

Curriculum Vitae

Keeyoon Sung, Ph.D

Research Interests

- (1) Laboratory study on Molecular spectroscopy in the infrared (for CO, CO₂, CH₄, NH₃, C₂H₆, OCS, and their isotopologs, etc.), which includes (a) Retrieval of spectroscopic line parameters through non-linear multispectrum fitting technique, (b) Pseudoline generation to reproduce temperature-dependent cross sections for hydrocarbons and nitriles, and (c) Development and validation of spectral line shape models including collisional line mixing effect and collisional induced absorption.
- (2) Atmospheric remote sensing using a MK-IV (ground-based and air-borne FT-IR)
- (3) Mass spectrum analysis for isotopic abundance characterization using IRMS

Education

Ph.D. in Atmospheric Sciences, ITPA/MSRC, SUNY at Stony Brook, NY (2003)
M.Sc. course completion in Astronomy, Seoul National Univ. Seoul, Korea (1998)
B.Sc. in Astron. & Space Sci., Chungnam Nat'l Univ. Daejeon, Korea (1996)
B.A. in English Education, Seoul National Univ. Seoul, Korea (1990)

Projects and tasks

[High Resolution Infrared Spectroscopy on Earth and Planetary Science \(Being PI on multiple projects\)](http://scienceandtechnology.jpl.nasa.gov/research/facilities/spectroscopy/)
(<http://scienceandtechnology.jpl.nasa.gov/research/facilities/spectroscopy/>)

This effort supports atmospheric remote sensing of the Earth, our Solar System (planets, moons and comets) and other astronomical bodies (such as cool brown dwarfs and exoplanets).

[Earth Atmospheric Remote Sensing with MK-IV](http://mark4sun.jpl.nasa.gov/)

(<http://mark4sun.jpl.nasa.gov/>)

Mark IV interferometer team uses a mid-infrared Fourier transform interferometer to monitor atmospheric composition changes using the Sun as a source. The Mark IV interferometer can be deployed in a stratospheric balloon gondola, on aircraft as well as on the ground-based sites.

[ABSCO/OCO-2 & 3 \(Orbiting Carbon Observatory\)](http://oco.jpl.nasa.gov/)

(<http://oco.jpl.nasa.gov/>)

The Orbiting Carbon Observatory-2 (OCO-2) is a mission designed to make precise, time-dependent global measurements of atmospheric carbon dioxide (CO₂) from an Earth orbiting satellite in search of their sinks and sources.

Professional Experience

Research scientist, Science Division, JPL/Caltech (2010 - present)
Caltech post-doc fellow, JPL/Caltech (2007 - 2010)
Post-doc fellow, Univ. of Toronto and Univ. of Waterloo (2003 - 2007)

NASA, JPL Honor/Awards/Recognition

Voyager award for proposal successes and quality research in the planetary science (2018)
Group Award to OCO-2 Algorithm Team (2016)
Group Achievement Award to Stratosphere Atmospheric Measurement Team (2015)
Group Award for OCO-2 Algorithm Development (2014)
Group Award to OCO-2 Science Implementation Team (2012)

Community services (Journal review, Contributor, Outreach)

Reviewer to J. Quant. Spectrosc. Radiat. Transfer, Nature, IEEE, Mol. Phys., J. Mol. Spectrosc., J. Geophys. Res., J. Chem. Phys., Can. J. Phys., Astron. Phys. J., etc.
NASA-ROSES proposal review (2016, 2017, 2019)

NASA SBIR/STTR proposal review (2009 – 2015)
NASA Astro 2020 Science White Paper (2019)
NASA Science Museum Alliance (2016 – present)
(<https://informal.jpl.nasa.gov/museum/>)

Selected Publications (out of 85 and counting)

- K. Sung**, E.H. Wishnow, T.J. Crawford, et al. *FTS measurements of O₂ collision-induced absorption in the 565–700 nm region using a high pressure gas absorption cell*, *J.Quant. Spectrosc. Radiat. Transfer*, 235, 232-243 (2019).
- D.W. Savin, et al. *Astro 2020 Science White Paper, State of the Profession Considerations for Laboratory Astrophysics*. National Academy of Science (2019)
- J. Fortney et al. *Astro 2020 Science White Paper, The Need for Laboratory Measurements and Ab Initio Studies to Aid Understanding of Exoplanetary Atmospheres*, National Academy of Science (2019)
- T. Karman, I.E. Gordon, ..., **K. Sung**, et al. *Update of the HITRAN collision-induced absorption section*, *J.Quant. Spectrosc. Radiat. Transfer*, 328, 160-175 (2019)
- E. Starikova, **K. Sung**, A.V. Nikitin, M. Rey. *Assignment and modeling of the 13CH₄ cold absorption spectrum in the 5471–5852 cm⁻¹ spectral range*. *J.Quant. Spectrosc. Radiat. Transfer*, <https://doi.org/10.1016/j.jqsrt.2019.06.002>
- N. Lombardo, C.A. Nixon, R. Achterberg, ..., **K. Sung**, et al. *Spatial and seasonal variations in C₃H_x hydrocarbon abundance in Titan's stratosphere from Cassini CIRS observations*. *Icarus* 317: 454-469 (2019).
- A. Nikitin, X. Thomas, L. Daumont, ..., **K. Sung**, et al. *Assignment and modelling of (CH₄)-C-12 spectra in the 5550-5695, 5718-5725 and 5792-5814 cm⁻¹ regions*. *J.Quant. Spectrosc. Radiat. Transfer*, 219: 323-332 (2018).
- V.M. Devi, D.C. Benner, **K. Sung**, et al. *Positions, intensities and line shape parameters for the 1 <- 0 bands of CO isotopologues*. *J.Quant. Spectrosc. Radiat. Transfer*, 218, 203-230 (2018).
- K. Sung**, G.C. Toon, B.J. Drouin, et al. *FT-IR measurements of cold propene (C₃H₆) cross-sections at temperatures between 150 and 299 K*. *J.Quant. Spectrosc. Radiat. Transfer*, 213, 119-132 (2018).
- G.C. Toon, J-F. Blavier, **K. Sung**. *Measurements of atmospheric ethene by solar absorption FTIR spectrometry*. *Atmos. Chem. Phys.* 18, 1 – 14 (2018). <https://doi.org/10.5194/acp-18-1-2018>
- E. Starikova, **K. Sung**, A.V. Nikitin, et al. *The ¹³CH₄ in the lower part of the Tetradecad at 80 K: Assignment and modeling*. *J.Quant. Spectrosc. Radiat. Transfer*, 206, 306-312 (2018).
- D. Jacquemart, **K. Sung**, M. Coleman, et al. *Measurements and modeling of (OCO)-O-16-C-12-O-17 spectroscopic parameters at 2 μm*. *J.Quant. Spectrosc. Radiat. Transfer*, 203: 249-264, (2017). doi: 10.1016/j.jqsrt.2017.03.002
- I.E. Gordon, L.S. Rothman, et al. *The HITRAN 2016 molecular spectroscopic database*. *J.Quant. Spectrosc. Radiat. Transfer*, 203, 3 – 69 (2017).
- O. Fabiano, V.H. Payne, ..., **K. Sung**, et al. *High accuracy absorption coefficients for the Orbiting Carbon Observatory-2 (OCO-2) mission: Validation of updated carbon dioxide cross-sections using atmospheric spectra*. *J.Quant. Spectrosc. Radiat. Transfer* 203, 213-223 (2017).
- A.V. Nikitin, X. Thomas, Daumont L, Rey M, **K. Sung**, G.C. Toon, Smith MAH, et al. *Measurements and modeling of long-path ¹²CH₄ spectra in the 5300–5550 cm⁻¹ region*. *J.Quant. Spectrosc. Radiat. Transfer*, 202, 255-264 (2017).
- V.M. Devi, D.C. D.C. Benner, **K. Sung**, et al. *Line parameters for CO₂ broadening in the ν₃ band of HD¹⁶O*. *J.Quant. Spectrosc. Radiat. Transfer*, 203, 158-174 (2017).
- J. Mendonca, K. Strong, **K. Sung**, V.M. Devi, et al. *Using high-resolution laboratory and ground-based solar spectra to assess CH₄ absorption coefficient calculations*. *J.Quant. Spectrosc. Radiat. Transfer*, 190, 48-59 (2017).
- B.J. Drouin, D.C. Benner, L.R. Brown, et al. *Multispectrum analysis of the oxygen A-band*. *J.Quant. Spectrosc. Radiat. Transfer*, 186, 118 – 138, (2017).

- G.C. Toon, J.-F. Blavier, **K. Sung**, et al. *HITRAN spectroscopy evaluation using solar occultation FTIR spectra*. J. Quant. Spectrosc. Radiat. Transfer, 182, 324 – 336 (2016).
- K. Sung**, S. Yu, J. Pearson, et al. *Far-infrared 14NH₃ line positions and intensities measured with a FT-IR and AILES beamline, Synchrotron SOLEIL*. J. MOL. SPECTROSC., 327, 1 – 20 (2016).
- N. Jacquinet-Husson, R. Armante, N.A. Scott, et al. *The 2015 edition of the GEISA spectroscopic database*. J. MOL. SPECTROSC., 327, 31 – 72 (2016).
- T. Delahaye, S. E. Maxwell, Z. D. Reed, H. Lin, J. T. Hodges, **K. Sung**, et al. *Precise methane absorption measurements in the 1.64 μm spectral region for the MERLIN mission*. JGR, Atmos., 121, 7360–7370, doi:10.1002/2016JD025024.
- V. M. Devi, D. C. Benner, **K. Sung**, L.R. Brown, et al. *Line parameters including temperature dependences of air- and self-broadened line shapes of $^{12}\text{C}^{16}\text{O}_2$: 1.6 μm region*. J. Quant. Spectrosc. Radiat. Transfer, 177, 117 – 144 (2016).
- D.C. Benner, V.M. Devi, **K. Sung**, L.R. Brown, et al. *Line parameters including temperature dependences of air- and self-broadened line shapes of $^{12}\text{C}^{16}\text{O}_2$: 2.06 μm region*. J. MOL. SPECTROSC., 326, 21 – 47 (2016).
- L. R. Brown, A.V. Nikitin, **K. Sung**, M. Rey, S.A. Tashkun, et al. *Measurements and modeling of cold $^{13}\text{CH}_4$ spectra in the 3750–4700 cm^{-1} region*. J. Quant. Spectrosc. Radiat. Transfer, 174, 88 – 100 (2016).
- K. Sung**, G.C. Toon, T.J. Crawford. *N_2 - and (H_2+He) -broadened cross sections of benzene (C_6H_6) in the 7 - 15 μm region for the Titan and jovian atmospheres*. Icarus, 271, 438 0 452 (2016). Erratum. Icarus, 281, 476 – 476 (2017).
- A.M. Daly, B.J. Drouin, J.C. Pearson, P. Groner, **K. Sung**, L.R. Brown, et al. *The ν_7 band of $\text{CH}_3\text{CH}_2\text{D}$ from 770-850 cm^{-1}* . J. Mol. Spectrosc., 316, 1 – 10 (2015).
- V. M. Devi, D. C. Benner, **K. Sung**, et al. *Self- and Air-broadened Line Shapes in the $2\nu_3$ P and R Branches of $^{12}\text{CH}_4$* . J. MOL. SPECTROSC., 315, 114 – 136 (2015).
- B.M. Elliott, **K. Sung**, C.E. Miller. *FT-IR spectra of ^{18}O -, and ^{13}C -enriched CO_2 in the ν_3 region: High accuracy-frequency calibration and spectroscopic constants for $^{16}\text{O}^{12}\text{C}^{18}\text{O}$, $^{18}\text{O}^{12}\text{C}^{18}\text{O}$, and $^{16}\text{O}^{13}\text{C}^{16}\text{O}$* . J. Mol. Spectrosc. 312, 78 – 86 (2015).
- V.M. Devi, D.C. Benner, M.A.H. Smith, A.W. Mantz, **K. Sung**, et al. *Self- and air-broadened line shape parameters in the $\nu_2+\nu_3$ band of $^{12}\text{CH}_4$: 4500 – 4630 cm^{-1}* , J. Quant. Spectrosc. Radiat. Transfer, 152: 149 – 165 (2015).
- N. Moazzen-Ahmadi, J.N. Oliaee, I. Ozier, E.H. Wishnow, **K. Sung**, et al. *An intensity study of the torsional bands of ethane at 35 μm* . J. Quant. Spectrosc. Radiat. Transfer, 151, 123 – 132 (2015).
- A.W. Mantz, **K. Sung**, LR Brown, Crawford TJ, MAH Smith, VM Devi, DC Benner. *A cryogenic Herriott cell vacuum-coupled to a Bruker IFS-125HR*. J. Mol. Spectrosc. 304, 12 – 14 (2014).
- C. di Lauro, F. Lattanzi, L.R. Brown, **K. Sung**, A.W. Mantz, M.A.H. Smith. *The ν_4 , ν_9 , ν_{10} and $\nu_6+\nu_{11}$ bands of $^{12}\text{CH}_3^{13}\text{CH}_3$ between 1345 and 1557 cm^{-1}* . J. Mol. Spectrosc. 302, 36 – 49 (2014).
- V.M. Devi, D.C. Benner, **K. Sung**, et al. *Line Positions and Intensities for the ν_{12} band of $^{13}\text{C}^{12}\text{CH}_6$* , J. Mol. Spectrosc. 301, 28 – 38 (2014).
- C.A. Nixon, D.E. Jennings, B. Bézard, S. Vinatier, N.A. Teanby, **K. Sung**, et al. *Detection of propene in Titan's atmosphere*, Astrophys. J. Lett. 776, L14 (2013).
- K. Sung**, G.C. Toon, A.W. Mantz, M.A.H. Smith. *FT-IR measurements of cold C_3H_8 cross sections at 7 - 15 μm for Titan atmosphere*. Icarus, 226, 1499 – 1513 (2013).
- L.R. Brown, **K. Sung**, D.C. Benner, V.M. Devi, et al., *Methane line parameters in the HITRAN 2012 database*, J. Quant. Spectrosc. Radiat. Transfer 130, 201 – 219 (2013).
- L.S. Rothman, I.E. Gordon, ..., **K. Sung**, et al. *The HITRAN 2012 Molecular Spectroscopic Database*, J. Quant. Spectrosc. Radiat. Transfer 130, 4 – 50 (2013).
- A.V. Nikitin, L.R. Brown, M. Rey, VI.G. Tyuterev, **K. Sung**, et al. *Preliminary modeling of CH_3D from 4000 to 4550 cm^{-1}* . J. Quant. Spectrosc. Radiat. Transfer 114, 1 – 12 (2013).
- K. Sung**, L.R. Brown, X. Huang, D.M. Schwenke, S.L. Coy, K.K. Lehmann. *Extended line positions, intensities, empirical lower state energies and quantum assignments of NH_3 from 6300 to 7000 cm^{-1}* . J. Quant. Spectrosc. Radiat. Transfer, 113, 1066 – 1183 (2012)

- G. Anglada-Escude, P. Plavachan, ..., **K. Sung**, et al. *Design and Construction of Absorption Cells for Precision Radial Velocities in the K Band Using Methane Isotopologues*, Pub. Astron. Soc. Pacific, 124, 586 – 597 (2012).
- V. M. Devi, D.C. Benner, M.A.H. Smith, A.W. Mantz, **K. Sung**, et al. *Spectral line parameters including temperature dependences of self- and air-broadening in the 2 – 0 band of CO at 2.3 μm* , Journal of Quantitative Spectroscopy & Radiative Transfer, doi:10.16 j.jqsrt.2012.02.010 (2012).
- C.S. Brauer, **K. Sung**, J.P. Pearson, L.R. Brown, and L.H. Xu. *Empirical line intensities of methanol in the 300 – 500 cm^{-1} region*. J. Mol. Spectrosc., 113, 128–139 (2012).
- C. di Lauro, ..., **K. Sung**, et al., *High resolution investigation of the 7 μm region of the ethane spectrum*, Planet. Space Sci. 60, 93–101 (2012)
- N. Jacquinet-Husson, L. Crepeau, R. ..., **K. Sung**, et al. *The 2009 edition of the GEISA spectroscopic database*, J. Quant. Spectrosc. Radiat. Transfer, 112, 2395–2445 (2011).
- R.A. Toth, **K. Sung**, L.R. Brown, and T. J. Crawford. *H_2^{16}O line strengths of the ν_2 and $2\nu_2-\nu_2$ bands: Revisited*. J. Mol. Spectrosc. 265, 59 – 68 (2011).
- K. Sung**, A.W. Mantz, L.R. Brown, M.A.H. Smith, T.J. Crawford, V.M. Devi, and D.C. Benner. *Cryogenic absorption cells operating inside a Bruker IFS-125HR: first results for $^{13}\text{CH}_4$ at 7 μm* . J. Mol. Spectrosc. 262, 122- 134 (2010).
- R.A. Toth, **K. Sung**, L.R. Brown, and T.J. Crawford. *Line positions and strengths of 41 bands including 10 OCS isotopologues in the 3850 - 4200 cm^{-1} region*. J. Quant. Spectrosc. Radiat. Transfer, 111, 1193–1208 (2010).
- L.S. Rothman, I.E. Gordon, ..., **K. Sung**, et al. *The HITRAN 2008 Molecular Spectroscopic Database*. J. Quant. Spectrosc. Radiat. Transfer, 110, 533 – 572 (2009).
- K. Sung**, L.R. Brown, R.A. Toth, and T.J. Crawford, *FT-IR measurements of H_2O -broadened half-widths of CO_2 at 4.3 μm* . Canad. J. Phys. 87, 469 -484 (2009).
- K. Sung**, R.A. Toth, L.R. Brown, and T.J. Crawford. *Line strength measurements of carbonyl sulfide ($^{16}\text{O}^{12}\text{C}^{32}\text{S}$) in the $2\nu_3$, $\nu_1+2\nu_2+\nu_3$, and $4\nu_2+\nu_3$ bands*. J. Quant. Spectrosc. Radiat. Transfer, 110, 2082 – 2101 (2009).
- D. Fu, **K. Sung**, C.D. Boone, K.A. Walker, and P.F. Bernath. *Ground-based solar absorption studies for the carbon cycle science by Fourier transform spectroscopy (CC-FTS) mission*. J. Quant. Spectrosc. Radiat. Transfer, 109, 2219 – 2243 (2008).
- K. Sung**, R. Skelton, K.A. Walker, C.D. Boone, D. Fu, and P.F. Bernath. *N_2O and O_3 Arctic Column Amounts from PARIS-IR Observations: Retrievals, Characterization and Error Analysis*. J. Quant. Spectrosc. Radiat. Transfer, 107, 385 – 406 (2007).
- K. Sung** and P. Varanasi. *CO_2 -broadened half-widths and CO_2 -induced line shifts of $^{12}\text{C}^{16}\text{O}$ relevant to the atmospheric spectra of Venus and Mars*. J. Quant. Spectrosc. Radiat. Transfer, 91, 319 – 332 (2005).
- K. Sung** and P. Varanasi. *Hydrogen-broadened half-widths and hydrogen-induced line shifts of $^{12}\text{C}^{16}\text{O}$ relevant to the Jovian atmospheric spectra*. J. Quant. Spectrosc. Radiat. Transfer, 85, 165 – 182 (2004).
- K. Sung** and P. Varanasi. *Intensities, collision-broadened half-widths, and collision-induced line shifts in the second overtone band of $^{12}\text{C}^{16}\text{O}$* . J. Quant. Spectrosc. Radiat. Transfer, 83, 445 – 458 (2004).
- V. Nemtchinov, **K. Sung**, and P. Varanasi. *Measurements of line intensities and half-widths in the 10 μm bands of $^{14}\text{NH}_3$* . J. Quant. Spectrosc. Radiat. Transfer, 83, 243 – 265 (2004).
- J. L. Fox and **K. Sung**. *Solar activity variations of the Venus thermosphere/ ionosphere*. J. Geophys. Res., 106, 21305 – 21335 (2001).
- Y. H. Kim, **K. Sung**, S. J. Kim, W. D. Cochran, D. F. Lester, L. Trafton, B. E. Clark. *An analysis of infrared images of Jupiter impacted by P/Shoemaker-Levy 9*. J. Korean Astron. Soc., 29, 245 – 253 (1996).