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BIBLIOGRAPHY

- M. F. A'Hearn, *ARA&A* **49**, 281 (2011).
- ALMA Partnership et al., *ApJ* **808**, L3 (2015).
- ALMA Partnership et al., *ALMA Cycle 4 Technical Handbook* (2016).
- F. C. Adams, *ARA&A* **48**, 47 (2010).
- F. C. Adams and F. H. Shu, *ApJ* **308**, 836 (1986).
- M. Agúndez and V. Wakelam, *Chemical Reviews* **113**, 8710 (2013).
- M. F. A'hearn, D. G. Schleicher, and P. D. Feldman, *ApJ* **274**, L99 (1983).
- V. Ahrens and G. Winnewisser, *Zeitschrift Naturforschung Teil A* **54**, 131 (1999).
- Y. Aikawa, *Chemical Reviews* **113**, 8961 (2013).
- Y. Aikawa and E. Herbst, *A&A* **351**, 233 (1999).
- Y. Aikawa and H. Nomura, *ApJ* **642**, 1152 (2006).
- Y. Aikawa et al., *ApJ* **486**, L51 (1997).
- Y. Aikawa et al., *Faraday Discussions* **109**, 281 (1998).
- Y. Aikawa et al., *ApJ* **552**, 639 (2001).
- Y. Aikawa et al., *A&A* **386**, 622 (2002).
- Y. Aikawa et al., *ApJ* **674**, 984 (2008).
- Y. Aikawa et al., *A&A* **538**, A57 (2012).
- V. Akimkin et al., *ApJ* **766**, 8 (2013).
- R. Alexander et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 475–496.
- Y. Alibert et al., *A&A* **434**, 343 (2005).
- Y. Alibert et al., *A&A* **558**, A109 (2013).
- L. J. Allamandola, A. G. G. M. Tielens, and J. R. Barker, *ApJS* **71**, 733 (1989).
- K. Altwegg et al., *Science Advances* **2** (2016).
- D. E. Anderson et al., *ApJ* **779**, 141 (2013).
- S. Andersson and E. F. van Dishoeck, *A&A* **491**, 907 (2008).
- S. Andersson et al., *J. Chem. Phys.* **124**, 064715 (2006).
- P. André et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 27–51.
- P. André et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 27–51.
- C. Arasa et al., *J. Chem. Phys.* **132**, 184510 (2010).
- C. Arasa et al., *J. Chem. Phys.* **134**, 164503 (2011).
- C. Arasa et al., *J. Chem. Phys.* **117**, 7064 (2013).

- H. G. Arce et al., *ApJ* **681**, L21 (2008).
- P. J. Armitage, *ARA&A* **49**, 195 (2011).
- M. Asplund et al., *ARA&A* **47**, 481 (2009).
- M. Audard et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 387–410.
- P. Ayotte et al., *J. Geophys. Res.* **106**, 33387 (2001).
- A. Bacmann et al., *A&A* **541**, L12 (2012).
- N. Balucani, C. Ceccarelli, and V. Taquet, *MNRAS* **449**, L16 (2015).
- A. Bar-Nun and D. Laufer, *Planet. Space Sci.* **86**, 160 (2013).
- A. Bar-Nun, G. Notesco, and T. Owen, *Icarus* **190**, 655 (2007).
- A. M. Baryshev et al., *A&A* **577**, A129 (2015).
- A. Belloche et al., *Science* **345**, 1584 (2014).
- S. P. Belov et al., *Journal of Molecular Spectroscopy* **173**, 380 (1995).
- S. P. Belov et al., *Journal of Molecular Spectroscopy* **191**, 17 (1998).
- M. T. Beltrán and W. J. de Wit, *A&A Rev.* **24**, 6 (2016).
- C. J. Bennett, C. Pirim, and T. M. Orlando, *Chemical Reviews* **113**, 9086 (2013).
- W. Benz et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 691–713.
- E. A. Bergin et al., *Proceedings of the National Academy of Science* **112**, 8965 (2015).
- O. Berné and A. G. G. M. Tielens, *Proceedings of the National Academy of Science* **109**, 401 (2012).
- M. Bertin et al., *Phys. Chem. Chem. Phys.* **14**, 9929 (2012).
- M. Bertin et al., *ApJ* **817**, L12 (2016).
- C. Bertout, G. Basri, and J. Bouvier, *ApJ* **330**, 350 (1988).
- F. L. Bettens et al., *ApJ* **510**, 789 (1999).
- A. Bieler et al., *Nature* **526**, 678 (2015).
- S. E. Bisschop et al., *A&A* **449**, 1297 (2006).
- S. E. Bisschop et al., *A&A* **488**, 959 (2008).
- B. Bitsch, M. Lambrechts, and A. Johansen, *A&A* **582**, A112 (2015).
- N. Biver et al., *A&A* **566**, L5 (2014).
- N. Biver et al., *Science Advances* **1**, 1500863 (2015).
- G. A. Blake et al., *ApJ* **315**, 621 (1987).
- G. A. Blake, E. F. van Dishoeck, and A. I. Sargent, *ApJ* **391**, L99 (1992).
- G. A. Blake et al., *ApJ* **428**, 680 (1994).
- M. D. Boamah et al., *Faraday Discuss.* **168**, 249 (2014).
- D. Bockelée-Morvan et al., *A&A* **353**, 1101 (2000).
- D. Bockelée-Morvan et al., *A&A* **583**, A6 (2015).

- M. Bogey, C. Demuyne, and J. L. Destombes, *Journal of Molecular Spectroscopy* **95**, 35 (1982).
- M. Bogey et al., *Journal of Molecular Spectroscopy* **182**, 85 (1997).
- R. C. Bohlin, B. D. Savage, and J. F. Drake, *ApJ* **224**, 132 (1978).
- A. C. A. Boogert et al., *A&A* **317**, 929 (1997).
- A. C. A. Boogert et al., *ApJ* **729**, 92 (2011).
- A. C. A. Boogert et al., *ApJ* **777**, 73 (2013).
- A. C. A. Boogert, P. A. Gerakines, and D. C. B. Whittet, *ARA&A* **53**, 541 (2015).
- S. Bottinelli et al., *ApJ* **615**, 354 (2004).
- S. Bottinelli et al., *ApJ* **617**, L69 (2004).
- C. Brinch and J. K. Jørgensen, *A&A* **559**, A82 (2013).
- C. Brinch, R. J. van Weeren, and M. R. Hogerheijde, *A&A* **489**, 617 (2008).
- F. A. v. Broekhuizen et al., *A&A* **441**, 249 (2005).
- W. A. Brown and A. S. Bolina, *MNRAS* **374**, 1006 (2007).
- D. Brownlee et al., *Science* **314**, 1711 (2006).
- S. Bruderer et al., *ApJ* **700**, 872 (2009).
- S. Bruderer et al., *ApJ* **720**, 1432 (2010).
- M. L. Cable et al., *Chemical Reviews* **112**, 1882 (2012).
- J. Cami et al., *Science* **329**, 1180 (2010).
- C. Camy-Peyret et al., *Journal of Molecular Spectroscopy* **109**, 300 (1985).
- F. Capaccioni et al., *Science* **347**, aaa0628 (2015).
- P. Caselli and C. Ceccarelli, *A&A Rev.* **20**, 56 (2012).
- P. Cassen and A. Moosman, *Icarus* **48**, 353 (1981).
- E. Caux et al., *A&A* **532**, A23 (2011).
- S. Cazaux and A. G. G. M. Tielens, *ApJ* **604**, 222 (2004).
- S. Cazaux et al., *ApJ* **593**, L51 (2003).
- C. Ceccarelli, D. J. Hollenbach, and A. G. G. M. Tielens, *ApJ* **471**, 400 (1996).
- C. Ceccarelli et al., *A&A* **355**, 1129 (2000).
- C. Ceccarelli et al., *In henrik b., klessen r. s., dullemond c. p., henning t. eds, protostars and planets vi, deuterium fractionation: the ariadne's thread from the precollapse phase to meteorites and comets today* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 859–882.
- J. Cernicharo et al., *ApJ* **759**, L43 (2012).
- R. Cesaroni et al., *A&A* **345**, 949 (1999).
- S. B. Charnley, A. G. G. M. Tielens, and T. J. Millar, *ApJ* **399**, L71 (1992).
- Y.-J. Chen et al., *ApJ* **798**, 80 (2015).
- A. C. Cheung et al., *Physical Review Letters* **21**, 1701 (1968).
- A. C. Cheung et al., *Nature* **221**, 626 (1969).
- T.-L. Chou et al., *ApJ* **796**, 70 (2014).

- K.-J. Chuang et al., MNRAS **455**, 1702 (2016).
- F. J. Ciesla, ApJ **740**, 9 (2011).
- F. J. Ciesla et al., ApJ **804**, 9 (2015).
- L. I. Cleeves, F. C. Adams, and E. A. Bergin, ApJ **772**, 5 (2013).
- L. I. Cleeves et al., Science **345**, 1590 (2014).
- L. I. Cleeves et al., ApJ **799**, 204 (2015).
- C. Codella et al., A&A **507**, L25 (2009).
- C. Codella et al., MNRAS **449**, L11 (2015).
- M. P. Collings et al., ApJ **583**, 1058 (2003).
- M. P. Collings et al., Ap&SS **285**, 633 (2003).
- M. P. Collings et al., MNRAS **354**, 1133 (2004).
- M. P. Collings et al., MNRAS **449**, 1826 (2015).
- M. A. Cordiner et al., ApJ **800**, L14 (2015).
- S. Courteau et al., Reviews of Modern Physics **86**, 47 (2014).
- A. Coutens et al., A&A **576**, A5 (2015).
- A. Coutens et al., A&A **590**, L6 (2016).
- A. Crapsi et al., A&A **486**, 245 (2008).
- J. Crovisier et al., A&A **418**, L35 (2004).
- G. A. Cruz-Diaz et al., A&A **592**, A68 (2016).
- H. M. Cuppen and E. Herbst, ApJ **668**, 294 (2007).
- H. M. Cuppen, L. J. Karssemeijer, and T. Lamberts, Chemical Reviews **113**, 8840 (2013).
- F. D'Antona and I. Mazzitelli, ApJS **90**, 467 (1994).
- A. Dalgarno, Proceedings of the National Academy of Science **103**, 12269 (2006).
- E. Dartois et al., A&A **342**, L32 (1999).
- A. M. Davis et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 809–831.
- G. Dipierro et al., MNRAS **453**, L73 (2015).
- E. F. v. Dishoeck et al., ApJ **447**, 760 (1995).
- E. F. v. Dishoeck et al., ApJ **447**, 760 (1995).
- E. F. v. Dishoeck, B. Jonkheid, and M. C. van Hemert, Faraday Discuss. **133**, 231 (2006).
- E. F. v. Dishoeck, E. Herbst, and D. A. Neufeld, Chemical Reviews **113**, 9043 (2013).
- E. F. v. Dishoeck et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 835–858.
- C. L. Dobbs et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 3–26.
- R. Dong, Z. Zhu, and B. Whitney, ApJ **809**, 93 (2015).
- B. T. Draine, ApJS **36**, 595 (1978).
- K. Drdla, G. R. Knapp, and E. F. van Dishoeck, ApJ **345**, 815 (1989).

- M. N. Drozdovskaya et al., MNRAS **445**, 913 (2014).
- M. N. Drozdovskaya et al., MNRAS **451**, 3836 (2015).
- A. Dubrulle et al., Zeitschrift Naturforschung Teil A **35**, 471 (1980).
- W. W. Duley, T. J. Millar, and D. A. Williams, MNRAS **192**, 945 (1980).
- F. Dulieu et al., Scientific Reports **3** (2013).
- C. P. Dullemond and C. Dominik, A&A **417**, 159 (2004).
- C. P. Dullemond and J. D. Monnier, ARA&A **48**, 205 (2010).
- M. M. Dunham et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 195–218.
- M. M. Dunham et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 195–218.
- A. Dutrey et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 317–338.
- J. L. Edridge, «Adsorption and desorption of model interstellar ices on a dust grain analogue surface.» PhD thesis (University of London, University College London (United Kingdom), Dec. 2010).
- P. Ehrenfreund et al., A&A **339**, L17 (1998).
- C. Espaillat et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 497–520.
- M. G. Evans et al., MNRAS **453**, 1147 (2015).
- N. J. Evans II et al., ApJS **181**, 321 (2009).
- B. Fabricant, D. Krieger, and J. S. Muentzer, J. Chem. Phys. **67**, 1576 (1977).
- E. C. Fayolle et al., A&A **529**, A74 (2011).
- E. C. Fayolle et al., A&A **556**, A122 (2013).
- E. C. Fayolle et al., ApJ **816**, L28 (2016).
- G. Fedoseev et al., MNRAS **448**, 1288 (2015).
- J. K. J. Fogel et al., ApJ **726**, 29 (2011).
- A. Frank et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 451–474.
- H. J. Fraser et al., MNRAS **327**, 1165 (2001).
- A. Fresneau et al., MNRAS **443**, 2991 (2014).
- A. Fresneau et al., MNRAS **451**, 1649 (2015).
- P. Friberg et al., A&A **195**, 281 (1988).
- G. W. Fuchs et al., A&A **505**, 629 (2009).
- K. Furuya and Y. Aikawa, ApJ **790**, 97 (2014).
- K. Furuya et al., ApJ **758**, 86 (2012).
- K. Furuya et al., ApJ **779**, 11 (2013).
- K. Furuya et al., A&A **584**, A124 (2015).
- D. Galli and F. Palla, ARA&A **51**, 163 (2013).

- Ó. Gálvez et al., *Icarus* **197**, 599 (2008).
- R. T. Garrod, *ApJ* **765**, 60 (2013).
- R. T. Garrod and E. Herbst, *A&A* **457**, 927 (2006).
- R. T. Garrod and T. Pauly, *ApJ* **735**, 15 (2011).
- R. T. Garrod and S. L. Widicus Weaver, *Chemical Reviews* **113**, 8939 (2013).
- R. T. Garrod, V. Wakelam, and E. Herbst, *A&A* **467**, 1103 (2007).
- R. T. Garrod, S. L. W. Weaver, and E. Herbst, *ApJ* **682**, 283 (2008).
- R. Garrod et al., *Faraday Discuss.* **133**, 51 (2006).
- W. D. Geppert and M. Larsson, *Chemical Reviews* **113**, 8872 (2013).
- W. D. Geppert et al., *Faraday Discuss.* **133**, 177 (2006).
- P. A. Gerakines, W. A. Schutte, and P. Ehrenfreund, *A&A* **312**, 289 (1996).
- E. L. Gibb et al., *ApJ* **536**, 347 (2000).
- E. L. Gibb et al., *ApJS* **151**, 35 (2004).
- F. C. Gillett and W. J. Forrest, *ApJ* **179**, 483 (1973).
- F. Goesmann et al., *Science* **349**, 020689 (2015).
- G. Y. Golubiatnikov et al., *Journal of Molecular Spectroscopy* **234**, 190 (2005).
- L. Gómez et al., *A&A* **529**, A161 (2011).
- R. J. A. Grim and J. M. Greenberg, *A&A* **181**, 155 (1987).
- S. Guerlet et al., *Icarus* **209**, 682 (2010).
- H. J. Habing, *Bull. Astr. Inst. Neth.* **19**, 421 (1968).
- W. Hagen, L. J. Allamandola, and J. M. Greenberg, *Ap&SS* **65**, 215 (1979).
- T. Hama and N. Watanabe, *Chemical Reviews* **113**, 8783 (2013).
- D. Harsono et al., *A&A* **555**, A45 (2013).
- D. Harsono et al., *A&A* **562**, A77 (2014).
- D. Harsono, S. Bruderer, and E. F. van Dishoeck, *A&A* **582**, A41 (2015).
- L. Hartmann and S. J. Kenyon, *ARA&A* **34**, 207 (1996).
- T. I. Hasegawa and E. Herbst, *MNRAS* **261**, 83 (1993).
- T. I. Hasegawa, E. Herbst, and C. M. Leung, *ApJS* **82**, 167 (1992).
- T. Hasegawa et al., *ApJ* **283**, 117 (1984).
- P. Helminger, R. L. Cook, and F. C. De Lucia, *Journal of Molecular Spectroscopy* **40**, 125 (1971).
- M. C. v. Hemert and E. F. van Dishoeck, *Chemic. Phys.* **343**, 292 (2008).
- M. C. v. Hemert, J. Takahashi, and E. F. v. Dishoeck,
- K. Heng and J. R. Lyons, *ApJ* **817**, 149 (2016).
- T. Henning and D. Semenov, *Chemical Reviews* **113**, 9016 (2013).
- T. Henning et al., *ApJ* **714**, 1511 (2010).
- E. Herbst, *Annual Review of Physical Chemistry* **46**, 27 (1995).
- E. Herbst and C. M. Leung, *MNRAS* **222**, 689 (1986).

- E. Herbst and E. F. van Dishoeck, *ARA&A* **47**, 427 (2009).
- V. J. Herrero et al., *Physical Chemistry Chemical Physics* **12**, 3164 (2010).
- F. Hersant et al., *A&A* **493**, L49 (2009).
- H. Hidaka et al., *ApJ* **614**, 1124 (2004).
- A. E. Higuchi et al., *ApJ* **798**, L33 (2015).
- R. E. Hillger and M. W. Strandberg, *Physical Review* **83**, 575 (1951).
- U. Hincelin et al., *ApJ* **775**, 44 (2013).
- U. Hincelin et al., *ApJ* **822**, 12 (2016).
- K. Hiraoka et al., *ApJ* **577**, 265 (2002).
- J. D. Ilee et al., *MNRAS* **417**, 2950 (2011).
- J. D. Ilee et al., *MNRAS* **429**, 2960 (2013).
- S. Inaba and M. Ikoma, *A&A* **410**, 711 (2003).
- Z. Ivezić and M. Elitzur, *MNRAS* **287**, 799 (1997).
- A. A. Jaber et al., *ApJ* **791**, 29 (2014).
- K. B. Jefferts et al., *ApJ* **168**, L111 (1971).
- K. L. Jessup, J. Spencer, and R. Yelle, *Icarus* **192**, 24 (2007).
- A. Johansen et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 547–570.
- K. G. Johnston et al., *ApJ* **813**, L19 (2015).
- A. P. Jones et al., *ApJ* **433**, 797 (1994).
- A. P. Jones et al., *A&A* **588**, A43 (2016).
- J. K. Jørgensen and et al., (2016).
- J. K. Jørgensen, F. L. Schöier, and E. F. van Dishoeck, *A&A* **389**, 908 (2002).
- J. K. Jørgensen et al., *A&A* **507**, 861 (2009).
- J. K. Jørgensen et al., *A&A* **534**, A100 (2011).
- J. K. Jørgensen et al., *ApJ* **757**, L4 (2012).
- A. Karska et al., *A&A* **552**, A141 (2013).
- L. J. Karssemeijer and H. M. Cuppen, *A&A* **569**, A107 (2014).
- L. J. Karssemeijer et al., *ApJ* **781**, 16 (2014).
- C. Knez et al., *ApJ* **635**, L145 (2005).
- W. Kofman et al., *Science* **349** (2015).
- L. Kolesníková et al., *ApJ* **784**, L7 (2014).
- J. Koning, G. J. Kroes, and C. Arasa, *J. Chem. Phys.* **138**, 104701 (2013).
- S. Kraus et al., *Nature* **466**, 339 (2010).
- L. E. Kristensen et al., *A&A* **516**, A57 (2010).
- L. E. Kristensen et al., *A&A* **542**, A8 (2012).
- M. R. Krumholz et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 243–266.

- Y.-J. Kuan and Y.-L. Chuang, in 40th cospar scientific assembly. held 2-10 august 2014, in moscow, russia, abstract f3.2-6-14. Vol. 40, COSPAR Meeting (2014), p. 1676.
- Y.-J. Kuan et al., *ApJ* **593**, 848 (2003).
- J. C. Laas et al., *ApJ* **728**, 71 (2011).
- R. B. Larson, *MNRAS* **145**, 405 (1969).
- L. Le Roy et al., *A&A* **583**, A1 (2015).
- J.-E. Lee and E. A. Bergin, *ApJ* **799**, 104 (2015).
- J.-E. Lee, E. A. Bergin, and H. Nomura, *ApJ* **710**, L21 (2010).
- T. M. Leen and M. M. Graff, *ApJ* **325**, 411 (1988).
- X. Li et al., *A&A* **555**, A14 (2013).
- Z.-Y. Li et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 173–194.
- R. A. Linke, M. A. Frerking, and P. Thaddeus, *ApJ* **234**, L139 (1979).
- H. Linnartz, S. Ioppolo, and G. Fedoseev, *ArXiv e-prints*: 1507.02729 (2015).
- D. J. P. Lommen et al., *A&A* **515**, A77 (2010).
- F. J. Lovas, D. R. Johnson, and L. E. Snyder, *ApJS* **41**, 451 (1979).
- A. Luca, D. Voulot, and D. Gerlich, *WDS'02 Proceedings of Contributed Papers PART II*, 294 (2002).
- K. L. Luhman, *ARA&A* **50**, 65 (2012).
- J. I. Lunine and D. J. Stevenson, *ApJS* **58**, 493 (1985).
- A. Maeda et al., *ApJS* **176**, 543 (2008).
- S. Maity, R. I. Kaiser, and B. M. Jones, *Phys. Chem. Chem. Phys.* **17**, 3081 (2015).
- U. Marboeuf et al., *A&A* **570**, A36 (2014).
- U. Marboeuf et al., *A&A* **570**, A35 (2014).
- R. Martín-Doménech et al., *A&A* **585**, A112 (2016).
- G. S. Mathews et al., *A&A* **557**, A132 (2013).
- B. C. Matthews et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 521–544.
- R. Mauersberger et al., *A&A* **313**, L1 (1996).
- A. J. Maury et al., *A&A* **563**, L2 (2014).
- D. McElroy et al., *A&A* **550**, A36 (2013).
- B. A. McGuire et al., *Science* **352**, 1449 (2016).
- T. J. Millar and E. Herbst, *A&A* **231**, 466 (1990).
- T. J. Millar and L. A. M. Nejad, *MNRAS* **217**, 507 (1985).
- T. J. Millar, C. M. Leung, and E. Herbst, *A&A* **183**, 109 (1987).
- Y. C. Minh et al., *ApJ* **360**, 136 (1990).
- M. Minissale and F. Dulieu, *J. Chem. Phys.* **141**, 014304 (2014).
- M. Minissale et al., *A&A* **559**, A49 (2013).

- M. Minissale et al., *A&A* **577**, A2 (2015).
- M. Minissale, E. Congiu, and F. Dulieu, *A&A* **585**, A146 (2016).
- M. Minissale et al., *A&A* **585**, A24 (2016).
- M. Minissale et al., *MNRAS* (2016).
- H. Minowa et al., *ApJ* **491**, L63 (1997).
- A. Miotello et al., *A&A* **567**, A32 (2014).
- G. F. Mitchell, *ApJ* **287**, 665 (1984).
- I. Morino, K. M. T. Yamada, and A. G. Maki, *Journal of Molecular Spectroscopy* **200**, 145 (2000).
- O. Mousis et al., *ApJ* **751**, L7 (2012).
- H. S. P. Müller and S. Brünken, *Journal of Molecular Spectroscopy* **232**, 213 (2005).
- H. S. P. Müller et al., *Journal of Molecular Structure* **742**, 215 (2005).
- H. S. P. Müller et al., *A&A* **587**, A92 (2016).
- M. J. Mumma and S. B. Charnley, *ARA&A* **49**, 471 (2011).
- N. M. Murillo et al., *A&A* **560**, A103 (2013).
- D. A. Neufeld and D. J. Hollenbach, *ApJ* **428**, 170 (1994).
- J. A. Noble et al., *ApJ* **735**, 121 (2011).
- K. Nomoto, C. Kobayashi, and N. Tominaga, *ARA&A* **51**, 457 (2013).
- H. Nomura et al., *A&A* **495**, 183 (2009).
- G. Notesco, A. Bar-Nun, and T. Owen, *Icarus* **162**, 183 (2003).
- K. I. Öberg, *Chemical Reviews*, in press (2016).
- K. I. Öberg et al., *ApJ* **621**, L33 (2005).
- K. I. Öberg et al., *A&A* **504**, 891 (2009).
- K. I. Öberg et al., *ApJ* **693**, 1209 (2009).
- K. I. Öberg, E. F. van Dishoeck, and H. Linnartz, *A&A* **496**, 281 (2009).
- K. I. Öberg et al., *ApJ* **716**, 825 (2010).
- K. I. Öberg et al., *ApJ* **718**, 832 (2010).
- K. I. Öberg et al., *ApJ* **740**, 14 (2011).
- K. I. Öberg, R. Murray-Clay, and E. A. Bergin, *ApJ* **743**, L16 (2011).
- K. I. Öberg et al., *ApJ* **740**, 109 (2011).
- K. I. Öberg et al., *ApJ* **771**, 95 (2013).
- K. I. Öberg et al., *ApJ* **810**, 112 (2015).
- K. I. Öberg et al., *Nature* **520**, 198 (2015).
- K. I. Öberg et al., in *The molecular universe*, Vol. 7, Proceedings of the International Astronomical Union (June 2011), pp. 65–78.
- N. Ohashi et al., *ApJ* **796**, 131 (2014).
- S. Okuzumi et al., *ApJ* **821**, 82 (2016).
- M. Oppenheimer and A. Dalgarno, *ApJ* **187**, 231 (1974).

- C. W. Ormel and H. H. Klahr, *A&A* **520**, A43 (2010).
- Y. Oya et al., *ApJ* **824**, 88 (2016).
- M. Padovani, P. Hennebelle, and D. Galli, *A&A* **560**, A114 (2013).
- L. Pagani et al., *Science* **329**, 1622 (2010).
- M. E. Palumbo, A. G. G. M. Tielens, and A. T. Tokunaga, *ApJ* **449**, 674 (1995).
- M. E. Palumbo, T. R. Geballe, and A. G. G. M. Tielens, *ApJ* **479**, 839 (1997).
- M. E. Palumbo et al., *ApJ* **685**, 1033 (2008).
- J. Pastor et al., *A&A* **252**, 320 (1991).
- D. Patel, D. Margolese, and T. R. Dyke, *J. Chem. Phys.* **70**, 2740 (1979).
- M. Pätzold et al., *Nature* **530**, 63 (2016).
- T. Pauly and R. T. Garrod, *ApJ* **817**, 146 (2016).
- M. V. Penston, *MNRAS* **144**, 425 (1969).
- A. A. Penzias et al., *ApJ* **168**, L53 (1971).
- T. G. Phillips et al., *A&A* **518**, L109 (2010).
- G. Pineau des Forets, E. Roueff, and D. R. Flower, *MNRAS* **223**, 743 (1986).
- C. Pinte et al., *ApJ* **816**, 25 (2016).
- A. L. Plunkett et al., *ApJ* **774**, 22 (2013).
- A. L. Plunkett et al., *Nature* **527**, 70 (2015).
- K. M. Pontoppidan, *A&A* **453**, L47 (2006).
- K. M. Pontoppidan et al., *A&A* **408**, 981 (2003).
- K. M. Pontoppidan et al., *A&A* **404**, L17 (2003).
- K. M. Pontoppidan, E. F. van Dishoeck, and E. Dartois, *A&A* **426**, 925 (2004).
- K. M. Pontoppidan et al., *ApJ* **656**, 980 (2007).
- K. M. Pontoppidan et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 363–385.
- F. X. Powell and D. R. Lide Jr., *J. Chem. Phys.* **41**, 1413 (1964).
- S. S. Prasad and W. T. Huntress Jr., *ApJ* **260**, 590 (1982).
- S. S. Prasad and S. P. Tarafdar, *ApJ* **267**, 603 (1983).
- C. Qi et al., *ApJ* **813**, 128 (2015).
- C. Qi et al., *ApJ* **799**, 110 (2015).
- L. Reboussin et al., *MNRAS* **440**, 3557 (2014).
- B. Reipurth et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 267–290.
- M. A. Requena-Torres et al., *ApJ* **655**, L37 (2007).
- L. Ricci et al., *A&A* **512**, A15 (2010).
- J. F. Roberts et al., *MNRAS* **382**, 733 (2007).
- S. D. Rodgers and S. B. Charnley, *ApJ* **546**, 324 (2001).
- M. Ruaud et al., *MNRAS* **447**, 4004 (2015).

- D. P. Ruffle and E. Herbst, *MNRAS* **324**, 1054 (2001).
- N. Sakai and S. Yamamoto, *Chemical Reviews* **113**, 8981 (2013).
- N. Sakai et al., *Nature* **507**, 78 (2014).
- T. Sakai et al., *ApJ* **775**, L31 (2013).
- S. A. Sandford et al., *ApJ* **329**, 498 (1988).
- J. Schneider et al., *A&A* **532**, A79 (2011).
- F. L. Schöier et al., *A&A* **390**, 1001 (2002).
- W. A. Schutte et al., *A&A* **343**, 966 (1999).
- K. R. Schwarz et al., *ApJ* **823**, 91 (2016).
- D. Semenov and D. Wiebe, *ApJS* **196**, 25 (2011).
- D. Semenov, D. Wiebe, and T. Henning, *ApJ* **647**, L57 (2006).
- D. Semenov et al., *A&A* **522**, A42 (2010).
- R. J. Shannon et al., *Nature Chemistry* **5**, 745 (2013).
- C. J. Shen et al., *A&A* **415**, 203 (2004).
- J. Shi, B. D. Teolis, and R. A. Baragiola, *Phys. Rev. B* **79**, 235422 (2009).
- F. H. Shu, *ApJ* **214**, 488 (1977).
- F. H. Shu, F. C. Adams, and S. Lizano, *ARA&A* **25**, 23 (1987).
- D. Smith et al., *A&A* **200**, 191 (1988).
- I. W. M. Smith, *ARA&A* **49**, 29 (2011).
- L. E. Snyder et al., *Physical Review Letters* **22**, 679 (1969).
- L. E. Snyder et al., *ApJ* **619**, 914 (2005).
- M. Spaans et al., *ApJ* **455**, L167 (1995).
- M. Sugimura et al., *PASJ* **63**, 459 (2011).
- F. F. S. v. d. Tak et al., *A&A* **412**, 133 (2003).
- J. C. Tan et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 149–172.
- K. Tanaka, T. Tanaka, and I. Suzuki, *J. Chem. Phys.* **82**, 2835 (1985).
- V. Taquet, C. Ceccarelli, and C. Kahane, *A&A* **538**, A42 (2012).
- V. Taquet et al., *ApJ* **804**, 81 (2015).
- V. Taquet, E. S. Wirström, and S. B. Charnley, *ApJ* **821**, 46 (2016).
- S. Terebey, F. H. Shu, and P. Cassen, *ApJ* **286**, 529 (1984).
- L. Testi et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 339–361.
- A. Thiabaud et al., *A&A* **562**, A27 (2014).
- A. Thiabaud et al., *A&A* **574**, A138 (2015).
- K. Thürmer et al., *Surface Science* **641**, 216 (2015).
- A. G. G. M. Tielens, *ARA&A* **46**, 289 (2008).
- A. G. G. M. Tielens, *Reviews of Modern Physics* **85**, 1021 (2013).

- A. G. G. M. Tielens and S. B. Charnley, *Origins of Life and Evolution of the Biosphere* **27**, 23 (1997).
- A. G. G. M. Tielens and W. Hagen, *A&A* **114**, 245 (1982).
- J. J. Tobin et al., *Nature* **492**, 83 (2012).
- J. J. Tobin et al., *ApJ* **771**, 48 (2013).
- J. J. Tobin et al., *ApJ* **805**, 125 (2015).
- W. Tsang and R. F. Hampson, *J. of Phys. and Chem. Ref. Data* **15**, 1087 (1986).
- S. Tsunekawa et al., *Journal of Molecular Spectroscopy* **134**, 63 (1989).
- B. E. Turner, *ApJ* **396**, L107 (1992).
- N. J. Turner et al., *Protostars and planets vi, volatiles in protoplanetary disks* (Univ. Arizona Press, Tucson, AZ, 2014), pp. 411–432.
- T. Umebayashi and T. Nakano, *PASJ* **33**, 617 (1981).
- C. Vastel et al., *ApJ* **795**, L2 (2014).
- A. I. Vasyunin and E. Herbst, *ApJ* **762**, 86 (2013).
- A. I. Vasyunin and E. Herbst, *ApJ* **769**, 34 (2013).
- A. I. Vasyunin et al., *ApJ* **727**, 76 (2011).
- T. Velusamy, W. D. Langer, and K. A. Marsh, *ApJ* **668**, L159 (2007).
- R. Visser and E. A. Bergin, *ApJ* **754**, L18 (2012).
- R. Visser and C. P. Dullemond, *A&A* **519**, A28 (2010).
- R. Visser et al., *A&A* **495**, 881 (2009).
- R. Visser, E. F. van Dishoeck, and J. H. Black, *A&A* **503**, 323 (2009).
- R. Visser, S. D. Doty, and E. F. van Dishoeck, *A&A* **534**, A132 (2011).
- R. Visser et al., *A&A* **537**, A55 (2012).
- R. Visser, E. A. Bergin, and J. K. Jørgensen, *A&A* **577**, A102 (2015).
- R. Viswanathan and T. R. Dyke, *Journal of Molecular Spectroscopy* **103**, 231 (1984).
- S. Viti et al., *MNRAS* **354**, 1141 (2004).
- V. Wakelam, H. M. Cuppen, and E. Herbst, *ArXiv e-prints*: 1309.7792 (2013).
- V. Wakelam et al., *MNRAS* **445**, 2854 (2014).
- C. Walsh, T. J. Millar, and H. Nomura, *ApJ* **722**, 1607 (2010).
- C. Walsh et al., *ApJ* **747**, 114 (2012).
- C. Walsh et al., *Faraday Discuss.* **168**, 389 (2014).
- C. Walsh et al., *A&A* **563**, A33 (2014).
- C. Walsh, H. Nomura, and E. van Dishoeck, *A&A* **582**, A88 (2015).
- C. Walsh et al., *ApJ* **823**, L10 (2016).
- S. F. Wampfler et al., *A&A* **552**, A56 (2013).
- N. Watanabe and A. Kouchi, *ApJ* **571**, L173 (2002).
- N. Watanabe et al., *ApJ* **616**, 638 (2004).
- N. Watanabe et al., *ApJ* **714**, L233 (2010).

- G. D. Watt and S. B. Charnley, *MNRAS* **213**, 157 (1985).
- R. J. v. Weeren, C. Brinch, and M. R. Hogerheijde, *A&A* **497**, 773 (2009).
- J. C. Weingartner and B. T. Draine, *ApJS* **134**, 263 (2001).
- D. C. B. Whittet et al., *A&A* **315**, L357 (1996).
- K. Willacy et al., *ApJ* **644**, 1202 (2006).
- J. P. Williams and L. A. Cieza, *ARA&A* **49**, 67 (2011).
- T. L. Wilson and R. Rood, *ARA&A* **32**, 191 (1994).
- G. Winnewisser and R. L. Cook, *Journal of Molecular Spectroscopy* **28**, 266 (1968).
- S. Wlodek, D. K. Bohme, and E. Herbst, *MNRAS* **235**, 493 (1988).
- P. Woitke et al., *A&A* **586**, A103 (2016).
- P. M. Woods et al., *ApJ* **777**, 90 (2013).
- P. M. Woods et al., *MNRAS* **450**, 1256 (2015).
- D. E. Woon, *ApJ* **569**, 541 (2002).
- L.-H. Xu et al., *J. Chem. Phys.* **137**, 104313 (2012).
- R. Yokochi et al., *Icarus* **218**, 760 (2012).
- H. W. Yorke and P. Bodenheimer, *ApJ* **525**, 330 (1999).
- N. Ysard et al., *A&A* **588**, A44 (2016).
- L. A. Zapata et al., *MNRAS* **447**, 1826 (2015).
- K. Zhang, G. A. Blake, and E. A. Bergin, *ApJ* **806**, L7 (2015).
- B. Zhao et al., *MNRAS* **460**, 2050 (2016).

