Hot chemistry and physics in the planet-forming zones of disks

Bast, J.E.

Appendix

Auxiliary figures

This appendix presents simulations of the spectra of all molecules considered here at higher spectral resolving power of $R = 3000$ and $R = 50000$, appropriate for future instruments. In addition, spectra at the *Spitzer* resolving power of $R = 600$ are included. All spectra are computed for $T_{ex} = 200$, 500 and 1000 K, $b = 5$ km s^{-1} and a column density of $1{\cdot}10^{16}$ cm^{-2}.

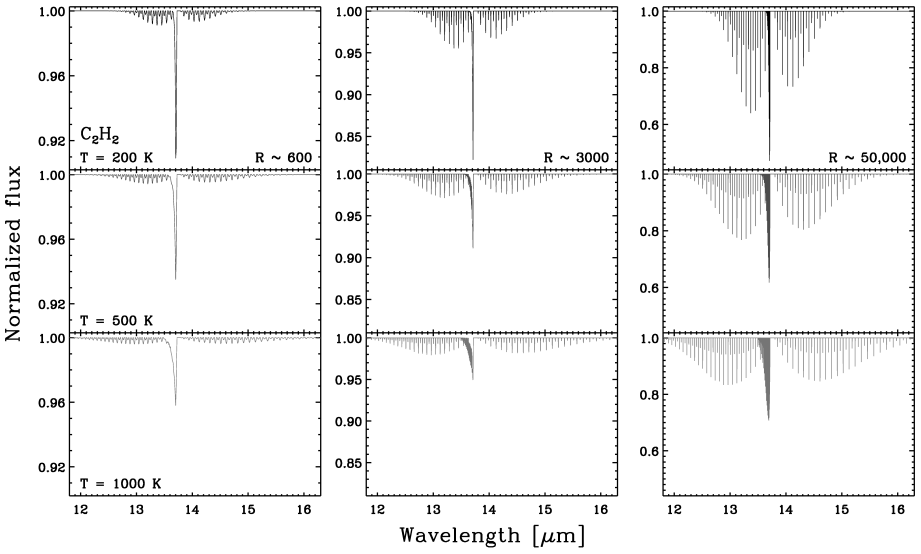

Figure 10 The synthetic spectrum of C_2H_2 at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right). Note the different vertical scales for the different spectral resolving powers in this and subsequent figures .

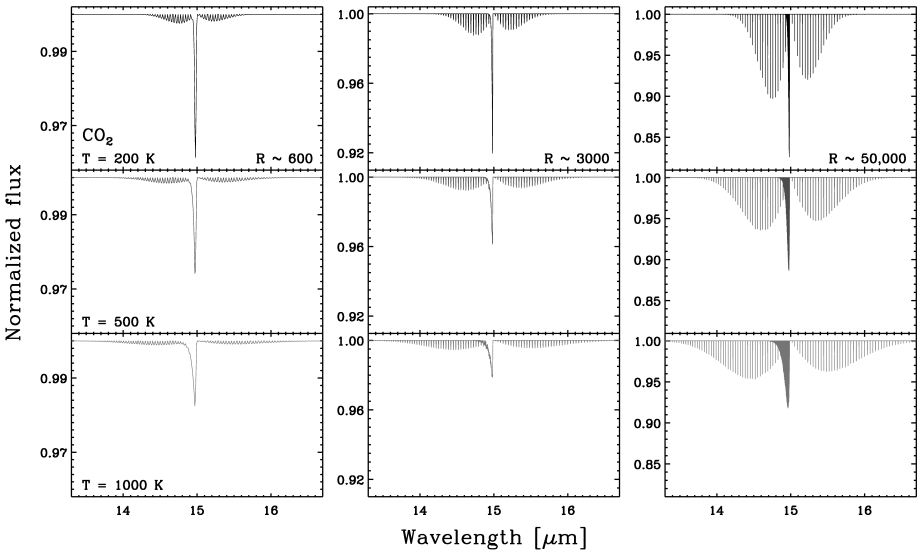

Figure 11 The synthetic spectrum of CO_2 at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

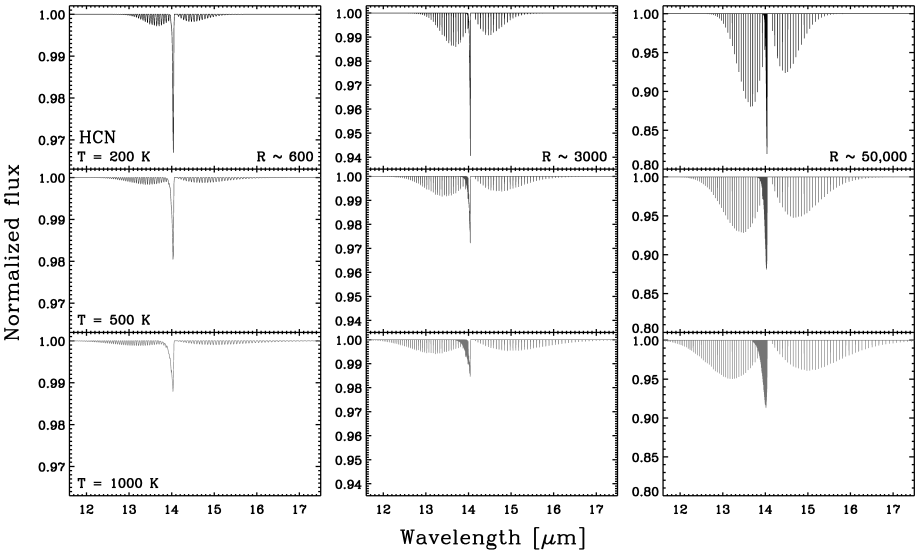

Figure 12 The synthetic spectrum of HCN at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

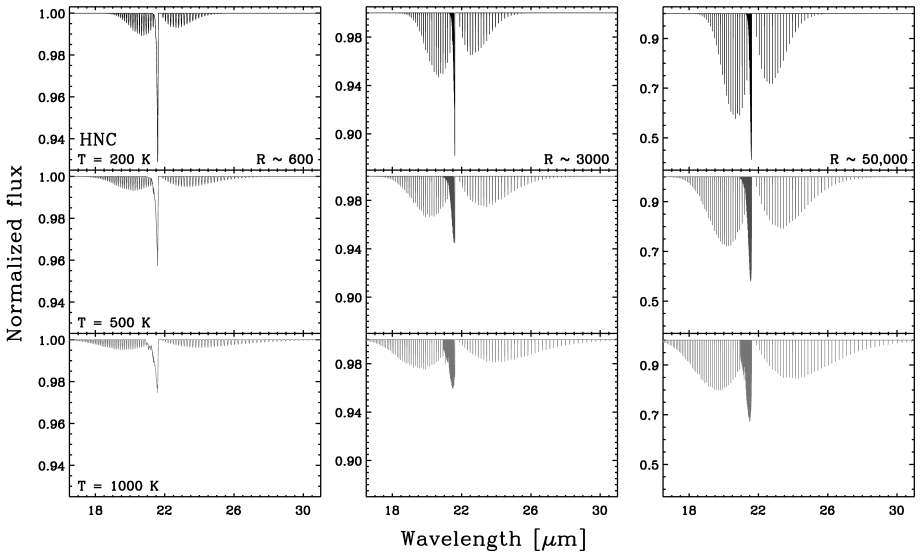

Figure 13 The synthetic spectrum of HNC at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

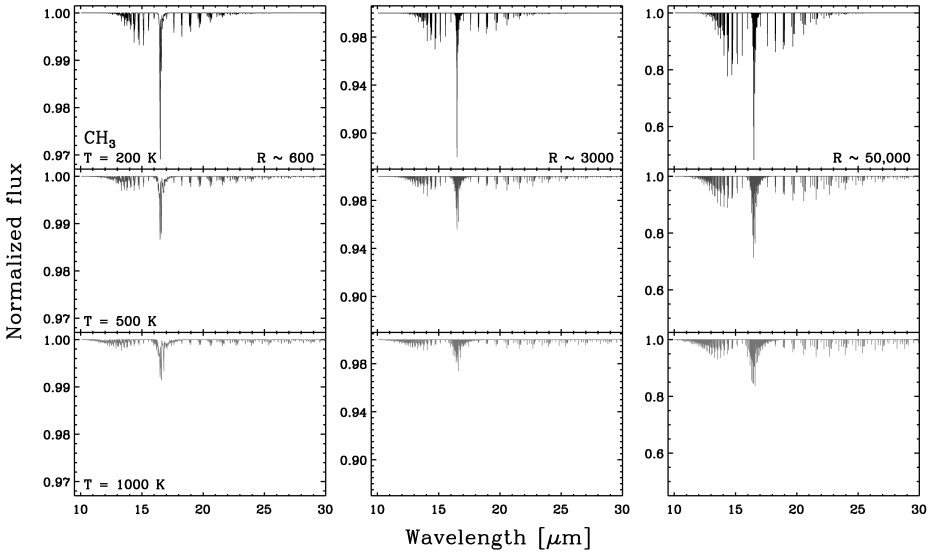

Figure 14 The synthetic spectrum of CH_3 at a column density of $1.0{\cdot}10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

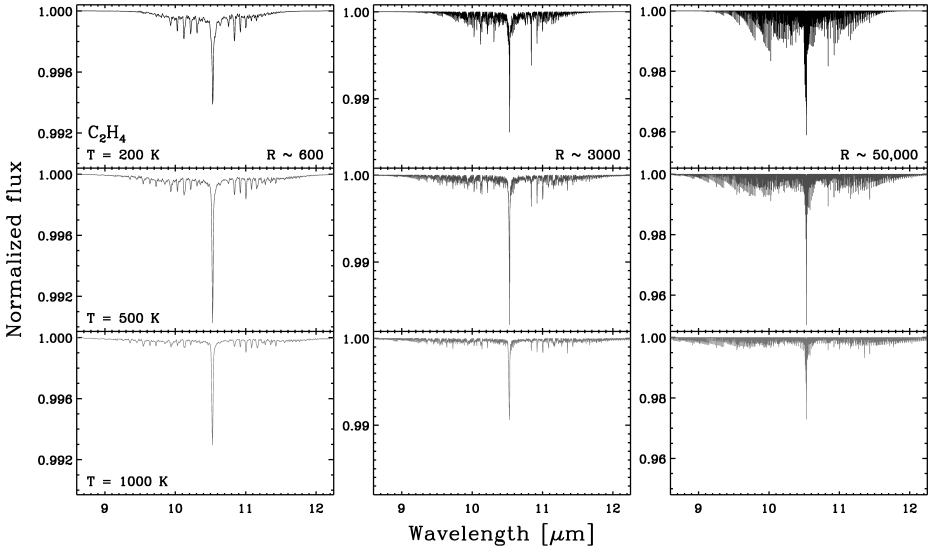

Figure 15 The synthetic spectrum of C_2H_4 at a column density of $1.0{\cdot}10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

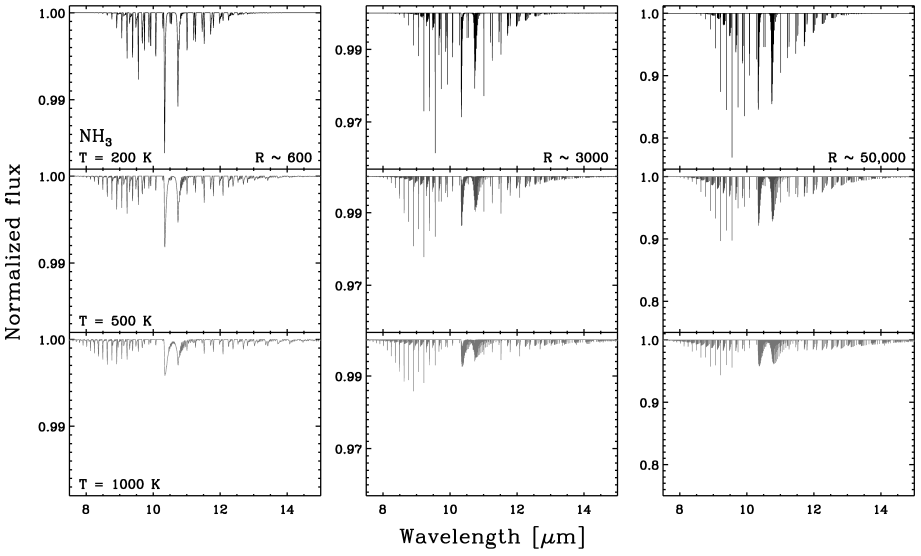

Figure 16 The synthetic spectrum of NH_3 at a column density of $1.0{\cdot}10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

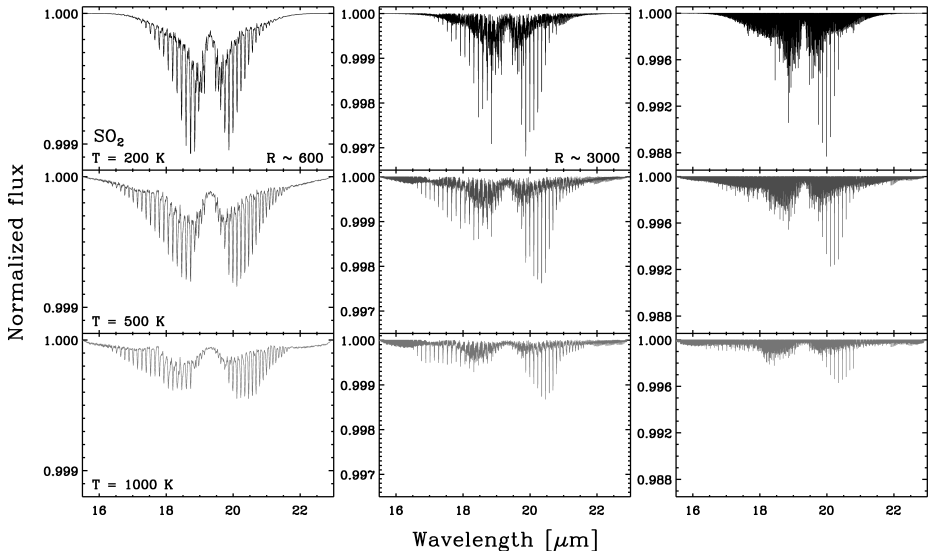

Figure 17 The synthetic spectrum of SO_2 at a column density of $1.0{\cdot}10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

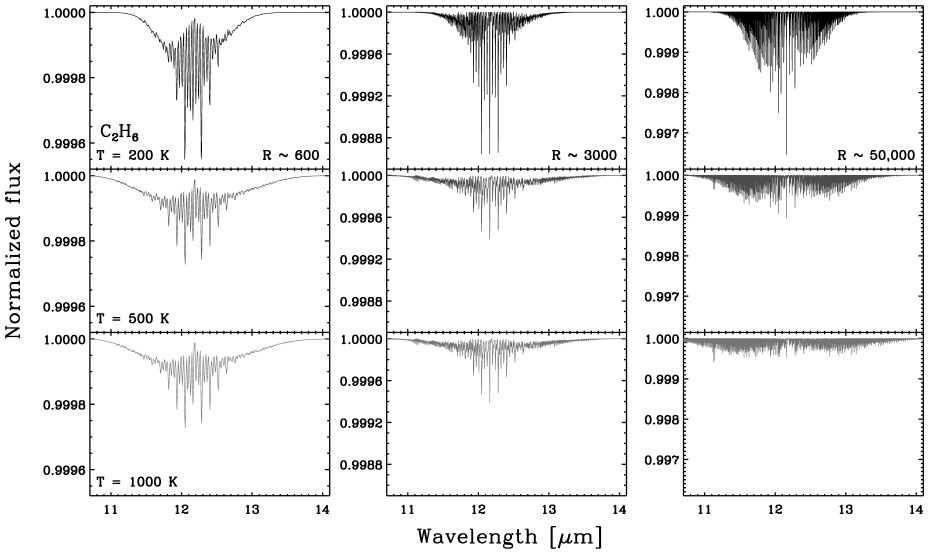

Figure 18 The synthetic spectrum of C_2H_6 at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

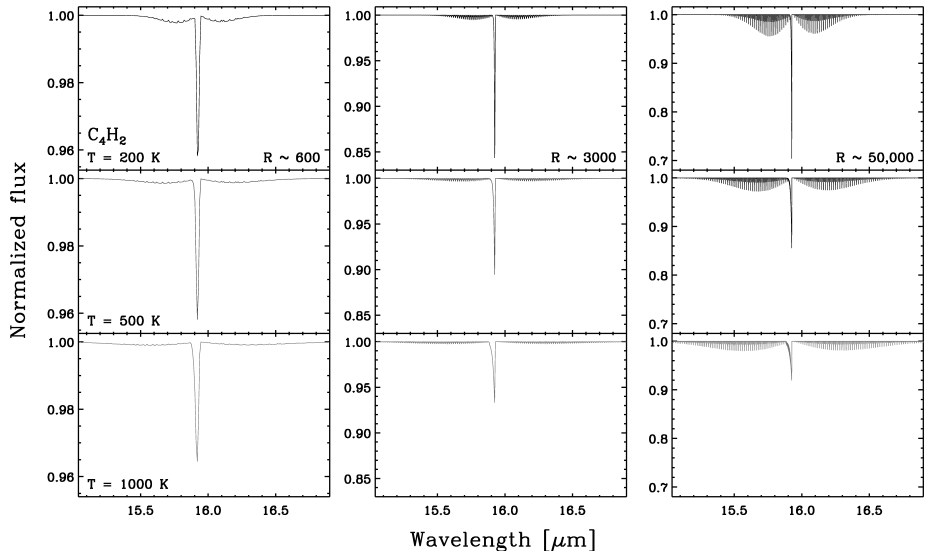

Figure 19 The synthetic spectrum of C_4H_2 at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

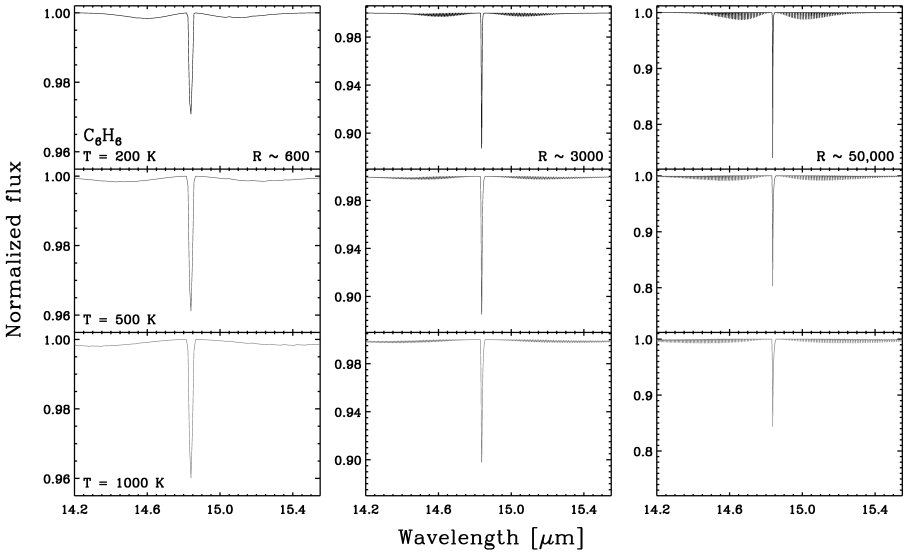

Figure 20 The synthetic spectrum of C_6H_6 at a column density of $1.0{\cdot}10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

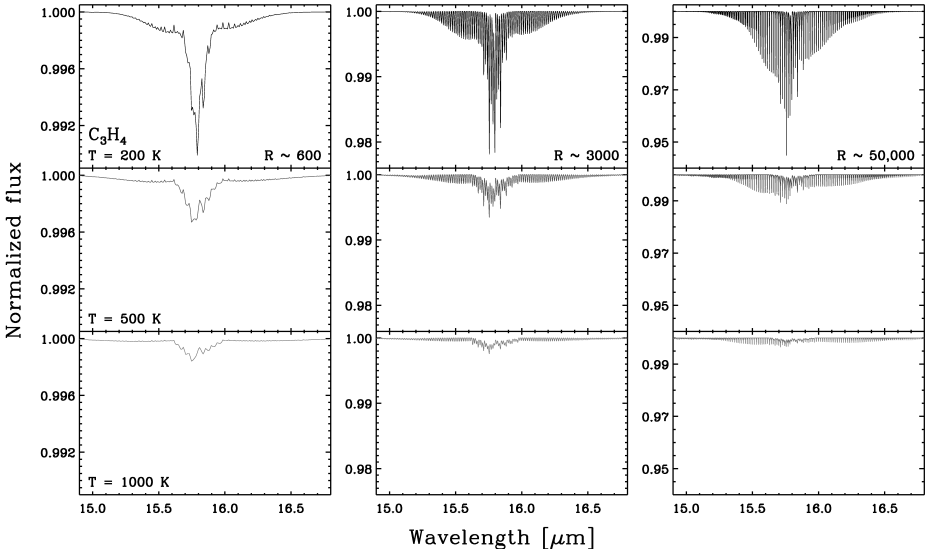

Figure 21 The synthetic spectrum of C_3H_4 at a column density of $1.0{\cdot}10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

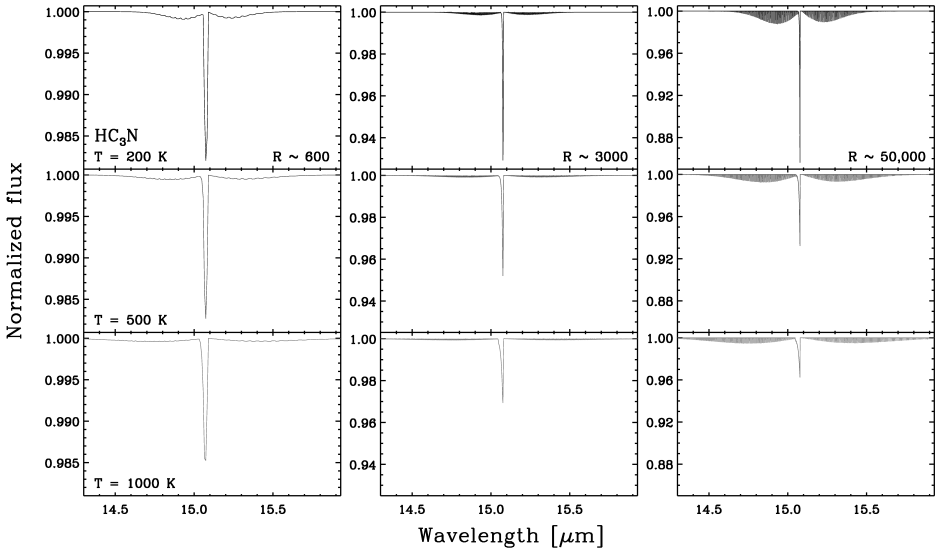

Figure 22 The synthetic spectrum of HC_3N at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

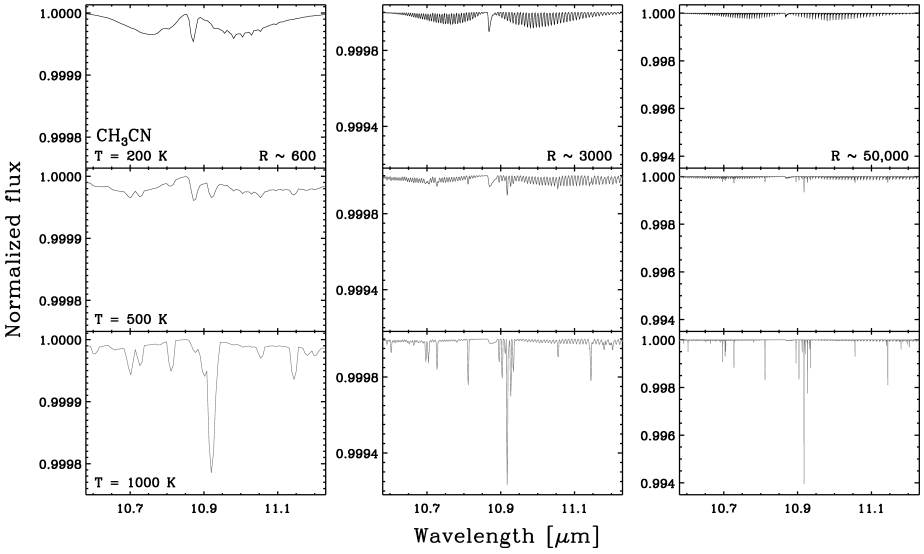

Figure 23 The synthetic spectrum of CH_3CN at a column density of $1.0 \cdot 10^{16}$ cm^{-2}, excitation temperatures of 200 (top), 500 (middle) and 1000 K (bottom), and spectral resolving powers of 600 (left), 3000 (middle) and 50,000 (right).

Bibliography

Adams, F. C., Lada, C. J., & Shu, F. H. 1987, ApJ, 312, 788

Alexander, R. D. 2008, MNRAS, 391, L64

Agúndez, M., Cernicharo, J., & Goicoechea, J. R. 2008, A&A, 483, 831

Aikawa, Y., Umebayashi, T., Nakano, T., & Miyama, S. M. 1999, ApJ, 519, 705

André, P., Ward-Thompson, D., & Barsony, M. 1993, ApJ, 406, 122

Andrews, S. M. & Williams, J. P. 2007, ApJ, 659, 705

Andrews, S., 2008, PhD thesis, University of Hawaii

Andrews, S. M., Wilner, D. J., Hughes, A. M., Qi, C., & Dullemond, C. P. 2009, ApJ, 700, 1502

Appenzeller, I., Krautter, J., & Jankovics, I. 1983, Astronomy and Astrophysics Supplement Series, 53, 291

Appenzeller, I., Jetter, R., & Jankovics, I. 1986, A&AS, 64, 65

Ardila, D. R., Basri, G., Walter, F. M., Valenti, J. A., & Johns-Krull, C. M. 2002, ApJ, 567, 1013

Aresu, G., Kamp, I., Meijerink, R., Woitke, P., Thi, W.-F., & Spaans, M. 2011, A&A, 526, A163

Augereau, J. C., Lagrange, A. M., Mouillet, D., & Ménard, F. 2001, A&A, 365, 78

Bally, J., O'Dell, C. R., & McCaughrean, M. J. 2000, AJ, 119, 2919

Bary, J. S., Matt, S. P., Skrutskie, M. F., Wilson, J. C., Peterson, D. E., & Nelson, M. J. 2008, ApJ, 687, 376

Bast, J. E., Brown, J. M., Herczeg, G. J., van Dishoeck, E. F., & Pontoppidan, K. M. 2011, A&A, 527, A119

Bast, J. E., Lahuis, F., Tielens, A. G. G. M. & van Dishoeck, E. F. 2012, submitted

Bergin, E. A., & Tafalla, M. 2007, ARA&A, 45, 339

Bergin, E. A., Aikawa, Y., Blake, G. A., & van Dishoeck, E. F. 2007, Protostars and Planets V, 751

Bergin, E. A. 2011, in 'Physical Processes in Circumstellar Disks Around Young Stars', ed. P. Garcia, (University of Chicago Press: Chicago), p. 55

Bergin, E. A. 2009, arXiv:0908.3708

Bethell, T. & Bergin, E. 2009, Science, 326, 1675
Bettens, R. P. A., Lee, H.-H., Herbst, E. 1995, ApJ, 443, 664
Bitner, M. A., Richter, M. J., Lacy, J. H., Greathouse, T. K., Jaffe, D. T., & Blake, G. A. 2007, ApJ, 661, L69
Blake, G. A., & Boogert, A. C. A. 2004, ApJ, 606, L73
Bockelée-Morvan, D. 2011, in 'The Molecular Universe', IAU Symposium 280, ed. J. Cernicharo & R. Bachiller (Cambridge University Press), p. 261
Bonev, B. P. & Mumma, M. J. 2006, ApJ, 653, 788
Boonman, A. M. S., van Dishoeck, E. F., Lahuis, F., & Doty, S. D. 2003, A&A, 399, 1063
Borucki, W. J., Koch, D. G., Basri, G., et al. 2011, ApJ, 736, 19
Bottinelli, S., Boogert, A. C. A., Bouwman, J., Beckwith, M., van Dishoeck, E. F., Öberg, K. I., Pontoppidan, K. M., Linnartz, H., Blake, G. A., Evans, N. J., & Lahuis, F. 2010, ApJ, 718, 1100
Bouvier, J., Alencar, S. H. P., Boutelier, T., et al. 2007, A&A, 463, 1017
Brandl, B., Blommaert, J., Glasse, A., Lenzen, R., & Pantin, E. 2010, The Messenger, 140, 30
Brittain, S. D., Rettig, T. W., Simon, T., Kulesa, C., DiSanti, M. A., & Dello Russo, N. 2003, ApJ, 588, 535
Brittain, S. D., Simon, T., Najita, J. R., & Rettig, T. W. 2007, ApJ, 659, 685
Brittain, S. D., Najita, J. R., & Carr, J. S. 2009, ApJ, 702, 85
Brogi, M., Snellen, I. A. G., de Kok, R. J., et al. 2012, Nature, 486, 502
Brown, J. M., Blake, G. A., Qi, C., Dullemond, C. P., Wilner, D. J., & Williams, J. P. 2009, ApJ, 704, 496
Brown, J., Pontoppidan, K.M., van Dishoeck, E.F., & Herczeg, G. 2012, subm.
Bruderer, S., van Dishoeck, E. F., Doty, S. D., & Herczeg, G. J. 2012, A&A, 541, A91
Calvet, N., Magris, G. C., Patino, A., & D'Alessio, P. 1992, Rev. Mexicana Astron. Astrofis., 24, 27
Carmona, A., van den Ancker, M. E., & Henning, T. 2007, A&A, 464, 687
Carr, J. S. 1989, ApJ, 345, 522
Carr, J. S., Tokunaga A. T., Najita, J., Shu, F. H., & Glassgold, A. E. 1993, ApJ, 411, L37
Carr, J. S., Tokunaga, A. T., & Najita, J. 2004, ApJ, 603, 213
Carr, J. S., & Najita, J. R. 2008, Science, 319, 1504
Carr, J. S., & Najita, J. R. 2011, ApJ, 733, 102
Chandler, C. J., Carlstrom, J. E., Scoville, N. Z., Dent, W. R. F., & Geballe, T. R. 1993, ApJ, 412, L71
Chandra, S., & Sharma, A. K. 2001, A&A, 376, 356
Charnley, S. B. 1997, ApJ, 481, 396
Cherchneff, I., Glassgold, A.E. 1993, ApJ, 419, L41

Chiang, E. I., & Goldreich, P. 1997, ApJ, 490, 368
Ciesla, F. J., Cuzzi, J. N. 2006, Icarus, 181, 178
Clampin, M., Krist, J. E., Ardila, D. R., et al. 2003, AJ, 126, 385
Clary, D. C. 1983, J. Chem. Phys., 78, 4915
Clough, S. A., Iacono, M. J., & Moncet, J. -L. 1982, J. Geophys. Res., 97, 15,761-15785.
Clough, S. A., Shephard, M. W., Mlawer, E. J., Delamere, J. S., Iacono, M. J., Cady-Pereira, K., Boukabara, S., & Brown, P. D. 2005, Journal of Quantitative Spectroscopy and Radiative Transfer, 91, 233
Crapsi, A., van Dishoeck, E. F., Hogerheijde, M. R., Pontoppidan, K. M., & Dullemond, C. P. 2008, A&A, 486, 245
Cutri, R. M., Skrutskie, M. F., van Dyk, S., Beichman, C. A., Carpenter, J. M., Chester, T., Cambresy, L., Evans, T., Fowler, J., Gizis, J., Howard, E., Huchra, J., Jarrett, T., Kopan, E. L., Kirkpatrick, J. D., Light, R. M., Marsh, K. A., McCallon, H., Schneider, S., Stiening, R., Sykes, M., Weinberg, M., Wheaton, W. A., Wheelock, S., & Zacarias, N. 2003, 2MASS All Sky Catalog of point sources. (The IRSA 2MASS All-Sky Point Source Catalog, NASA/IPAC Infrared Science Archive.)
D'Alessio, P., Canto, J., Calvet, N., & Lizano, S. 1998, ApJ, 500, 411
Decin, L., Morris, P. W., Appleton, P. N., et al. 2004, ApJS, 154, 408
Désert, J.-M., Bean, J., Miller-Ricci Kempton, E., et al. 2011, ApJ, 731, L40
di Francesco, J., Evans, N. J., II, Caselli, P., et al. 2007, Protostars and Planets V, 17
Doppmann, G. W., Najita, J. R., & Carr, J. S. 2008, ApJ, 685, 298
Doty, S. D., van Dishoeck, E. F., van der Tak, F. F. S., & Boonman, A. M. S. 2002, A&A, 389, 446
Draine, B. T., Roberge, W. G., Dalgarno, A. 1983, ApJ, 264, 485
Dutrey, A., Guilloteau, S., & Guelin, M. 1997, A&A, 317, L55
Dullemond, C. P., & Dominik, C. 2004, A&A, 417, 159
Dullemond, C. P., & Monnier, J. D. 2010, ARA&A, 48, 205
Dumouchel, F., Faure, A., & Lique, F. 2010, MNRAS, 406, 2488
Edwards, S., Fischer, W., Hillenbrand, L., & Kwan, J. 2006, ApJ, 646, 319
Ehrenfreund, P., & Charnley, S. B. 2000, ARA&A, 38, 427
Eisner, J. A., Hillenbrand, L. A., White, R. J., Akeson, R. L., & Sargent, A. I. 2005, ApJ, 623, 952
Ercolano, B., & Owen, J. E.
Evans, N. J., II, Lacy, J. H., & Carr, J. S. 1991, ApJ, 383, 674
Evans, N.J. et al. 2003, PASP, 115, 965
Evans, N. J., Dunham, M. M., Jørgensen, J. K., et al. 2009, ApJS, 181, 321
Fedele, D., Pascucci, I., Brittain, S., Kamp, I., Woitke, P., Williams, J. P., Dent, W. R. F., & Thi, W.-F. 2011, ApJ, 732, 106

Fuente, A., Cernicharo, J., Agúndez, M., Berné, O., Goicoechea, J. R., Alonso-Albi, T., & Marcelino, N. 2010, A&A, 524, A19
Fuente, A., Cernicharo, J., & Agúndez, M. 2012, arXiv:1206.5076
Fukagawa, M., Hayashi, M., Tamura, M., et al. 2004, ApJ, 605, L53
Garcia Lopez, R., Natta, A., Testi, L., & Habart, E. 2006, A&A, 459, 837
Garrod, R. T., Weaver, S. L. W., & Herbst, E. 2008, ApJ, 682, 283
Geers, V. C., et al. 2006, A&A, 459, 545
Gibb, E. L., Rettig, T., Brittain, S., Haywood, R., Simon, T., & Kulesa, C. 2004, ApJ, 610, L113
Gibb, E. L., Van Brunt, K. A., Brittain, S. D., & Rettig, T. W. 2007, ApJ, 660, 1572
Gibb, E. & Troutman, M., 2011, IAU Symposium 280, Poster 31
Glass, I. S. & Penston, M. V. 1974, Royal Astronomical Society, 167, 237
Glassgold, A. E. & Najita, J. R. 2001, Young Stars Near Earth: Progress and Prospects, 244, 251
Glassgold, A. E., Meijerink, R., & Najita, J. R. 2009, ApJ, 701, 142
Goicoechea, J. R., & Nakagawa, T. 2011, in 'Conditions and impact of star formation', EAS series, vol. 52, ed. M. Röllig et al. (EDP Sciences), p. 253
Gorti, U., & Hollenbach, D. 2008, ApJ, 683, 287
Gorti, U., Dullemond, C. P., & Hollenbach, D. 2009, ApJ, 705, 1237
Gorti, U., & Hollenbach, D. 2009, ApJ, 690, 1539
Gorti, U., Hollenbach, D., Najita, J., & Pascucci, I. 2011, ApJ, 735, 90
Grady, C. A., Woodgate, B., Bruhweiler, F. C., et al. 1999, ApJ, 523, L151
Grady, C. A., Woodgate, B. E., Bowers, C. W., et al. 2005, ApJ, 630, 958
Grady, C. A., et al. 2009, ApJ, 699, 1822
Gras-Velázquez, À., & Ray, T. P. 2005, A&A, 443, 541
Gregory, S. G., Matt, S. P., Donati, J.-F., & Jardine, M. 2008, MNRAS, 389, 1839
Guenther, E. W., Esposito, M., Mundt, R., Covino, E., Alcalá, J. M., Cusano, F., & Stecklum, B. 2007, A&A, 467, 1147
Günther, H. M., & Schmitt, J. H. M. M. 2008, A&A, 481, 735
Gullbring, E., Hartmann, L., Briceno, C., & Calvet, N. 1998, ApJ, 492, 323
Hartigan, P., Hartmann, L., Kenyon, S. J., Strom, S. E., & Skrutskie, M. F. 1990, ApJ, 354, L25
Hartmann, L., Hewett, R., & Calvet, N. 1994, ApJ, 426, 669
Hartmann, L., Calvet, N., Gullbring, E., & D'Alessio, P. 1998, ApJ, 495, 385
Heap, S. R., Lindler, D. J., Lanz, T. M., et al. 2000, ApJ, 539, 435
Heinzeller, D., Nomura, H., Walsh, C., & Millar, T. J. 2011, ApJ, 731, 115
Helmich, F. P. 1996, PhD thesis, Leiden Observatory, Leiden University
Henning, T., et al. 2010, ApJ, 714, 1511
Herczeg, G. J., & Hillenbrand, L. A. 2008, ApJ, 681, 594
Herbst, E., & van Dishoeck, E. F. 2009, ARA&A, 47, 427

Hogerheijde, M. 1998, Ph.D. Thesis,
Hogerheijde, M., et al. 2011, Science, 334, 338
Hughes, A. M., Wilner, D. J., Cho, J., Marrone, D. P., Lazarian, A., Andrews, S. M., & Rao, R. 2009, ApJ, 704, 1204
Ida, S., & Lin, D. N. C. 2004, ApJ, 604, 388
Isella, A., Carpenter, J. M., & Sargent, A. I. 2009, ApJ, 701, 260
Jacquinet-Husson, N., Crepeau, L., Armante, R. et al. 2011 JQSRT, 112, 2395
Kamp, I. & Dullemond, C. P. 2004, ApJ, 615, 991
Kamp, I., Tilling, I., Woitke, P., Thi, W.-F., & Hogerheijde, M. 2010, A&A, 510, A18
Kasting, J. F., Whitmire, D. P., & Reynolds, R. T. 1993, Icarus, 101, 108
Kastner, J. H., Zuckerman, B., Weintraub, D. A., & Forveille, T. 1997, Science, 277, 67
Käufl, H.-U., Ballester, P., Biereichel, P., et al. 2004, Proc. SPIE, 5492, 1218
Kenyon, S. J., & Hartmann, L. 1987, ApJ, 323, 714
Kessler-Silacci, J., Augereau, J.-C., Dullemond, C. P., et al. 2006, ApJ, 639, 275
Klahr, H., & Bodenheimer, P. 2006, ApJ, 639, 432
Kley, W., Bitsch, B., & Klahr, H. 2009, A&A, 506, 971
Knez, C., Lacy, J. H., Evans, N. J., II, van Dishoeck, E. F., & Richter, M. J. 2009, ApJ, 696, 471
Kominami, J., & Ida, S. 2002, Icarus, 157, 43
Koresko, C. D., Herbst, T. M., & Leinert, C. 1997, ApJ, 480, 741
Koresko, C. D., Blake, G. A., Brown, M. E., Sargent, A. I., & Koerner, D. W. 1999, ApJ, 525, L49
Kress, M. E., Tielens, A. G. G. M. & Frenklach, M. 2010, Advances in Space Research, 46, 44
Krotkov, R., Wang, D., & Scoville, N. Z. 1980, ApJ, 240, 940
Kruger, A. J., Richter, M. J., Carr, J. S., et al. 2011, ApJ, 729, 145
Kurosawa, R., Harries, T. J., & Symington, N. H. 2006, MNRAS, 370, 580
Lacy, J. H., Evans, N. J., II; Achtermann, J. M., Bruce, D. E., Arens, J. F., Carr, J. S. 1989, ApJ, 342, L43
Lahuis, F., & van Dishoeck, E. F. 2000, A&A, 355, 699
Lahuis, F., & Boogert, A. 2003, SFChem 2002: Chemistry as a Diagnostic of Star Formation, ed. C. L. Curry & M. Fich (NRC Press, Ottawa, Canada), p. 335
Lahuis, F., et al. 2006, ApJ, 636, L145
Lahuis, F., et al. 2006b, c2d Spectroscopy Explanatory Suppl. (Pasadena: Spitzer Science Center)
Lahuis, F., van Dishoeck, E. F., Blake, G. A., et al. 2007, ApJ, 665, 492
Lahuis, F., Kamp, I., Thi, W. F., van Dishoeck, E. F. & Woitke, P. 2011, IAU Symposium 280, Poster 44
Langer, W. D.; Graedel, T. E. 1989, ApJS, 69, 241

Langer, W. D. & Penzias, A. A. 1990, ApJ, 357, 477
Leinert, C., Beck, T. L., Ligori, S., Simon, M., Woitas, J., & Howell, R. R. 2001, A&A, 369, 215
Lissauer, J. J. 1993, ARA&A, 31, 129
Loinard, L., Torres, R. M., Mioduszewski, A. J., & Rodríguez, L. F. 2008, ApJ, 675, L29
Lommen, D., Wright, C. M., Maddison, S. T., Jørgensen, J. K., Bourke, T. L., van Dishoeck, E. F., Hughes, A., Wilner, D. J., Burton, M., & van Langevelde, H. J. 2007, A&A, 462, 211
Luhman, K. L., Allen, L. E., Allen, P. R., et al. 2008, ApJ, 675, 1375
Madhusudhan, N., Harrington, J., Stevenson, K. B., et al. 2011, Nature, 469, 64
Madhusudhan, N. & Seager, S. 2011, The Astrophysical Journal, 729, 41
Mandell, A. M., Mumma, M. J., Blake, G. A., Bonev, B. P., Villanueva, G. L., & Salyk, C. 2008, ApJ, 681, L25
Mandell, A. M., Deming, L. D., Blake, G. A., Knutson, H. A., Mumma, M. J., Villanueva, G. L., & Salyk, C. 2011, ApJ, 728, 18
Mandell, A. M., Bast, J., van Dishoeck, E. F., et al. 2012, ApJ, 747, 92
Markwick, A. J., Ilgner, M., Millar, T. J., & Henning, T. 2002, A&A, 385, 632
Markwick, A. J., & Charnley, S. B. 2004, Astrobiology: Future Perspectives, 305, 33
Martin, S. C. 1997, ApJ, 478, L33
Mayor, M., & Queloz, D. 1995, Nature, 378, 355
McCaughrean, M. J., & O'Dell, C. R. 1995, NASA, PRC95-45b,ST Sci OPO
Meijerink, R., Poelman, D. R., Spaans, M., Tielens, A. G. G. M., & Glassgold, A. E. 2008, ApJ, 689, L57
Meijerink, R., Pontoppidan, K. M., Blake, G. A., Poelman, D. R., & Dullemond, C. P. 2009, ApJ, 704, 1471
Melo, C. H. F. 2003, A&A, 410, 269
Men'shchikov, A. B., & Henning, T. 1997, A&A, 318, 879
Millar, T. J., & Herbst, E. 1994, A&A, 288, 561
Mitchell, G. F. 1984, ApJS, 54, 81
Mordasini, C., Alibert, Y., & Benz, W. 2009, A&A, 501, 1139
Mordasini, C., Alibert, Y., Benz, W., & Naef, D. 2009, A&A, 501, 1161
Mumma, M. J., et al. 2011, ApJ, 734, L7
Mumma, M. J. & Charnley, S. B. 2011, Annual Review of Astronomy and Astrophysics, 49, 471
Muzerolle, J., Calvet, N., & Hartmann, L. 2001, ApJ, 550, 944
Muzerolle, J., Calvet, N., Hartmann, L., & D'Alessio, P. 2003, ApJ, 597, L149
Najita, J., Carr, J. S., Glassgold, A. E., Shu, F. H. & Tokunaga, A. T. 1996, ApJ, 462, 919
Najita, J. R., Edwards, S., Basri, G., & Carr, J. 2000, Protostars and Planets IV,

eds. V. Mannings, (Tucson: Univ. of Arizona), 457
Najita, J., Carr, J. S., & Mathieu, R. D. 2003, ApJ, 589, 931
Najita, J. R., Carr, J. S., Glassgold, A. E., & Valenti, J. A. 2007, Protostars and Planets V, ed. B. Reipurth, (Tucson: Univ. of Arizona), 507
Najita, J. R., Carr, J. S., Strom, S. E., Watson, D. M., Pascucci, I., Hollenbach, D., Gorti, U., & Keller, L. 2010, ApJ, 712, 274
Najita, J. R., Ádámkovics, M., & Glassgold, A. E. 2011, ApJ, 743, 147
Natta, A., Meyer, M. R., & Beckwith, S. V. W. 2000, ApJ, 534, 838
Natta, A., Testi, L., & Randich, S. 2006, A&A, 452, 245
Natta, A., Testi, L., Calvet, N., et al. 2007, Protostars and Planets V, 767
Najita, J. R., Ádámkovics, M., & Glassgold, A. E. 2011, ApJ, 743, 147
Nomura, H., Aikawa, Y., Tsujimoto, M., Nakagawa, Y., & Millar, T. J. 2007, ApJ, 661, 334
Nomura, H., Aikawa, Y., Nakagawa, Y., & Millar, T. J. 2009, A&A, 495, 183
Öberg, K. I., Boogert, A. C. A., Pontoppidan, K. M., et al. 2008, ApJ, 678, 1032
Öberg, K. I., Garrod, R. T., van Dishoeck, E. F., & Linnartz, H. 2009, A&A, 504, 891
Öberg, K. I., et al. 2011, ApJ, 734, 98
O'Dell, C. R., Wen, Z., & Hu, X. 1993, ApJ, 410, 696
Oliveira, I., et al. 2010, ApJ, 714, 778
Pascucci, I., Apai, D., Luhman, K., Henning, T., Bouwman, J., Meyer, M. R., Lahuis, F., & Natta, A. 2009, ApJ, 696, 143
Paufique, J., Biereichel, P., Donaldson, R., et al. 2004, Proc. SPIE, 5490, 216
Pineau des Forêts, G., Flower, D. R., Hartquist, T. W., Millar, T. J. 1987, MNRAS, 227, 993
Pontoppidan, K. M. 2006, A&A, 453, L47
Pontoppidan, K. M., Dullemond, C. P., Blake, G. A., Boogert, A. C. A., van Dishoeck, E. F., Evans, N. J., II, Kessler-Silacci, J., & Lahuis, F. 2007, ApJ, 656, 980
Pontoppidan, K. M., Blake, G. A., van Dishoeck, E. F., Smette, A., Ireland, M. J., & Brown, J. 2008, ApJ, 684, 1323
Pontoppidan, K. M., Meijerink, R., Dullemond, C. P., & Blake, G. A. 2009, ApJ, 704, 1482
Pontoppidan, K. M., Salyk, C., Blake, G. A., Meijerink, R., Carr, J. S., & Najita, J. 2010, ApJ, 720, 887
Pontoppidan, K. M., Blake, G. A., & Smette, A. 2011, ApJ, 733, 84
Pontoppidan, K. M., van Dishoeck, E., Blake, G. A., et al. 2011, The Messenger, 143, 32
Prato, L., Greene, T. P., & Simon, M. 2003, ApJ, 584, 853
Prinn, R. G. 1993, Protostars and Planets III, ed. E. Levy & J. I. Lunine (Tucson: University of Arizona Press), 1005

Przygodda, F. 2004, Ph.D. Thesis, , Max-Planck Institute of Astronomy, Heidelberg
Qi, C., Wilner, D. J., Calvet, N., Bourke, T. L., Blake, G. A., Hogerheijde, M. R., Ho, P. T. P., & Bergin, E. 2006, ApJ, 636, L157
Reipurth, B., & Zinnecker, H. 1993, A&A, 278, 81
Rettig, T. W., Haywood, J., Simon, T., Brittain, S. D., & Gibb, E. 2004, ApJ, 616, L163
Ricci, L., Testi, L., Natta, A., Neri, R., Cabrit, S., & Herczeg, G. J. 2010, A&A, 512, A15
Richter, M. J., Lacy, J. H., Jaffe, D. T., Mar, D. J., Goertz, J., Moller, W. M., Strong, S., Greathouse, T. K. 2006, SPIE, 6296, p.62691
Robitaille, T. P., Whitney, B. A., Indebetouw, R., & Wood, K. 2007, The Astrophysical Journal Supplement Series, 169, 328
Roccatagliata, V., Ratzka, T., Henning, T., et al. 2011, A&A, 534, A33
Rodgers, S. D., & Charnley, S. B. 2003, ApJ, 585, 355
Rothman, L. S., Gordon, I. E., Barbe, A. et al. 2009, JQSRT, 110, 533
Salyk, C., Blake, G. A., Boogert, A. C. A., & Brown, J. M. 2007, ApJ, 655, L105
Salyk, C., Pontoppidan, K. M., Blake, G. A., Lahuis, F., van Dishoeck, E. F., & Evans, N. J., II 2008, ApJ, 676, L49
Salyk, C., Blake, G. A., Boogert, A. C. A., & Brown, J. M. 2009, ApJ, 699, 330
Salyk, C., Pontoppidan, K. M., Blake, G. A., Najita, J. R., & Carr, J. S. 2011, ApJ, 731, 130
Salyk, C., Blake, G. A., Boogert, A. C. A., & Brown, J. M. 2011, ApJ, 743, 112
Schegerer, A. A., Wolf, S., Hummel, C. A., Quanz, S. P., & Richichi, A. 2009, A&A, 502, 367
Schöier, F. L., van der Tak, F. F. S., van Dishoeck, E. F., & Black, J. H. 2005, A&A, 432, 369
Smith, I. W. M., & Warr, J. F. 1991, J. Chem. Soc., Faraday Trans., 87, 807
Smith, R. L., Pontoppidan, K. M., Young, E. D., Morris, M. R., & van Dishoeck, E. F. 2009, ApJ, 701, 163
Smith, I.W.M. 2011, ARA&A, 49, 29
Stäuber, P., Doty, S. D., van Dishoeck, E. F., & Benz, A. O. 2005, A&A, 440, 949
Stempels, H. C., & Piskunov, N. 2003, A&A, 408, 693
Sternberg, A., & Dalgarno, A. 1995, ApJS, 99, 565
Störzer, H., & Hollenbach, D. 1999, ApJ, 515, 669
Takami, M., Bailey, J., & Chrysostomou, A. 2003, A&A, 397, 675
Thi, W.-F., van Zadelhoff, G.-J., & van Dishoeck, E. F. 2004, A&A, 425, 955
Thompson, R. I. 1985, ApJ, 299, L41
Tielens, A. G. G. M., Charnley, S. B. 1997, Origin of Life, 27, p.23
Trilling, D. E., Lunine, J. I., & Benz, W. 2002, A&A, 394, 241
Valenti, J. A., Basri, G., & Johns, C. M. 1993, AJ, 106, 2024

Valenti, J. A., Johns-Krull, C. M., & Linsky, J. L. 2000, ApJS, 129, 399
van der Plas, G., van den Ancker, M. E., Acke, B., Carmona, A., Dominik, C., Fedele, D., & Waters, L. B. F. M. 2009, A&A, 500, 1137
van der Tak, F. F. S., Black, J. H., Schöier, F. L., Jansen, D. J., & van Dishoeck, E. F. 2007, A&A, 468, 627
Vasyunin, A. I., Wiebe, D. S., Birnstiel, T., Zhukovska, S., Henning, T., & Dullemond, C. P. 2011, ApJ, 727, 76
Viti, S., Jimenez-Serra, I., Yates, J. A., Codella, C., Vasta, M., Caselli, P., Lefloch, B., Ceccarelli, C. 2011, ApJ, 740, L3
Walsh, C., Millar, T. J., & Nomura, H. 2010, ApJ, 722, 1607
Walsh, C., Nomura, H., Millar, T. J., & Aikawa, Y. 2012, ApJ, 747, 114
Ward, W. R. 1997, Icarus, 126, 261
Whittet, D. C. B., Prusti, T., Franco, G. A. P., Gerakines, P. A., Kilkenny, D., Larson, K. A., & Wesselius, P. R. 1997, A&A, 327, 1194
Willacy, K., Klahr, H. H., Millar, T. J., & Henning, T. 1998, A&A, 338, 995
Willacy, K., & Woods, P. M. 2009, ApJ, 703, 479
Wilson, T. L., & Rood, R. 1994, ARA&A, 32, 191
Woitke, P., Kamp, I., & Thi, W.-F. 2009, A&A, 501, 383
Woods, P. M., Willacy, K. 2007, ApJ, 655, L49
Yang, H., Johns-Krull, C. M., & Valenti, J. A. 2007, AJ, 133, 73