11038
- Szczerba, R., Schmidt, M. R., & Pulecka, M. 2007, *Baltic Astronomy*, 16, 134
- Tappe, A., Lada, C. J., Black, J. H., & Muench, A. A. 2008, *Astrophys. J. Lett.*, 680, L117
- Tenenbaum, E. D., Dodd, J. L., Milam, S. N., Woolf, N. J., & Ziurys, L. M. 2010, *ApJ*, 720, L102
- Tenenbaum, E. D. & Ziurys, L. M. 2010, *ApJ*, 712, L93
- Thaddeus, P., Cummins, S. E., & Linke, R. A. 1984, *ApJ*, 283, L45
- Thaddeus, P., Gottlieb, C. A., Gupta, H., et al. 2008, *ApJ*, 677, 1132
- Tielens, A. G. G. M. 2013, *Reviews of Modern Physics*, 85, 1021
- Tobin, J. J., Hartmann, L., Bergin, E., et al. 2012, *ApJ*, 748, 16
- Truhlar, D. G. & Garrett, B. C. 1984, *Annual Review of Physical Chemistry*, 35, 159
- Truhlar, D. G. & Garrett, B. C. 1984, *Annu. Rev. Phys. Chem.*, 35, 159
- Tsang, W. & Hampson, R. F. 1986, *J. Phys. Chem. Ref. Data*, 15, 1087
- Turner, B. E. 1974, *Ap&SS*, 29, 247
- van Dishoeck, E. F. 1988, in *Rate Coefficients in Astrochemistry*, ed. T. J. Millar, and D. A. Williams, Kluwer Academic Publishers, Dordrecht, 49
- van Dishoeck, E. F. 1998, *The Molecular Astrophysics of Stars and Galaxies*, edited by Thomas W. Hartquist and David A. Williams. Clarendon Press, Oxford, 1998., p.53, 4, 53
- van Dishoeck, E. F. 2014, *Faraday Discuss.*, 168, 9
- van Dishoeck, E. F. & Black, J. H. 1988, *ApJ*, 334, 771
- van Dishoeck, E. F. & Dalgarno, A. 1984, *ApJ*, 277, 576
- van Dishoeck, E. F., Herbst, E., & Neufeld, D. A. 2013, *Chemical Reviews*, 113, 9043
- van Dishoeck, E. F., Jonkheid, B., & van Hemert, M. C. 2006, *Faraday Discuss.*, 303, 231
- van Dishoeck, E. F., van Hemert, M. C., Allison, A. C., & Dalgarno, A. 1984, *ApJ*, 81, 5709
- van Dishoeck, E. F. & Visser, R. 2011, *ArXiv e-prints*
- Varandas, A. J. C., Voronin, A. I., Riganelli, A., & Caridade, P. J. S. B. 1997, *Chem. Phys. Lett.*, 278, 325
- Viala, Y. P., Letzelter, C., Eidelsberg, M., & Rostas, F. 1988, *A&A*, 193, 265
- Visser, R., Geers, V. C., Dullemond, C. P., et al. 2007, *A&A*, 466, 229
- Visser, R., van Dishoeck, E. F., & Black, J. H. 2009, *A&A*, 503, 323
- Vlemmings, W. H. T., Ramstedt, S., Rao, R., & Maercker, M. 2012, *A&A*, 540, L3
- Wakelam, V., Herbst, E., Loison, J.-C., et al. 2012, *ApJ*, 199, 21
- Wakelam, V., Smith, I. W. M., Herbst, E., et al. 2010, *Space Sci. Rev.*, 156, 13

- Wakelam, V., Smith, I. W. M., Loison, J.-C., et al. 2013, ArXiv e-prints
- Walch, S. P., Wagner, A. F., Thom. H. Dunning, J., & Schatz, G. C. 1980, *J. Chem. Phys.*, 72, 2894
- Walsh, C., Harada, N., Herbst, E., & Millar, T. J. 2009, *ApJ*, 700, 752
- Walter, C. W., Cosby, P., & Helm, H. 1993, *J. Chem. Phys.*, 99, 3553
- Wang, W., Rosa, C., & Brandao, J. 2006, *Chem. Phys. Lett.*, 418, 250
- Watanabe, N. & Kouchi, A. 2002, *ApJ*, 571, L173
- Wayne, R. P. 2000, *Chemistry of Atmospheres* (Oxford University Press)
- Weck, P. F., Balakrishnan, N., ao, B., Rosa, C., & Wang, W. 2006, *J. Chem. Phys.*, 124, 74308
- Wei, Q., Li, X., & Li, T. 2010, *Chem. Phys.*, 368, 58
- Westenberg, A. A. & Haas, N. d. A. 1967, *J. Chem. Phys.*, 47, 4241
- Willacy, K. & Millar, T. J. 1997, *A&A*, 324, 237
- Willems, F. J. & de Jong, T. 1986, *ApJ*, 309, L39
- Woodall, J., Agúndez, M., Markwick-Kemper, A. J., & Millar, T. J. 2007, *A&A*, 466, 1197
- Woods, P. M., Schöier, F. L., Nyman, L.-Å., & Olofsson, H. 2003, *A&A*, 402, 617
- Wu, C. Y. R., Judge, D. L., Tsai, M.-H., et al. 2012, *J. Chem. Phys.*, 136, 044301
- Wu, M. & Fehlner, T. 1975, *Chem. Phys. Lett.*, 36, 114
- Zack, L. N., Halfen, D. T., & Ziurys, L. M. 2011, *ApJ*, 733, L36
- Zhai, H., Zhang, P., & Zhou, P. 2012, *Comput. Theor. Chem.*, 986, 25
- Ziurys, L. M. 2006, *Pro. Natl. Acad. Sci.*, 103, 12274
- Ziurys, L. M., Milam, S. N., Apponi, A. J., & Woolf, N. J. 2007, *Nature*, 447, 1094
- Ziurys, L. M., Tenenbaum, E. D., Pulliam, R. L., Woolf, N. J., & Milam, S. N. 2009, *ApJ*, 695, 1604

