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Half-widths (self)

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CO_2 [2] 626, 636, 628, 627, 638, 637, 828, 827, 838, 837

Positions

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Half-widths (air)

0. L.S. Rothman, R.R. Gamache, A. Goldman, L.R. Brown, R.A. Toth, H.M. Pickett, R.L. Poynter, J.-M. Flaud, C. Camy-Peyret, A. Barbe, N. Husson, C.P. Rinsland, and M.A.H. Smith, "The HITRAN database: 1986 Edition," *Appl.Opt.* **26,** 4058-4097 (1987).
1. R.R. Gamache and L.S. Rothman, "Theoretical N_2-broadened halfwidths of $^{16}O_3$," *Appl.Opt.*

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3. Average values from Ref. 1 as a function of J ($J \leq 35$) used for lines not in database of Ref. 1.
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6. Use of values obtained for the ν_1/ ν_2 bands from Ref. 4.
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Half-widths (self)
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Temperature dependence of air-broadened half-width
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3. Use of values obtained for the ν_3 band from Ref. 2.
4. Use of values obtained for the ν_1/ ν_2 bands from Ref. 2.

Pressure shift (air)
1. Mean values of M.A.H. Smith, private communication (2004) based on V. Malathy Devi, D.C. Benner, M.A.H. Smith, and C.P. Rinsland, "Air-broadening and shift coefficients of O_3 lines in the ν_2 band and their temperature dependence," *J.Mol.Spectrosc.* **182,** 221-238 (1997); M.A.H. Smith, V. Malathy Devi, D.C. Benner, and C.P. Rinsland, "Temperature dependence of air-broadening and shift coefficients of O_3 lines in the ν_1 band," *J.Mol.Spectrosc.* **182,** 239-259 (1997); M.A.H. Smith, C.P. Rinsland, V. Malathy Devi, and E.S. Prochaska, "Measurements of pressure broadening and shifts of O_3 lines in the 3-μm region," *J.Mol.Spectrosc.* **164,** 239-259 (1994); M.A.H. Smith, C.P. Rinsland, V. Malathy Devi, and E.S. Prochaska, "Erratum: Measurements of pressure broadening and shifts of O_3 lines in the 3-μm region" by M.A.H. Smith, C.P. Rinsland, V. Malathy Devi, and E.S. Prochaska," *J.Mol.Spectrosc.* **165,** 596 (1994).

N_2O [4] 446, 456, 546, 448, 447

Positions

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3. K. Chance, K.W. Jucks, D.G. Johnson, and W.A. Traub, "The Smithsonian Astrophysical Observatory Database SAO92," *JQSRT* **52,** 447-457 (1994).
4. J.W.C. Johns, Z. Lu, M. Weber, J.M. Sirota, and D.C. Reuter, "Absolute Intensities in the ν_2 fundamental of N_2O at 17 μm," *J.Mol.Spectrosc.* **177,** 203-210 (1996).
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Intensities

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1. K. Chance, K.W. Jucks, D.G. Johnson, and W.A. Traub, "The Smithsonian Astrophysical Observatory Database SAO92," *JQSRT* **52**, 447-457 (1994).
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Half-widths (air)

0. L.S. Rothman, R.R. Gamache, A. Goldman, L.R. Brown, R.A. Toth, H.M. Pickett, R.L. Poynter, J.-M. Flaud, C. Camy-Peyret, A. Barbe, N. Husson, C.P. Rinsland, and M.A.H. Smith, "The HITRAN database: 1986 Edition," *Appl.Opt.* **26,** 4058-4097 (1987).
1. K. Chance, K.W. Jucks, D.G. Johnson, and W.A. Traub, "The Smithsonian Astrophysical Observatory Database SAO92," *JQSRT* **52**, 447-457 (1994).
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(1984).
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Half-widths (self)
1. Third-order polynomial fit of experimental results based on: R.A. Toth, "Line strengths (900-3600 cm^{-1}), self-broadened linewidths, and frequency shifts (1800-2660 cm^{-1}) of N_2O," *Appl.Opt.* **32,** 7326-7365 (1993).

Temperature dependence of air-broadened half-width
1. Fixed to a constant value of 0.75 based on the two works: N. Lacome, A. Levy, and G. Guelachvili, "Fourier transform measurement of self-, N_2-, and O_2-broadening of N_2O lines: temperature dependence of linewidths," *Appl.Opt.* **23,** 425-434 (1984); V. Nemtchinov, C. Sun, and P. Varanasi, "Measurements of Line Intensities and Line Widths in the ν_3-fundamental Band of Nitrous Oxide at Atmospheric Temperatures," *JQSRT* **83,** 267-284 (2004).

Pressure shift (air)
1. R.A. Toth, "Linelist of N_2O parameters from 500 to 7500 cm^{-1}," see http://mark4sun.jpl.nasa.gov/n2o.html.

CO [5] 26, 36, 28, 27, 38, 37

Positions

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Intensities

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Half-widths (air)

1. T. Nakazawa and M. Tanaka, "Measurements of Intensities and Self- and Foreign gas broadened halfwidths of spectral Lines in the CO fundamental Band," *JQSRT* **28,** 409-416 (1982); values for transitions having $20< |m| \leq 33$ are extrapolated, while those for $|m| > 34$ are assumed to be constant (0.0400 cm^{-1}/atm).
2. Polynomial fit of several measurements (M.A.H. Smith, private communication, 2004). For details, see L.S. Rothman, D. Jacquemart, A. Barbe, D.C. Benner, M. Birk, L.R. Brown, M. Carleer, C. Chackerian Jr, K. Chance, L.H. Coudert, V. Dana, V.M. Devi, J.-M. Flaud, R.R. Gamache, A. Goldman, J.-M. Hartmann, K.W. Jucks, A.G. Maki, J.-Y. Mandin, S. Massie, J. Orphal, A. Perrin, C.P. Rinsland, M.A.H. Smith, J. Tennyson, R.N. Tolchenov, R.A. Toth, J. Vander Auwera, P. Varanasi, and G. Wagner, "The *HITRAN* 2004 Molecular Spectroscopic Database," *JQSRT* **96,** 139-204 (2005).

Half-widths (self)

1. T. Nakazawa and M. Tanaka, "Measurements of Intensities and Self- and Foreign gas broadened halfwidths of spectral Lines in the CO fundamental Band," *JQSRT* **28,** 409-416 (1982); values for transitions having $20< |m| \leq 33$ are extrapolated, while those for $|m| > 34$ are

assumed to be constant (0.0460 cm^{-1}/atm).

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Temperature dependence of air-broadened half-width

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Pressure shift (air)

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CH_4 [6] 211, 311, 212, 312

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Half-widths (air)

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5. Molecular Hamiltonian constants for the v″= 1 and v′= 1 of the $X\Sigma$ state are from G. Rouillé et al (Ref. 1). Vibrational term values are from P.H. Krupenie (Ref. 2), upper vibrational state energy shifted to agree with band center of G. Rouillé et al for (1←0) band.

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12. Molecular Hamiltonian constants for the v″= 0 state of $X\Sigma$ are from G. Rouillé et al (Ref. 1). For the v′ = 1 of the $a\Delta_g$ state the constants of J. Brault (Ref. 10) are used. Vibrational term values are from P.H. Krupenie (Ref. 2). Upper vibrational state energy shifted by -0.050385 cm^{-1} to agree with data of J. Brault (Ref. 10).

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22. Molecular Hamiltonian constants for the v″= 0 state of $X\Sigma$ are from G. Rouillé et al (Ref. 1). For the v′= 1 of the $b\Sigma$ state, the constants of D.L. Albritton (Ref. 18) are used. Vibrational and electronic term values are from P.H. Krupenie (Ref. 2). Dunham zero point energy correction applied to zero point energy of upper vibrational state.

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27. Molecular Hamiltonian constants for the v″= 0 state of $X\Sigma$ are from M. Mizushima and S. Yamamoto (Ref. 6). For the v′= 1 of the $b\Sigma$ state, the constants of W.S. Benedict (Ref. 20) are used. Vibrational and electronic term values are from P.H. Krupenie (Ref. 2). Dunham zero point energy correction applied to zero point energy of upper vibrational state. Electronic term value is shifted by (-0.041-0.014) cm^{-1}, unknown reference.

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Intensities

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Half-widths (self)

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Temperature dependence of air-broadened half-width

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NO_2 [10] 646

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Half-widths (self)

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NH_3 [11] 4111, 5111

Positions

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11. Same as Ref. 5 above, but upper-state level is unassigned due to mixing from perturbations.

Intensities

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15. Intensities have been rescaled by multiplying by a factor of 1.067, Ref. 7

16. Intensities have been rescaled by multiplying by a factor of 1.067, Ref. 8

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Half-widths (self)

1. Set to a constant value of 0.8 cm^{-1}/atm based on the works of L. Zu, P.A. Hamilton, and P.B. Davies, "Pressure broadening and frequency measurements of nitric acid lines in the 683 GHz region," *JQSRT* **73,** 545-556 (2002) and P. Brockman, C.H. Bair, and F. Allario, "High resolution spectral measurement of the HNO_3 11.3-µm band using tunable diode lasers," *Appl.Opt.* **17,** 91-99 (1978).

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Temperature dependence of air-broadened half-width

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OH [13] 61, 81, 62

Positions

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Half-widths (air)

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HF [14] 19

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HCl [15] 15, 17

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HI [17] 17

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ClO [18] 56, 76

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OCS [19] 622, 624, 632, 623, 822

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Pressure shift (air)
1. A.S. Pine and C.P. Rinsland, "The role of torsional hot bands in modeling atmospheric ethane," *JQSRT* **62,** 445-458 (1999).

PH_3 [28] 1111

Positions

0. L.S. Rothman, R.R. Gamache, A. Goldman, L.R. Brown, R.A. Toth, H.M. Pickett, R.L. Poynter, J.-M. Flaud, C. Camy-Peyret, A. Barbe, N. Husson, C.P. Rinsland, and M.A.H. Smith, "The HITRAN database: 1986 Edition," *Appl.Opt.* **26,** 4058-4097 (1987).

1. G. Tarrago, M. Dang-Nhu, and A. Goldman, "Analysis of Phosphine Absorption in the Region 9-10 μm and High Resolution Line-by-Line Simulation of the ν_2 and ν_4 Bands," *J.Mol.Spectrosc.* **88,** 311-322 (1981).

2. L.R. Brown, R.L. Sams, I. Kleiner, C. Cottaz, and L. Sagui, "Line Intensities of the Phosphine Dyad at 10 μm," *J.Mol.Spectrosc.* **215,** 178-203 (2002).

3. G. Tarrago, N. Lacome, A. Levy, G. Guelachvili, B. Benzard, and P. Drossart, "Phosphine Spectrum at 4-5 μm: Analysis and Line-by-Line Simulation of $2\nu_2$, $\nu_2 + \nu_4$, $2\nu_4$, ν_1, and ν_3 Bands," *J.Mol.Spectrosc.* **154,** 30-42 (1992).

4. R.A.H. Butler, L. Sagui, I. Kleiner, and L.R. Brown, "The absorption spectrum of phosphine (PH_3) between 2.8 and 3.7 μm: Line positions, intensities, and assignments," *J.Mol.Spectrosc.* **238,** 178-192 (2006).

Intensities

0. L.S. Rothman, R.R. Gamache, A. Goldman, L.R. Brown, R.A. Toth, H.M. Pickett, R.L. Poynter, J.-M. Flaud, C. Camy-Peyret, A. Barbe, N. Husson, C.P. Rinsland, and M.A.H. Smith, "The HITRAN database: 1986 Edition," *Appl.Opt.* **26,** 4058-4097 (1987).

1. L.R. Brown, R.L. Sams, I. Kleiner, C. Cottaz, and L. Sagui, "Line Intensities of the Phosphine Dyad at 10 μm," *J.Mol.Spectrosc.* **215,** 178-203 (2002).

2. G. Tarrago, N. Lacome, A. Levy, G. Guelachvili, B. Benzard, and P. Drossart, "Phosphine Spectrum at 4-5 μm: Analysis and Line-by-Line Simulation of $2\nu_2$, $\nu_2 + \nu_4$, $2\nu_4$, ν_1, and ν_3 Bands," *J.Mol.Spectrosc.* **154,** 30-42 (1992).

3. R.A.H. Butler, L. Sagui, I. Kleiner, and L.R. Brown, "The absorption spectrum of phosphine (PH_3) between 2.8 and 3.7 μm: Line positions, intensities, and assignments," *J.Mol.Spectrosc.* **238,** 178-192 (2006).

Half-widths (air)

0. L.S. Rothman, R.R. Gamache, A. Goldman, L.R. Brown, R.A. Toth, H.M. Pickett, R.L. Poynter, J.-M. Flaud, C. Camy-Peyret, A. Barbe, N. Husson, C.P. Rinsland, and M.A.H. Smith, "The HITRAN database: 1986 Edition," *Appl.Opt.* **26,** 4058-4097 (1987).

1. L.R. Brown, R.L. Sams, I. Kleiner, C. Cottaz, and L. Sagui, "Line Intensities of the Phosphine Dyad at 10 μm," *J.Mol.Spectrosc.* **215,** 178-203 (2002).

2. Scaled by 0.9 from the nitrogen-broadened widths in R.A.H. Butler, L. Sagui, I. Kleiner, and L.R. Brown, "The absorption spectrum of phosphine (PH_3) between 2.8 and 3.7 μm: Line positions, intensities, and assignments," *J.Mol.Spectrosc.* **238,** 178-192 (2006).

Half-widths (self)

1. L.R. Brown, R.L. Sams, I. Kleiner, C. Cottaz, and L. Sagui, "Line Intensities of the Phosphine Dyad at 10 μm," *J.Mol.Spectrosc.* **215,** 178-203 (2002).

2. R.A.H. Butler, L. Sagui, I. Kleiner, and L.R. Brown, "The absorption spectrum of phosphine (PH_3) between 2.8 and 3.7 μm: Line positions, intensities, and assignments," *J.Mol.Spectrosc.* **238,** 178-192 (2006).

Temperature dependence of air-broadened half-width

1. R.A.H. Butler, L. Sagui, I. Kleiner, and L.R. Brown, "The absorption spectrum of phosphine (PH_3) between 2.8 and 3.7 μm: Line positions, intensities, and assignments," *J.Mol.Spectrosc.* **238,** 178-192 (2006).

COF_2 [29] 269

Positions

1. L.R. Brown and E.A. Cohen, "The C-O Stretch Regions of COF_2: the Interaction of the ν_1, $2\nu_2$, and $2\nu_3 + \nu_6$ Bands," private communication (1991).
2. E.A. Cohen and W. Lewis-Bevan, "Further Measurements of the Rotational Spectrum of COF_2: Improved Molecular Constants for the Ground and ν_2 States," *J.Mol.Spectrosc.* **148,** 378-384 (1991).
3. C. Camy-Peyret, J.-M. Flaud, A. Goldman, F.J. Murcray, R.D. Blatherwick, F.S. Bonomo, D.G. Murcray, and C.P. Rinsland, "The ν_4 Band of Carbonyl Fluoride," *J.Mol.Spectrosc.* 149, 481-490 (1991).
4. A. Goldman, C.P. Rinsland, R.D. Blatherwick, and F.S. Bonomo, "Spectroscopic line parameters for the ν_6 band of carbonyl fluoride," *Appl.Opt.* **29,** 1860-1863 (1990).
5. C.P. Rinsland, NASA Langley Research Center, private communication (1992).
6. L.R. Brown, Jet Propulsion Laboratory, private communication (1992).
7. L.R. Brown, Jet Propulsion Laboratory, private communication (2001).

Intensities

1. L.R. Brown and E.A. Cohen, "The C-O Stretch Regions of COF_2: the Interaction of the ν_1, $2\nu_2$, and $2\nu_3 + \nu_6$ Bands," private communication (1991).
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4. A. Goldman, C.P. Rinsland, R.D. Blatherwick, and F.S. Bonomo, "Spectroscopic line parameters for the ν_6 band of carbonyl fluoride," *Appl.Opt.* **29,** 1860-1863 (1990).
7. L.R. Brown, Jet Propulsion Laboratory, private communication (2001).

Half-widths (air)

1. R.D. May, "Line Intensities and Collisional-broadening Parameters for the ν_4 and ν_6 Bands of Carbonyl Fluoride," *JQSRT* **48,** 701-712 (1992).

SF_6 [30] 29

Positions

1. C.P. Rinsland, L.R. Brown, and C.B. Farmer, "Infrared Spectroscopic Detection of Sulfur Hexafluoride (SF_6) in the Lower Stratosphere and Upper Troposphere," *J.Geophys.Res.* **95,** 5577-5585 (1990); B. Bobin, C.J. Borde, J. Borde, and C. Breant, "Vibration-Rotation Molecular Constants for the Ground and (ν_3=1) States of $^{32}SF_6$ from Saturated Absorption Spectroscopy," *J.Mol.Spectrosc.* **121,** 91-127 (1987); B. Bobin, private communication (1990).
2. C.P. Rinsland, NASA Langley Research Center, private communication (1992).
3. O. Acef, C.J. Bordé, A. Clairon, G. Pierre, and B. Sartakov, "New Accurate Fit of an Extended Set of Saturation Data for the ν_3 Band of SF_6: Comparison of Hamiltonians in the Spherical and Cubic Tensor Formalisms," *J.Mol.Spectrosc.***199,**188-204 (2000); V. Boudon, G. Pierre, "Rovibrational spectroscopy of sulphur hexafluoride: A review" *Recent Research Developments in Molecular Spectroscopy*, S.G. Pandalai, Editor, *Transworld Research Network*, Trivandrum, India **1,** 25-55 (2002).
4. The calculations were performed by V. Boudon (2008) with the HTDS software (http://icb.u-bourgogne.fr/OMR/SMA/SHTDS) using data reviewed in V. Boudon, G. Pierre, "Rovibrational spectroscopy of sulphur hexafluoride: A Review," in *Recent Research Developments in Molecular Spectroscopy*, S.G. Pandalai, Editor, *Transworld Research Network*, Trivandrum, India **1,** 25-55 (2002).
5. The calculations were performed by V. Boudon (2008) with the HTDS software (http://icb.u-bourgogne.fr/OMR/SMA/SHTDS) using data from V. Boudon, G. Pierre, H. Burger, "High Resolution Spectroscopy and Analysis of the ν_4 Bending Region of SF_6 Near 615 cm^{-1} *J.Mol.Spectrosc.* **205**, 304–311 (2001).

Intensities

1. C.P. Rinsland, L.R. Brown, and C.B. Farmer, "Infrared Spectroscopic Detection of Sulfur Hexafluoride (SF_6) in the Lower Stratosphere and Upper Troposphere," *J.Geophys.Res.* **95,** 5577-5585 (1990); K. Fox, *Opt.Comm.* **19,** 397-400 (1976); B. Bobin, private communication (1990).
2. O. Acef, C.J. Bordé, A. Clairon, G. Pierre, B. Sartakov, "New Accurate Fit of an Extended Set of Saturation Data for the ν_3 Band of SF_6: Comparison of Hamiltonians in the Spherical and Cubic Tensor Formalisms," *J.Mol.Spectrosc.***199,**188-204 (2000); V. Boudon, G. Pierre, "Rovibrational spectroscopy of sulphur hexafluoride: A review in recent research developments in molecular spectroscopy," S. G. Pandalai Editor, *Transworld Research Network*, Trivandrum, India **1,**25-55 (2002).
3. The calculations were performed by V. Boudon (2008) with the HTDS software (http://icb.u-bourgogne.fr/OMR/SMA/SHTDS) using data from K.C. Kim, W.B. Person, D. Seitz, and B.J. Krohn, "Analysis of the ν_4 (615 cm^{-1}) region of the Fourier transform and diode laser spectra of SF_6," *J.Mol.Spectrosc.*, **76**, 322–340 (1979) and W.B. Person, and B.J. Krohn, "Coriolis intensity perturbations of the ν_4 band of SF_6," *J.Mol.Spectrosc.*, **98**, 229–257 (1983).

Half-widths (air)

1. C.P. Rinsland, L.R. Brown, and C.B. Farmer, "Infrared Spectroscopic Detection of Sulfur Hexafluoride (SF_6) in the Lower Stratosphere and Upper Troposphere," *J.Geophys.Res.* **95,** 5577-5585 (1990); G.D.T. Tejwani and K. Fox, "Calculated self- and foreign-gas-broadened linewidths for SF_6," *JQSRT* **37,** 541-546 (1987).

Half-widths (self)

1. G.D.T. Tejwani and K. Fox, "Calculated self- and foreign-gas-broadened linewidths for SF_6," *JQSRT* **37,** 541-546 (1987).

Temperature dependence of air-broadened half-width

1. G.D.T. Tejwani and K. Fox, "Calculated self- and foreign-gas-broadened linewidths for SF_6," *JQSRT* **37,** 541-546 (1987).

H_2S [31] 121,141,131

Positions

1. A. Goldman and J.R. Gillis, "Line Parameters and Line by Line Calculations for Molecules of Stratospheric Interest," University of Denver Progress Report (1984).
2. J.-M. Flaud, C. Camy-Peyret, and J.W.C. Johns, "The far infrared spectrum of hydrogen sulfide. The (000) rotational constants of $H_2{}^{32}S$, $H_2{}^{33}S$ and $H_2{}^{34}S$," *Can.J.Phys.* **61,** 1462-1473 (1983).
3. L. Sinitsa, Institute of Atmospheric Optics (Tomsk), private communication (1994).
4. L. Lechuga-Fossat, J.-M. Flaud, C. Camy-Peyret, and J.W.C. Johns, "The spectrum of natural hydrogen sulfide between 2150 and 2950 cm^{-1}," *Can.J.Phys.* **62,** 1889-1923 (1984).
5. L.R. Brown, J.A. Crisp, D. Crisp, V. Naumenko, M.A. Smirnov, L.N. Sinitsa, and A. Perrin, "The Absorption Spectrum of H_2S between 2150 and 4260 cm^{-1}: Analysis of the Positions and Intensities in the First [$2\nu_2$, ν_1 and ν_3] and Second [$3\nu_2$, $\nu_1 + \nu_2$ and $\nu_2 + \nu_3$] Triad Region," *J.Mol. Spectrosc.* **188,** 148-174 (1998).

Intensities

1. A. Goldman and J.R. Gillis, "Line Parameters and Line by Line Calculations for Molecules of Stratospheric Interest," University of Denver Progress Report (1984).
2. J.-M. Flaud, C. Camy-Peyret, and J.W.C. Johns, "The far infrared spectrum of hydrogen sulfide. The (000) rotational constants of $H_2{}^{32}S$, $H_2{}^{33}S$ and $H_2{}^{34}S$," *Can.J.Phys.* **61,** 1462-1473 (1983).
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Half-widths (air)

1. A. Goldman and J.R. Gillis, "Line Parameters and Line by Line Calculations for Molecules of Stratospheric Interest," University of Denver Progress Report (1984).
2. J. Waschull, F. Kuhnemann, and B. Sumpf, "Self-, air- and Helium Broadening of the ν_2 band of H_2S," *J.Mol.Spectrosc.* **165,** 150-158 (1994).
3. B. Sumpf, I Meusel, and H.-D. Kronfeldt, "Self- and air-Broadening in the ν_1 and ν_3 bands of H_2S," *J.Mol.Spectrosc.* **177,** 143-145 (1996).
4. A. Kissel, B. Sumpf, H.-D. Kronfeldt, B.A. Tikhomirov, and Yu.N. Ponomarev, "Molecular-Gas-Pressure-Induced Line-Shift and Line-Broadening in the ν_2-Band of H_2S," *J.Mol.Spectrosc.* **216,** 345-354 (2002).
5. B. Sumpf, A. Kissel, and H.-D. Kronfeldt, "Line-Broadening and Line-Shift in the ν_1, ν_3, and $2\nu_2$ bands of H_2S," in preparation.
6. Average values of Refs 2-5.

Half-widths (self)

1. J. Waschull, F. Kuhnemann, and B. Sumpf, "Self-, air- and Helium Broadening of the ν_2 band of H_2S," *J.Mol.Spectrosc.* **165,** 150-158 (1994).

2. B. Sumpf, I Meusel, and H.-D. Kronfeldt, "Self- and air-Broadening in the ν_1 and ν_3 bands of H_2S," *J.Mol.Spectrosc.* **177,** 143-145 (1996).
3. B. Sumpf, "Experimental Investigation of the Self-Broadening Coefficients in the $\nu_1 + \nu_3$ band of SO_2 and the $2\nu_2$ band of H_2S," *J.Mol.Spectrosc.* **181,** 160-167 (1997).
4. Average values of Refs 1-3.

Pressure shift (air)
1. A. Kissel, B. Sumpf, H.-D. Kronfeldt, B.A. Tikhomirov, and Yu.N. Ponomarev, "Molecular-Gas-Pressure-Induced Line-Shift and Line-Broadening in the ν_2-Band of H_2S," *J.Mol.Spectrosc.* **216,** 345-354 (2002).
2. B. Sumpf, A. Kissel, and H.-D. Kronfeldt, "Line-Broadening and Line-Shift in the ν_1, ν_3, and $2\nu_2$ bands of H_2S," in preparation
3. L.S. Rothman, D. Jacquemart, A. Barbe, D.C. Benner, M. Birk, L.R. Brown, M. Carleer, C. Chackerian Jr, K. Chance, L.H. Coudert, V. Dana, V.M. Devi, J.-M. Flaud, R.R. Gamache, A. Goldman, J.-M. Hartmann, K.W. Jucks, A.G. Maki, J.-Y. Mandin, S. Massie, J. Orphal, A. Perrin, C.P. Rinsland, M.A.H. Smith, J. Tennyson, R.N. Tolchenov, R.A. Toth, J. Vander Auwera, P. Varanasi, and G. Wagner, "The *HITRAN* 2004 Molecular Spectroscopic Database," *JQSRT* **96,** 139-204 (2005).

HCOOH [32] 126

Positions

1. A. Goldman, F.H. Murcray, D.G. Murcray, and C.P. Rinsland, "A Search for Formic Acid in the Upper Troposphere: A Tentative Identification of the 1105 cm^{-1} ν_6 band Q branch in High Resolution Balloon-borne Absorption Spectra," *Geophys.Res.Let.* **11,** 307-310 (1984); A. Goldman and J.R. Gillis, "Line Parameters and Line-by-line Calculations for Molecules of Stratospheric Interest," Progress Report, Dept. of Physics, Univ. Denver (1984).
2. A. Perrin, C.P. Rinsland, and A. Goldman, "Spectral parameters for the ν_6 region of HCOOH and its measurement in the infrared tropospheric spectrum," *J.Geophys.Res.* **104,** 18,661-18,666 (1999).
3. J. Vander Auwera, private communication (2004), based on J. Vander Auwera, "High-Resolution Investigation of the Far-Infrared Spectrum of Formic Acid," *J.Mol.Spectrosc.* **155,** 136-142 (1992).
4. A. Perrin and J. Vander Auwera, "An improved database for the 9 μm region of the formic acid spectrum," *JQSRT* **108,** 363-370 (2007).
5. A. Perrin, J. Vander Auwera, and Z. Zelinger, "High-resolution Fourier transform study of the ν_3 fundamental band of *trans*-formic acid," *JQSRT* **110,** 743-755 (2009).

Intensities

1. A. Goldman, F.H. Murcray, D.G. Murcray, and C.P. Rinsland, "A Search for Formic Acid in the Upper Troposphere: A Tentative Identification of the 1105 cm^{-1} ν_6 band Q branch in High Resolution Balloon-borne Absorption Spectra," *Geophys.Res.Let.* **11,** 307-310 (1984); A. Goldman and J.R. Gillis, "Line Parameters and Line-by-line Calculations for Molecules of Stratospheric Interest," Progress Report, Dept. of Physics, Univ. Denver (1984).
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5. A. Perrin, J. Vander Auwera, and Z. Zelinger, "High-resolution Fourier transform study of the ν_3 fundamental band of *trans*-formic acid," *JQSRT* **110,** 743-755 (2009).

Half-widths (air)

1. A. Goldman and J.R. Gillis, "Line Parameters and Line-by-line Calculations for Molecules of Stratospheric Interest," Progress Report, Dept. of Physics, Univ. Denver (1984).
2. A. Perrin and J. Vander Auwera, "An improved database for the 9 μm region of the formic acid spectrum," *JQSRT* **108,** 363-370 (2007).

Half-widths (self)

1. A. Perrin, C.P. Rinsland, and A. Goldman, "Spectral parameters for the ν_6 region of HCOOH and its measurement in the infrared tropospheric spectrum," *J.Geophys.Res.* **104,** 18,661-18,666

(1999).
2. A. Perrin and J. Vander Auwera, "An improved database for the 9 μm region of the formic acid spectrum," *JQSRT* **108,** 363-370 (2007). Note that the value takes into account the contribution from the dimer.

Temperature dependence of air-broadened half-width

1. A. Goldman, private communication (1996).

HO_2 [33] 166

Positions

1. C. Yamada, Y. Endo, and E. Hirota, "Difference frequency laser spectroscopy of the ν_1 band of the HO_2 radical," *J.Chem.Phys.* **78,** 4379-4384 (1983).
2. K. Nagai, Y. Endo, and E. Hirota, "Diode Laser Spectroscopy of the HO_2 ν_2 Band," *J.Mol.Spectrosc.* **89,** 520-527 (1981).
3. D.D. Nelson, Jr., and M.S. Zahniser, "Diode Laser Spectroscopy of the ν_3 Vibration of the HO_2 Radical," *J.Mol.Spectrosc.* **150,** 527-534 (1991).
4. K. Chance, K.W. Jucks, D.G. Johnson, and W.A. Traub, "The Smithsonian Astrophysical Observatory Database SAO92," *JQSRT* **52,** 447-457 (1994).

Intensities

1. M.S. Zahniser, K.E. McCurdy, and A.C. Stanton, "Quantitative Spectroscopic Studies of the HO_2 Radical: Band Strength Measurements for the ν_1 and ν_2 Vibrational Bands," *J.Phys.Chem.* **93,** 1065-1070 (1989).
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Half-widths (air)

1. D.D. Nelson and M.S. Zahniser "Air broadening measurements for the ν_2 vibrational band of the hydroperoxyl radical," *J.Mol.Spectrosc.* **166,** 273-279 (1994).
2. K. Chance, K.W. Jucks, D.G. Johnson, and W.A. Traub, "The Smithsonian Astrophysical Observatory Database SAO92," *JQSRT* **52,** 447-457 (1994).

O [34] 6

Positions

1. L.R. Zink, K.M. Evenson, F. Matsushima, T. Nelis, and R. L. Robinson, "Atomic oxygen fine-structure splittings with tunable far-infrared spectroscopy," *Astrophys.J.* **371,** L85-L86 (1991).

Intensities

1. H.M. Pickett, R.L. Poynter, E.A. Cohen, M.L. Delitsky, J.C. Pearson, and H.S.P. Müller, "Submillimeter, Millimeter, and Microwave Spectral Line Catalog," JPL Publication 800-23, rev. 4 (1996).

Half-widths (air)

1. Does not have the standard HITRAN definition of Lorentz air broadening, but a default value of 0.05 cm^{-1}/atm was appended.

$ClONO_2$ [35] 5646, 7646

Positions

1. W. Bell, G. Duxbury, and D.D. Stuart, "High-Resolution Spectra of the ν_4 Band of Chlorine Nitrate," *J.Mol.Spectrosc.* **152,** 283-297 (1992); A. Goldman, C.P. Rinsland, F.J. Murcray, R.D. Blatherwick, and D.G. Murcray, "High Resolution Studies of Heavy NOy Molecules in Atmospheric Spectra," *JQSRT* **52,** 367-377 (1994).

Intensities

1. A. Goldman, C.P. Rinsland, F.J. Murcray, R.D. Blatherwick, and D.G. Murcray, "High Resolution Studies of Heavy NOy Molecules in Atmospheric Spectra," *JQSRT* **52,** 367-377 (1994).

Half-widths (air)

1. A. Goldman, C.P. Rinsland, F.J. Murcray, R.D. Blatherwick, and D.G. Murcray, "High Resolution Studies of Heavy NOy Molecules in Atmospheric Spectra," *JQSRT* **52,** 367-377 (1994).

NO^+ [36] 46

Positions

1. Positions based on a fit by D.R. Smith, AF Phillips Lab, using data of F.P. Billingsley, *Chem.Phys.Lett.* **23,** 160-166 (1973), K.P. Huber and G. Herzberg, "Molecular Spectra and Molecular Structure IV. Constants of Diatomic Molecules," Van Nostrand Reinhold Co., NY (1979), and D.R. Smith, E.R. Huppi, and R.M. Nadile, "Improved Rotational Constants for the Ground Electronic State of NO^+ from Atmospheric Emission Spectra," private communication; D.R. Smith, E.R. Huppi, and J.O. Wise, "Observation of highly rotationally excited NO^+ emissions in the themosphere," *J.Atmos.Solar-Terrestrial Phys.* **62,** 1189-1198 (2000).

2. Positions based on a fit by I. Gordon (2006), using data of W.C. Ho, I. Ozier, D.T. Cramb, and M.C.L. Gerry, "Diode Laser Spectroscopy of the Vibrational Fundamental of NO^+," *J.Mol.Spectrosc.* **149,** 559-561 (1991); G. Hilpert, H. Linnartz, M. Havenith, J.J. ter Meulen, and W.L. Meerts, "Tunable infrared and far-infrared direct absorption spectroscopy of molecular ions in a supersonic jet expansion," *Chem.Phys.Letters*. **219**, 384-388 (1994); M. López-Puertas, J.-M. Flaud, J. Peralta-Calvillo, B. Funke, and S. Gil-López, "NO^+ fundamental and first hot ro-vibrational line frequencies from MIPAS/Envisat atmospheric spectra," *J.Mol.Spectrosc.* **237,** 218-224 (2006); W.C. Bowman, E. Herbst, and F.C. De Lucia, "Millimeter and submillimeter spectrum of NO^+," *J.Chem.Phys.* **77,** 4261–4262 (1982); E. Miescher, "Rotationsanalyse der NO^+-banden,"*Helv.Phys.Acta* **29,** 135–144 (1956).

Intensities

1. H.-J. Werner and P. Rosmus, "Ab Initio Calculations of Radiative Transition Probabilities in the $X^1\Sigma^+$ Ground State of the NO^+ Ion," *J.Mol.Spectrosc.* **96,** 362-367 (1982).

Half-widths (air)

1. Default value of 0.06 cm^{-1}/atm chosen, but applications are most likely not required to work in Lorentzian regime.

HOBr [37] 169, 161

Positions

1. E.A. Cohen, G.A. McRae, T.L. Tan, R.R. Friedl, J.W.C. Johns, and N. Noël, "The ν_1 Band of HOBr," *J.Mol.Spectrosc.* **173,** 55-61 (1995).

Intensities

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Half-widths (air)

1. A constant value of 0.06 cm^{-1}/atm has been assumed for the air-broadened halfwidth with a temperature-dependence coefficient $n = 0.67$.

C_2H_4 [38] 221, 231

Positions

1. I. Cauuet, J. Walrand, G. Blanquet, A. Valentin, L. Henry, Ch. Lambeau, M. DeVleeschouwer, and A. Fayt, "Extension to Third-Order Coriolis Terms of the Analysis of ν_{10}, ν_7, and ν_4 Levels of Ethylene on the Basis of Fourier Transform and Diode Laser Spectra," *J.Mol.Spectrosc.* **139,** 191-214 (1990); J. Legrand, M. Azizi, F. Herlemont, and A. Fayt, "Saturation Spectroscopy of C_2H_4 Using a CO_2 Laser Sideband Spectrometer," *J.Mol.Spectrosc.* **171,** 13-21 (1995); E. Rusinek, H. Fichoux, M. Khelkhal, F. Herlemont, J. Legrand, and A. Fayt, "Subdoppler study of the ν_7 band of C_2H_4 with a CO_2 Laser Sideband Spectrometer," *J.Mol.Spectrosc.* 189, 64-73 (1998).
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3. M. Rotger, V. Boudon, and J. Vander Auwera, "Line positions and intensities in the ν_{12} band of ethylene near 1450 cm^{-1}: An experimental and theoretical study," *JQSRT* **109**, 952-962 (2008).

Intensities

1. I. Cauuet, J. Walrand, G. Blanquet, A. Valentin, L. Henry, Ch. Lambeau, M. DeVleeschouwer, and A. Fayt, "Extension to Third-Order Coriolis Terms of the Analysis of ν_{10}, ν_7, and ν_4 Levels of Ethylene on the Basis of Fourier Transform and Diode Laser Spectra," *J.Mol.Spectrosc.* **139,** 191-214 (1990); W.E. Blass, L. Jennings, A.C. Ewing, S.J. Daunt, M.C. Weber, L. Senesac, S. Hager, J.J. Hillman, D.C. Reuter, and J.M. Sirota, "Absolute intensities in the ν_7 band of ethylene: tunable laser measurements used to calibrate FTS broadband spectra," *JQSRT* **68,** 467-472 (2001).
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Half-widths (air)

1. J.F. Brannon, Jr. and P. Varanasi, "Tunable Diode Laser Measurements on the 951.7393 cm^{-1} Line of $^{12}C_2H_4$ at Planetary Atmospheric Temperatures," *JQSRT* **47,** 237-242 (1992).
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Half-widths (self)

1. M. Rotger, V. Boudon, and J. Vander Auwera, "Line positions and intensities in the ν_{12} band of ethylene near 1450 cm^{-1}: An experimental and theoretical study," *JQSRT* **109**, 952-962 (2008).

Temperature dependence of air-broadened half-width

1. J.F. Brannon, Jr. and P. Varanasi, "Tunable Diode Laser Measurements on the 951.7393 cm^{-1} Line of $^{12}C_2H_4$ at Planetary Atmospheric Temperatures," *JQSRT* **47,** 237-242 (1992).

CH_3OH [39] 2161

Positions

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Intensities

1. L.H. Xu, R.M. Lees, P. Wang, L.R. Brown, I. Kleiner, and J.W.C. Johns, "New assignments, line intensities and HITRAN database for CH_3OH at 10 μm," *J.Mol.Spectrosc.* **228,** 453-470 (2004).

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Half-widths (air)

1. L.H. Xu, R.M. Lees, P. Wang, L.R. Brown, I. Kleiner, and J.W.C. Johns, "New assignments, line intensities and HITRAN database for CH_3OH at 10 μm," *J.Mol.Spectrosc.* **228,** 453-470 (2004).

Half-widths (self)

1. L.H. Xu, R.M. Lees, P. Wang, L.R. Brown, I. Kleiner, and J.W.C. Johns, "New assignments, line intensities and HITRAN database for CH_3OH at 10 μm," *J.Mol.Spectrosc.* **228,** 453-470 (2004).

Temperature dependence of air-broadened half-width

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CH_3Br [40] 219, 211

Positions

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Halfwidths (air)

1. D. Jacquemart, F. Kwabia Tchana, N. Lacome, and I. Kleiner, "A complete set of line parameters for CH_3Br in the 10-μm spectral region," *JQSRT* **105**, 264-302 (2007).

Halfwidths (self)

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Temperature dependence of air-broadened half-width

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CH_3CN [41] 2124

Positions

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Intensities

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Halfwidths (air)

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Halfwidths (self)

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Temperature dependence of air-broadened half-width

1. C.P. Rinsland, V. Malathy Devi, D. Chris Benner, T.A. Blake, R.L. Sams, L.R. Brown, I. Kleiner, A. Dehayem-Kamadjeu, H.S.P. Müller, R.R. Gamache, D.L. Niles, and T. Masiello, "Multispectrum analysis of the ν_4 band of CH_3CN: Positions, intensities, self- and N_2-broadening, and pressure-induced shifts," *JQSRT* **109**, 974-994 (2008).

Shifts

1. C.P. Rinsland, V. Malathy Devi, D. Chris Benner, T.A. Blake, R.L. Sams, L.R. Brown, I. Kleiner, A. Dehayem-Kamadjeu, H.S.P. Müller, R.R. Gamache, D.L. Niles, and T. Masiello, "Multispectrum analysis of the ν_4 band of CH_3CN: Positions, intensities, self- and N_2-broadening, and pressure-induced shifts," *JQSRT* **109**, 974-994 (2008).

CF_4 [42] 29

Positions
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Intensities
1. V. Boudon, Université de Bourgogne, private communication (2008).

Half-widths (air)
1. S. Höjer and R.D. May, "Air-Broadening Coefficients for the ν_3 Band of CF_4," *J.Mol.Spectrosc.* **178**, 139-142 (1996).

Half-widths (self)
1. Estimate (0.08 $cm^{-1}atm^{-1}$).

Temperature dependence of air-broadened half-width
1. S. Höjer and R.D. May, "Air-Broadening Coefficients for the ν_3 Band of CF_4," *J.Mol.Spectrosc.* **178**, 139-142 (1996).

CS [46] 22, 23, 24, 32

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Half-widths (air)

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Half-widths (self)

1. F. Misago, M. Lepère, J.-P. Bouanich, and G. Blanquet, "Self-broadening Coefficients in the ν_3-ν_1 Band of CS_2," *J.Mol.Spectrosc.* **254,** 16-19 (2009). (Estimate obtained from extrapolating CS nitrogen-broadening parameters from CS_2-nitrogen broadening parameters by comparing CO to CO_2 self-broadening parameters found in the HITRAN2008 database.)

Temperature dependence of air-broadened half-width

1. Default value of 0.75 chosen.

** Cross-section files **

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12. K. Smith, D. Newnham, M. Page, J. Ballard, and G. Duxbury, "Infrared Absorption Cross-sections and Integrated Absorption Intensities of HCF-134 and HCF-143a Vapour," *JQSRT* **59,** 437-451 (1998).

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Transform measurements of SO_2 absorption cross sections: II. Temperature dependence in the 29 000 – 44 000 cm^{-1} (227-345 nm) region," *JQSRT* **110,** 2115-2126 (2009).
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** Collision Induced Absorption (CIA) files **

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Molecules and isotopologues in line-by-line portion of HITRAN

Molecule Number	Molecule	Isotopologue (AFGL notation)	Fractional Abundance	Spectral Coverage (cm^{-1})	Number of lines	Total number
1	H_2O	161	0.9973	0 – 25233	37432	69201
		181	$1.999\ 10^{-3}$	0 – 14519	9753	
		171	$3.719\ 10^{-4}$	10 – 14473	6992	
		162	$3.107\ 10^{-4}$	0 – 22708	13238	
		182	$6.230\ 10^{-7}$	0 – 3825	1611	
		172	$1.158\ 10^{-7}$	1234 – 1599	175	
2	CO_2	626	0.9842	352 – 12785	128170	314919
		636	$1.106\ 10^{-2}$	438 – 12463	49777	
		628	$3.947\ 10^{-3}$	0 – 11423	79958	
		627	$7.339\ 10^{-4}$	0 – 8271	19264	
		638	$4.434\ 10^{-5}$	489 – 6745	26737	
		637	$8.246\ 10^{-6}$	583 – 6769	2953	
		828	$3.957\ 10^{-6}$	491 – 8161	7118	
		827	$1.472\ 10^{-6}$	626 – 5047	821	
		838	$4.446\ 10^{-8}$	4599 – 4888	121	
3	O_3	666	0.9929	0 – 5787	249456	409686
		668	$3.982\ 10^{-3}$	0 – 2768	44302	
		686	$1.991\ 10^{-3}$	1 – 2740	18887	
		667	$7.405\ 10^{-4}$	0 – 2122	65106	
		676	$3.702\ 10^{-4}$	0 – 2101	31935	
4	N_2O	446	0.9903	0 – 7797	33074	47843
		456	$3.641\ 10^{-3}$	5 – 5086	4222	
		546	$3.641\ 10^{-3}$	4 – 4704	4592	
		448	$1.986\ 10^{-3}$	542 – 4672	4250	
		447	$3.693\ 10^{-4}$	550 – 4430	1705	
5	CO	26	0.9865	3 – 8465	917	4477
		36	$1.108\ 10^{-2}$	3 – 6279	780	
		28	$1.978\ 10^{-3}$	3 – 6267	760	
		27	$3.679\ 10^{-4}$	3 – 6339	728	
		38	$2.222\ 10^{-5}$	3 – 6124	712	
		37	$4.133\ 10^{-6}$	1807 – 6197	580	
6	CH_4	211	0.9883	0 – 9200	212061	290091
		311	$1.110\ 10^{-2}$	0 – 6070	28793	
		212	$6.158\ 10^{-4}$	7 – 6511	45024	
		312	$6.918\ 10^{-6}$	959 – 1695	4213	
7	O_2	66	0.9953	0 – 15928	1431	6430
		68	$3.991\ 10^{-3}$	1 – 15852	674	
		67	$7.422\ 10^{-4}$	0 – 14537	4325	

Molecule Number	Molecule	Isotopologue (AFGL notation)	Fractional Abundance	Spectral Coverage (cm^{-1})	Number of lines	Total number
8	NO	46	0.9940	0 – 9274	103701	105079
		56	$3.654\ 10^{-3}$	1609 – 2061	699	
		48	$1.993\ 10^{-3}$	1602 – 2039	679	
9	SO_2	626	0.9457	0 – 4093	72460	95121
		646	$4.195\ 10^{-2}$	0 – 2501	22661	
10	NO_2	646	0.9916	0 – 3075	104223	104223
11	NH_3	446	0.9959	0 – 5295	27994	29084
		456	$3.661\ 10^{-3}$	0 – 5180	1090	
12	HNO_3	146	0.9891	0 – 1770	487254	487254
13	OH	61	0.9975	0 – 19268	30769	31976
		81	$2.000\ 10^{-3}$	0 – 329	295	
		62	$1.554\ 10^{-4}$	0 – 332	912	
14	HF	19	0.9998	41 – 11536	107	107
15	HCl	15	0.7576	20 – 13459	324	613
		17	0.2422	20 – 10995	289	
16	HBr	19	0.5068	16 – 9759	651	1293
		11	0.4931	16 – 9758	642	
17	HI	17	0.9998	12 – 8488	806	806
18	ClO	56	0.7559	0 – 1208	5721	11501
		76	0.2417	0 – 1200	5780	
19	OCS	622	0.9374	0 – 4200	15618	29361
		624	$4.158\ 10^{-2}$	0 – 4166	6087	
		632	$1.053\ 10^{-2}$	0 – 4056	3129	
		623	$7.399\ 10^{-3}$	0 – 4164	2886	
		822	$1.880\ 10^{-3}$	0 – 4046	1641	
20	H_2CO	126	0.9862	0 – 3100	36120	37050
		136	$1.108\ 10^{-2}$	0 – 73	563	
		128	$1.978\ 10^{-3}$	0 – 48	367	
21	HOCl	165	0.7558	1 – 3800	8877	16276
		167	0.2417	1 – 3800	7399	
22	N_2	44	0.9927	1992 – 2626	120	120
23	HCN	124	0.9851	0 – 3424	2955	4253
		134	$1.107\ 10^{-2}$	2 – 3405	652	
		125	$3.622\ 10^{-3}$	2 – 3420	646	
24	CH_3Cl	215	0.7489	0 – 3173	100293	196220
		217	0.2395	0 – 3162	95927	
25	H_2O_2	1661	0.9950	0 – 1731	126983	126983
26	C_2H_2	1221	0.9776	604 – 9890	11055	11340
		1231	$2.197\ 10^{-2}$	613 – 6589	285	

Molecule Number	Molecule	Isotopologue (AFGL notation)	Fractional Abundance	Spectral Coverage (cm^{-1})	Number of lines	Total number
27	C_2H_6	1221	0.9770	706 – 3001	28439	28439
28	PH_3	1111	0.9995	770 – 3602	20099	20099
29	COF_2	269	0.9865	725 – 2002	70601	70601
30	**SF_6**	**29**	**0.9502**	**580 – 996**	**2889065**	**2889065**
31	H_2S	121 141 131	0.9499 $4.214\ 10^{-2}$ $7.498\ 10^{-3}$	2 – 4257 5 – 4172 5 – 4099	12330 4894 3564	20788
32	HCOOH	126	0.9839	10 – 1890	62684	62684
33	HO_2	166	0.9951	0 – 3676	38804	38804
34	O	6	0.9976	68 – 159	2	2
35	**$ClONO_2$**	**5646** **7646**	**0.7496** **0.2397**	**763 – 798** **765 – 791**	**21988** **10211**	**32199**
36	NO^+	46	0.9940	1634 – 2531	1206	1206
37	HOBr	169 161	0.5056 0.4919	0 – 316 0 – 316	2177 2181	4358
38	C_2H_4	221 231	0.9773 $2.196\ 10^{-2}$	701 – 3243 2947 – 3181	18097 281	18378
39	CH_3OH	2161	0.9859	0 – 1408	19897	19897
40	CH_3Br	219 211	0.5010 0.4874	794 – 1706 796 – 1697	18692 18219	36911
41	CH_3CN	2124	0.9739	890 – 946	3572	3572
42	**CF_4**	**29**	**0.9889**	**594 – 1313**	**60033**	**60033**

Note: Rows highlighted in pink are for molecules that have been relegated to a sub-folder since they do not have sufficient hot bands included.

Uncertainty Codes used in HITRAN Database

Line position and Pressure shift (cm^{-1})		Intensity, Halfwidths, and Temperature-dependence	
Code	**Uncertainty Range**	**Code**	**Uncertainty Range**
0	≥1. or Unreported	0	Unreported or Unavailable
1	≥0.1 and <1.	1	Default or Constant
2	≥0.01 and <0.1	2	Average or Estimate
3	≥0.001 and <0.01	3	≥ 20%
4	≥0.0001 and <0.001	4	≥ 10% and < 20%
5	≥0.00001 and <0.0001	5	≥ 5% and < 10%
6	≥0.000001 and <0.00001	6	≥ 2% and < 5%
7	≥0.0000001 and <0.000001	7	≥ 1% and < 2%
8	≥0.00000001 and <0.0000001	8	< 1%
9	≥0.000000001		